#### PEARSON NEW INTERNATIONAL EDITION

#### **Psychology: The Science of Behavior Carlson Miller Heth** Donahoe Martin **Seventh Edition**



ALWAYS LEARNING"

# **Pearson New International Edition**

Psychology: The Science of Behavior Carlson Miller Heth Donahoe Martin Seventh Edition

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ISBN 10: 1-292-03969-8 ISBN 13: 978-1-292-03969-5

#### British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

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- **absolute threshold** The minimum value of a stimulus that can be detected.
- **accommodation** The process of altering the thickness of the lens to focus images of near or distant objects on the retina. In Piaget's theory of cognitive development, the process by which existing schemas are modified or changed by new experiences.
- acetylcholine (ACh) (a see tul koh leen) A neurotransmitter found in the brain, spinal cord, and parts of the peripheral nervous system; responsible for muscular contraction.
- **acquisition** Increase in the environmental guidance of behavior as the result of either a classical- or operant-conditioning procedure.
- **action potential** A brief electrochemical event that is carried by an axon from the soma of the neuron to its terminal buttons; causes the release of a neurotransmitter.
- activational effect (of hormone) The effect of a hormone that occurs in the fully developed organism; may depend on the organism's prior exposure to the organizational effects of hormones.
- activation-synthesis theory A theory of dreaming that explains dreams as resulting from the incidental synthesis of cortical activity produced by mechanisms in the pons.
- **actor–observer effect** Our tendency to attribute our own behavior to situational factors but others' behavior to dispositional factors.
- actual developmental level In Vygotsky's theory, the stage of cognitive development reached by a child, as demonstrated by the child's ability to solve problems on his or her own.
- actuarial judgments Diagnoses of psychological disorders or predictions of future behavior based on statistical analyses of outcome data.
- additive color mixing The perception of two or more lights of different wavelengths seen together as light of an intermediate wavelength.adenosine A product of brain metabolism; activates neurons in the preoptic area, inducing
- **agoraphobia** An anxiety disorder characterized by fear of and avoidance of being in places where escape may be difficult; this disorder often is accompanied by panic attacks.

sleep.

- **agrammatism** A language disturbance; difficulty in the production and comprehension of grammatical features, such as proper use of function words, word endings, and word order. Often seen in cases of Broca's aphasia.
- **akinetopsia** Loss of the ability to perceive movement due to damage in the visual association cortex.
- **algorithm** A procedure that consists of a series of steps that, if followed, will solve a specific type of problem.

- **all-or-none law** The principle that once an action potential is triggered in an axon, it is propagated, without becoming smaller, to the end of the axon.
- **allele** Alternative forms of the same gene for a trait. **alpha activity** Rhythmical, medium-frequency electroencephalogram activity, usually indicating a state of quiet relaxation.
- altruistic behavior Behavior benefiting another organism at an apparent cost to the individual who executes the action.
- Alzheimer's disease A fatal degenerative disease in which neurons of the brain progressively die, causing loss of memory and deterioration of other cognitive processes.
- AMPA receptor Type of receptor for the excitatory neurotransmitter glutamate, rapidly facilitates firing of the neuron.
- **amygdala** (*a mig da la*) A part of the limbic system of the brain located deep in the temporal lobe; damage causes changes in emotional and aggressive behavior.
- **anal stage** The second of Freud's psychosexual stages, during which the primary erogenous zone is the anus because of the pleasure derived from vacating a full bowel.
- analytic intelligence In Sternberg's triarchic theory, the cognitive mechanisms people use to plan and execute tasks; includes metacomponents, performance components, and knowledge-acquisition components.
- analytic processing system The basis of deliberate, abstract, and higher-order reasoning.
- anandamide (a nan da mide) The most important endogenous cannabinoid.
- anatomical coding A means by which the nervous system represents information; different features are coded by the activity of different neurons.
- androgen insensitivity syndrome A condition caused by a congenital lack of functioning androgen receptors; in a person with XY sex chromosomes, causes the development of a female with testes but no internal sex organs.
- **androgens** The primary class of sex hormones in males. The most important androgen is testosterone.
- animism The belief that all animals and all moving objects possess spirits controlling their movements and thoughts.
- **anorexia nervosa** Eating disorder characterized by severe weight loss due to reduced food intake, sometimes to the point of starvation.
- **anterograde amnesia** A condition in which a person has difficulty forming new long-term memories of events that occur after that time.
- antianxiety drugs Drugs used to treat anxietyrelated disorders, including benzodiazepines as well as some tricyclic antidepressants.

- **antibodies** Proteins in the immune system that recognize antigens and help kill invading microorganisms.
- anticipatory anxiety A fear of having a panic attack; may lead to the development of a phobia.
- **antidepressant drugs** Drugs used to treat depression, including tricyclics, monoamine oxidase inhibitors, and SSRIs.
- **antigens** The unique proteins found on the surface of bacteria; these proteins enable the immune system to recognize the bacteria as foreign substances.
- antimanic/mood-stabilizing drugs Drugs used to treat the bipolar disorders, such as lithium carbonate.
- antipsychotic drugs Drugs used to treat schizophrenic disorders.
- antisocial personality disorder A disorder characterized by a failure to conform to standards of decency; repeated lying and stealing; a failure to sustain lasting, loving relationships; low tolerance of boredom; and a complete lack of guilt.
- anxiety A sense of apprehension or doom that is accompanied by many physiological reactions, such as accelerated heart rate, sweaty palms, and tightness in the stomach.
- apoptosis (ay po toe sis) Death of a cell caused by a chemical signal that activates a genetic mechanism inside the cell.
- appeasement gesture Stereotyped gesture made by a submissive animal in response to a threat gesture by a dominant animal; tends to avert an attack.
- **archetypes** Universal thought forms and patterns that Jung believed resided in the collective unconscious.
- artificial intelligence A field of cognitive science in which researchers design computer programs to simulate human cognitive abilities; this endeavor may help cognitive psychologists understand the mechanisms that underlie these abilities.
- artificial neural networks A model of the nervous system based on interconnected networks of units that have some of the properties of neurons.
- **artificial selection** Procedure that differentially mates organisms to produce offspring with specific characteristics.
- assimilation In Piaget's theory, the process by which new information about the world is incorporated into existing schemas.
- **attachment** A social and emotional bond between infant and caregiver that spans both time and space.
- attention-deficit/hyperactivity disorder A psychological disorder with symptoms of inattention, hyperactivity, and impulsivity usually diagnosed in childhood.

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**attitude** An evaluation of a person, place, or thing. **attribution** The process by which people infer the

- causes of their own and other people's behavior. **auditory hair cell** The sensory neuron of the auditory system; located on the basilar membrane.
- autistic disorder A psychological disorder marked by symptoms of severe limitations of social interaction and communication, often accompanied by mental retardation and usually diagnosed in childhood.
- autoimmune diseases Diseases such as rheumatoid arthritis, diabetes, lupus, and multiple sclerosis, in which the immune system attacks and destroys some of the body's own tissue.
- automatic processing Forming memories of events and experiences with little or no attention or effort.
- automatic reinforcement Process in which a behavior inherently produces stimuli that function as reinforcers for that same behavior; especially important in language acquisition.
- **autonomic nervous system (ANS)** The portion of the peripheral nervous system that controls the functions of the glands and internal organs.
- **autosomes** The 22 pairs of chromosomes that are not sex chromosomes.
- availability heuristic A general rule for judging the likelihood or importance of an event by the ease with which examples of that event are recalled.
- **aversion therapy** A form of behavior therapy in which the client is trained to respond negatively to an originally attractive stimulus that has been paired with an aversive stimulus.
- avoidant attachment As observed in the Strange Situation test, a kind of attachment in which infants avoid or ignore their mothers and often do not cuddle when held.
- axon A long, thin part of a neuron attached to the soma; divides into a few or many branches, ending in terminal buttons.
- **B lymphocytes** White blood cells that develop in bone marrow and release immunoglobulins to defend the body against antigens.
- **barbiturate** A drug that causes sedation; one of several derivatives of barbituric acid.
- **basal ganglia** A group of nuclei in the brain interconnected with the cerebral cortex, thalamus and brain stem; involved in control of slow movements and movements of large muscles.
- **base-rate fallacy** The failure to consider the actual statistical likelihood that a person, place, or thing is a member of a particular category.
- **base rate neglect** In decision making, the failure to consider available information that bears on the issue at hand, such as the failure to consider the data from a control group.
- **basic orientations** Horney's sets of personality characteristics that correspond to the strategies of moving toward others, moving against others, and moving away from others.

- **basic-level concept** A concept that makes essential distinctions at an everyday level.
- **basilar membrane** (*bazz i ler*) A membrane that divides the cochlea of the inner ear into two compartments. The receptive organ for audition resides here.
- **behavior genetics** The branch of psychology that studies the role of genetics in behavior.
- **behavior modification** Behavior therapy based on the principles of operant conditioning.
- **behaviorism** A movement in psychology that asserts that the only proper subject matter for scientific study in psychology is observable behavior.
- **belief in a just world** The belief that people get what they deserve in life; a form of the fundamental attribution error.
- **benzodiazepine** (*ben zoe dy azz a peen*) A class of drug having anxiolytic ("tranquilizing") effects, such as diazepam (Valium).
- **beta activity** Irregular, high-frequency electroencephalogram activity, usually indicating a state of alertness or arousal.
- **Binet–Simon Scale** An intelligence test developed by Binet and Simon in 1905; the precursor of the Stanford–Binet Scale.
- **binocular cue** A cue for the perception of depth that requires the use of both eyes.
- **biological evolution** Changes in characteristics over successive generations due to natural selection and mutation.
- **biomedical therapies** Therapies utilized by psychiatrists and other medical practitioners to target abnormal neural functions and abnormal physiological functions more generally.
- biopsychosocial perspective An approach to psychological disorders that considers them to be result from the interaction of genetic, physiological, developmental, and environmental factors.
- **bipedalism** Habitually walking upright on two legs.
- **bipolar cell** A neuron in the retina that receives information from photoreceptors and passes it on to the ganglion cells, from which axons proceed through the optic nerves to the brain.
- **bipolar I disorder** A mood disorder in which alternating states of depression and mania are separated by periods of relatively normal affect.
- **bipolar II disorder** A mood disorder; marked by major depressive episodes that are accompanied by less severe mania (hypomanic episodes).
- **black widow spider venom** A drug that stimulates the release of acetylcholine by terminal buttons.
- **blindsight** The ability of a person who cannot perceive objects in a part of his or her visual field to reach for them accurately while remaining unaware of seeing them.
- **blocking design** Two-phase procedure in which behavior is first conditioned to one stimulus, and then a second stimulus is introduced, and conditioning continues. Behavior does

not become conditioned to the second stimulus even though it is temporally contiguous with the reinforcing stimulus.

- **blood–brain barrier** A barrier between the blood and the brain produced by the cells in the walls of the brain's capillaries; prevents some substances from passing from the blood into the brain.
- **borderline personality disorder** A disorder whose diagnostic criteria include pervasive instability of interpersonal relationships, selfimage, and emotions as well as impulsivity; suicidal efforts and self-mutilation may also occur.
- **bottom-up processing** Perception based on successive analyses of the details of the stimuli that are present.
- **botulinum toxin** (*bot you lin um*) A drug that prevents the release of acetylcholine by terminal buttons.
- **brain lesion** Damage to a particular region of the brain.
- **brain stem** The "stem" of the brain, including the medulla, pons, and midbrain.
- **brightness** A perceptual dimension of color, most closely related to the intensity or degree of radiant energy emitted by a visual stimulus.
- Broca's aphasia Severe difficulty in articulating words, especially function words, caused by brain damage that includes Broca's area, a region of the left (speech-dominated) frontal cortex.
- **bulimia nervosa** Eating disorder characterized by gorging binges followed by self-induced vomiting or use of laxatives; often accompanied by feelings of guilt and depression.
- **bystander intervention** The intervention of a person in a situation that appears to require his or her aid.
- **Cannon–Bard theory** Theory of emotion proposing that feelings of emotion, as well as behavioral and physiological responses, are directly elicited by the environment.
- **carbon dating** Method to determine the age at which an organism lived by measuring the amount of radioactive carbon (C14).
- **case study** A detailed description of an individual's behavior during the course of clinical treatment or diagnosis.
- cataplexy A symptom of narcolepsy; although awake, the individual is temporarily paralyzed.
- catatonic schizophrenia A type of schizophrenia characterized primarily by motor disturbances, including catatonic postures and waxy flexibility.
- **causal event** An event that causes another event to occur.
- **central fissure** The fissure that separates the frontal lobe from the parietal lobe
- **central nervous system (CNS)** The brain and the spinal cord.
- central traits Characteristics of the individual, which, according to Asch, have greater influence on one's impression of another person.

- **cerebellum** (*sair a bell um*) A pair of hemispheres resembling the cerebral hemispheres but much smaller and lying beneath and in back of them; controls posture and movements, especially rapid ones.
- **cerebral achromatopsia** The inability to discriminate colors; caused by damage to the visual association cortex.
- **cerebral cortex** The outer layer of the cerebral hemispheres of the brain, approximately 3 mm thick.
- **cerebral hemisphere** The largest part of the brain; covered by the cerebral cortex and containing parts of the brain that evolved most recently.
- **cerebral ventricle** One of the hollow spaces within the brain, filled with cerebrospinal fluid.
- **cerebrospinal fluid (CSF)** The liquid in which the brain and spinal cord float; provides a shock-absorbing cushion.
- **change blindness** Failure to detect a change when vision is interrupted.
- **chemosense** One of the two sense modalities (gustation and olfaction) that detect the presence of particular molecules present in the environment.
- child-directed speech The speech of an adult directed toward a child; differs in several ways from adult-directed speech and tends to facilitate the learning of language by children.
- chromosomal aberration Displacement or deletion of genes within chromosomes, or a change in the number of chromosomes.
- **chromosomes** Paired rod-like structures in the nucleus of a cell; contain genes.
- chunking A process by which information is simplified by rules, which make it easily remembered once the rules are learned. For example, the string of letters NBCCBSNPR is easier to remember if a person learns the rule that organizes them into smaller "chunks": NBC, CBS, and NPR.
- cilium (plural: cilia) A hairlike appendage of a cell; involved in movement or in transducing sensory information. Cilia are found on the receptors in the auditory and vestibular system.
- **cingulotomy** The surgical destruction of nerve fibers that connect the prefrontal cortex with the limbic system; used to reduce intense anxiety and other symptoms of obsessive-compulsive disorder.
- **circadian rhythm** A daily rhythmical change in behaviors or physiological processes.
- **classical procedure** Conditioning procedure in which a neutral stimulus precedes an eliciting stimulus with the result that the neutral stimulus evokes a learned response resembling the elicited response.
- client-centered therapy A form of psychotherapy in which the client decides what to talk about without strong direction or judgment from the therapist.
- clinical judgments Diagnoses of psychological disorders or predictions of future behavior

based largely on experts' knowledge of symptoms and past clinical experience.

- clinical neuropsychologist A psychologist who specializes in the identification and treatment of the behavioral consequences of nervous system disorders and injuries.
- clinical observation Observation of the behavior of people or animals while they are undergoing diagnosis or treatment.
- **clinical psychology** The branch of psychology devoted to the investigation and treatment of abnormal behavior and mental disorders.
- **cochlea** (*cock lee uh*) or *coke lee uh*) A snail-shaped chamber set in bone in the inner ear, where audition takes place.
- **cochlear implant** An electronic device surgically implanted in the inner ear that can enable a deaf person to hear.
- cocktail-party problem Trying to follow one conversation while other, potentially distracting conversations are going on around us.
- **cognitive appraisal** Our perception of a stressful situation; occurs in two stages, primary appraisal and secondary appraisal.
- cognitive dissonance theory The theory that changes in attitude can be motivated by an unpleasant state of tension caused by a disparity between our attitudes and our behavior.
- **cognitive neuroscience** The branch of psychology that attempts to understand cognitive psychological functions by studying the brain mechanisms that are responsible for them.
- **cognitive psychology** The branch of psychology that studies mental processes and complex behaviors such as perception, attention, learning and memory, verbal behavior, concept formation, and problem solving.
- **cognitive reappraisal** Any coping strategy in which we alter our perception of the threat posed by a stressor to reduce stress. Also called cognitive restructuring.
- **cognitive restructuring** A therapeutic process that seeks to help clients replace maladaptive thoughts with more constructive ways of thinking.
- cognitive-behavioral therapy A form of psychotherapy that focuses on altering clients' perceptions, thoughts, feelings, and beliefs as well as environments to produce desired changes.
- collective unconscious According to Jung, the shared unconscious memories and ideas inherited from our ancestors over the course of human evolution.
- **coma** A condition in which an individual seems to be sleeping but cannot be awakened.
- **community psychologist** A psychologist who works for the well-being of individuals in the social system, attempting to improve the system rather than treating people as problems.
- **community psychology** A form of treatment and education whose goal is to address psychological problems through assessment

and intervention in the sociocultural contexts in which problems develop.

- **comorbid** Refers to the tendency of one type of psychological disorder to occur together with one or more other disorders.
- **companionate love** Love that is characterized by a deep, enduring affection and caring for another person, accompanied by a strong desire to maintain the relationship.
- **comparative psychology** The branch of psychology that studies the behavior of members of a variety of species in an attempt to explain behavior in terms of evolutionary adaptation to the environment.
- **compliance** Engaging in a particular behavior at another person's request.
- **compulsion** An irresistible impulse to repeat some action over and over even though it serves no useful purpose.
- **concept** A category of objects or events that share certain attributes.
- **concordance research** Studies the similarity of traits between twins, especially identical twins. Twins are concordant if they exhibit the same phenotype.
- **concurrent schedule** Reinforcement schedules in which reinforcers are available for responding on two or more alternative operants.
- conditioned emotional response (CER) A classically conditioned response that occurs when a neutral stimulus is followed by an aversive stimulus; usually includes autonomic, behavioral, and endocrine components such as changes in heart rate, freezing, and secretion of stress-related hormones.
- **conditioned** (secondary) reinforcer Stimulus that can function as a reinforcer after it has been paired with another stimulus that can already function as a reinforcer. Also known as *conditioned suppression*.
- **conditioned response (CR)** Response that is acquired by the CS in a classical procedure after the CS has been paired with the US.
- **conditioned stimulus (CS)** Neutral stimulus that evokes a conditional response (CR) through pairing with a US in a classical procedure.
- **conditioning** Process that produces learning (change in the environmental guidance of behavior) in classical and operant procedures.
- **conditions of worth** Conditions that others place on us for receiving their positive regard.
- **conduction aphasia** An inability to remember words that are heard, although they usually can be understood and responded to appropriately. This disability is caused by damage to Wernicke's and Broca's areas.
- **cone** A photoreceptor that is responsible for acute daytime vision and for color perception.
- **confidentiality** Privacy of participants and nondisclosure of their participation in a research project.
- **confirmation bias** A tendency to seek evidence that might confirm a hypothesis rather than evidence that might disconfirm it.

- **conformity** Adoption of the attitudes and behaviors that characterize a particular group of people.
- **confounding of variables** Inadvertent simultaneous manipulation of more than one variable. The results of an experiment in which variables are confounded permit no valid conclusions about cause and effect.
- **conscience** The internalization of the rules and restrictions of society; it determines which behaviors are permissible and punishes wrongdoing with feelings of guilt.
- **consciousness** The awareness of complex private processes such as perception, thinking, and remembering.
- **consensus** The extent to which a person's behavior is what most people would do; can be a basis for others' attributions about the person's motives.
- conservation The fact that specific properties of objects (for example, volume, mass, length, or number) remain the same despite apparent changes in the shape or arrangement of those objects.
- **consistency** The extent to which a person generally behaves in the same way toward another person, an event, or a stimulus; can be the basis for others' attributions about the person's motives.
- consolidation The change of information from a state of short-term activation into structural changes in the brain. These changes are considered permanent and are hence part of long-term memory.
- **consumer psychologist** A psychologist who studies consumer behavior and works for organizations that manufacture products or that buy products or services.
- **content word** A noun, verb, adjective, or adverb that conveys meaning.
- contextual discrimination Discrimination procedure in which the stimulus in whose presence the behavior is reinforced varies with the value of another stimulus, the stimulus context.
- **contralateral** Residing in the side of the body opposite the reference point.
- **control group** A comparison group used in an experiment, the members of which are exposed to the naturally occurring or zero value of the independent variable.
- **conventional level** Kohlberg's second level of moral development, in which people realize that a society has instituted moral rules to maintain order and to serve the best interests of members of the society.
- **convergence** In depth perception, the result of conjugate eye movements whereby the fixation point for each eye is identical; feedback from these movements provides information about the distance of visual objects from the viewer.
- **coping strategy** A plan of action that a person follows to reduce the experience of stress, either in anticipation of encountering a stressor or in response to its occurrence.
- **cornea** The transparent tissue covering the front of the eye.

- **coronary heart disease (CHD)** The narrowing of blood vessels that supply oxygen and nutrients to the heart.
- **corpus callosum** (*core pus ka low sum*) A large bundle of axons ("white matter") that connects the cortex of the two cerebral hemispheres.
- **correctional mechanism** Mechanism that restores the system variable to the set point in a regulatory process.
- **correlation coefficient** A measurement of the degree to which two variables are related.
- correlational study The examination of relations between two or more measurements of behavior or other characteristics of people or other animals.
- **counterbalancing** Systematic variation of conditions in an experiment, such as the order of presentation of stimuli, so that different participants encounter the conditions in different orders; prevents confounding of independent variables with time-dependent processes such as habituation or fatigue.
- countertransference Process in which a psychoanalyst projects his or her emotions onto a client.
- **covert sensitization** A form of behavior therapy in which a client imagines the aversive consequences of his or her inappropriate behavior.
- **cranial nerve** A bundle of nerve fibers attached to the base of the brain; conveys sensory information from the face and head and carries messages to muscles and glands.
- creative intelligence In Sternberg's triarchic theory, the ability to deal effectively with novel situations and to solve problems automatically that have been encountered previously.
- **criterion** An independent measure of the variable a test is designed to measure.
- critical period A specific time in development during which certain experiences must occur for normal development to take place.
- cross-cultural psychology The branch of psychology that studies the impact of culture on behavior.
- **cross-sectional study** A study of development in which individuals of different ages are compared at the same time.
- crystallized intelligence According to Cattell, intellectual abilities that have developed through exposure to information-rich contexts, especially schools; expressed in general knowledge and skills.
- **CT scanner** A device that uses a special x-ray machine and a computer to produce images of the brain that appear as slices taken parallel to the top of the skull.
- **culture** Socially transmitted knowledge, customs, and behavior of a group of people.
- **culture-bound syndrome** Highly unusual psychological disorders that are similar to nonpsychotic psychological disorders (such as phobias) but are specific to only one or a few cultures.
- **cumulative record** Graphic presentation of data in which every response moves the curve upward as time passes.

- **curare** (*kew rahr ee*) A drug that binds with and blocks acetylcholine receptors, preventing the neurotransmitter to exert its effects.
- **dark adaptation** The process by which the eye becomes capable of distinguishing dimly illuminated objects after going from a bright region to a dark one.
- **debriefing** Full disclosure to research participants of the nature and purpose of a research project after its completion.
- **deductive reasoning** The mental process by which people arrive at specific conclusions from general principles or rules.
- **deep processing** Analysis of the complex characteristics of a stimulus, such as its meaning or its relation to other stimuli.
- **deep structure** The essential meaning of a sentence, without regard to the grammatical features (surface structure) of the sentence that are needed to express it in words.
- **defense mechanisms** Mental systems that become active whenever unconscious instinctual drives of the id come into conflict with internalized prohibitions of the superego.
- **deinstitutionalization** The process of returning previously institutionalized patients to their communities for treatment of psychological problems and psychological disorders.
- **delta activity** Rhythmical electroencephalogram activity with a frequency of less than 3.5 Hz, indicating deep (slow-wave) sleep.
- **dendrite** A treelike part of a neuron on which other neurons form synapses.
- **dependent variable** The variable measured in an experiment and hypothesized to be affected by the independent variable.
- **deprivation** Reduction of an organism's contact with a stimulus below the level that the organism would choose; for example, reduced contact with food in food deprivation.
- **descriptive statistics** Mathematical procedures for organizing collections of data.
- **detector** Mechanism that signals when the system variable deviates from its set point in a regulatory process.
- **determinism** In psychology, the doctrine that behavior is the result of prior events.
- **deuteranopia** A form of hereditary anomalous color vision; caused by defective "green" cones in the retina.
- **developmental psychology** The branch of psychology that studies the changes in behavioral, perceptual, cognitive, social, and emotional capacities of organisms as a function of age and experience.
- **deviation IQ** A procedure for computing the IQ; compares an individual's score with those received by other individuals of the same chronological age.
- diathesis-stress model A causal account of mental disorders suggesting that these disorders develop when a person possesses a predisposition for a disorder and encounters stressors that exceed his or her abilities to cope with them.
- **dichotic-listening test** A task that requires a person to listen to one of two different messages

being presented simultaneously, one to each ear, through headphones.

- **difference threshold** An alternate name for *justnoticeable difference* (*jnd*).
- differential conditioning procedure Procedure in which behavior has different consequences as the environment changes.
- **diffusion of responsibility** A factor in the failure of bystander intervention, stating the fact that when several bystanders are present, no one person assumes responsibility for helping.
- **direct dyslexia** A reading disorder caused by brain damage in which people can read words aloud without understanding them.
- **discrimination** Differential treatment of people based on their membership in a particular group.
- **discriminative stimulus** Stimulus that controls behavior as the result of a differential conditioning procedure.
- **disorganized schizophrenia** A type of schizophrenia characterized primarily by disturbances of thought and a flattened or silly affect.
- **disoriented attachment** As observed in the Strange Situation test, a kind of attachment in which infants behave in confused and contradictory ways toward their mothers.
- **dispositional factors** An individual's traits, needs, and intentions, which can affect his or her behavior.
- **dissociative amnesia** A dissociative disorder characterized by the inability to remember important events or personal information.
- **dissociative disorders** A class of disorders in which anxiety is reduced by a sudden disruption in consciousness, which in turn produces changes in memory or in the person's sense of identity.
- **dissociative fugue** Amnesia with no apparent physiological cause, often accompanied by adoption of a new identity and relocation to a new community.
- dissociative identity disorder A rare dissociative disorder in which two or more distinct personalities exist within the same person; each personality dominates in turn. (Formerly known as multiple personality disorder.)
- distinctive features Physical characteristics of an object that help distinguish it from other objects.
- distinctiveness The extent to which a person behaves differently toward different people, events, or other stimuli; can be the basis for others' attributions about the person's motives.
- divided attention The process by which we distribute awareness among different stimuli or tasks so that we can respond to them or perform them simultaneously.
- **DNA** Deoxyribonucleic acid. Molecule resembling a twisted ladder whose sides are connected by rungs of pairs of nucleotides (adenine, thymine, guanine, and cytosine).
- doctrine of specific nerve energies Johannes Müller's observation that different nerve fibers convey specific information from one

part of the body to the brain or from the brain to one part of the body.

- **dominant allele** A trait that is exhibited when only one allele is present, a trait expressed in heterozygous cells.
- **dopamine** (DA) A monoamine neurotransmitter involved in control of brain mechanisms of movement and reinforcement; a neuromodulator that increases synaptic efficacy between interconnected neurons that are active at the same time: important in reinforcement.
- **dopamine hypothesis** The hypothesis that the positive symptoms of schizophrenia are caused by overactivity of synapses in the brain that use dopamine.
- **dorsal stream** The flow of information from the primary visual cortex to the visual association area in the parietal lobe; used to form the perception of an object's location in three-dimensional space (the "where" system).
- **double bind** The conflict caused for a child when he or she is given inconsistent messages or cues from a parent.
- **double-blind study** An experiment in which neither the participants nor the researchers know the value of the independent variable.
- **Down's syndrome** Chromosomal aberration consisting of an extra 21st chromosome. Produces varying physical and behavioral impairment.
- **dream interpretation** The method in psychoanalysis whereby the therapist interprets the client's report of a dream (its manifest content) in terms of its deeper, symbolic meaning (its latent content).
- **drug therapy** Reliance on the use of pharmaceutical substances for the treatment of psychological disorders.
- **dualism** The philosophical belief that reality consists of mind and matter.
- echoic memory A form of sensory memory for sounds that have just been perceived.
- eclectic approach An approach to therapy in which the therapist uses whatever method he or she feels will work best for a particular client at a particular time.
- effortful processing Practicing or rehearsing information through either shallow or deep processing.
- **ego** The general manager of personality, making decisions balancing the pleasures that will be pursued at the id's demand against the person's safety requirements and the moral dictates of the superego.
- egocentrism Self-centeredness; Piaget proposed that preoperational children can see the world only from their own perspectives.
- **ego-ideal** The internalization of what a person would like to be—his or her goals and ambitions.
- elaboration likelihood model A model that explains the effectiveness of persuasive messages in terms of two routes to persuasion. The central route requires a person to think critically about an argument, whereas the peripheral route entails merely the association of the argument with something positive.

- **elaborative rehearsal** Processing information on a meaningful level, such as forming associations, attending to the meaning of the material, thinking about it, and so on.
- electroconvulsive therapy (ECT) Treatment for severe depression that involves passing small amounts of electric current through the brain to produce seizures.
- electroencephalogram (EEG) An electrical brain potential recorded by placing electrodes on the scalp.
- electromyogram A record of muscle activity.
- electro-oculogram A record of eye movements.
- eliciting stimulus Stimulus that evokes behavior, commonly as a result of natural selection.
- embryonic stage The second stage of prenatal development, beginning 2 weeks and ending about 8 weeks after conception, during which the heart begins to beat, the brain starts to function, and most of the major body structures begin to form.
- emitted response Response permitted by the environment with no specific controlling stimulus.
- **emotional stability** The tendency to be relaxed and at peace with oneself.
- emotion-focused coping Any coping behavior that aims to reduce stress by changing our own emotional reaction to a stressor.
- **empiricism** The philosophical view that all knowledge is obtained through observation and experience.
- **encoding** The process by which sensory information is converted into a form that can be used by the brain's memory system.
- encoding specificity The principle that how we encode information determines our ability to retrieve it later.
- endocrine gland A gland that secretes a hormone.
- endogenous cannabinoid (can ob in oid) A neuromodulator whose action is mimicked by THC and other drugs present in marijuana.
- endogenous opioid (*ope ee oyd*) A neuromodulator whose action is mimicked by a natural or synthetic opiate, such as opium, morphine, or heroin.
- engineering psychologist A psychologist who studies the ways that people and machines work together and helps design machines that are safer and easier to operate.
- enzymes Proteins that regulate processes that occur within cells—organic catalysts.
- **epigenetics** Mechanisms through which cells inherit modifications that are not due to DNA sequences.
- **episodic memory** A type of long-term memory that serves as a record of life experiences.
- equilibration A process activated when a child's abilities to assimilate and accommodate fail to adjust.
- equivalence class A set of physically unrelated stimuli that all control the appropriate behavior without direct training after the stimuli have appeared in multiple contextual discriminations.

- escape or withdrawal response Response that terminates or reduces contact with an aversive stimulus; the aversive stimulus may be either conditioned or unconditioned.
- estrous cycle Ovulatory cycle in mammals other than primates; the sequence of physical and hormonal changes that accompany the ripening and disintegration of ova.
- ethnocentrism The idea that our own cultural, racial, national, or religious group is superior to or more deserving than others.
- etiology The sources of a disorder.
- evolutionary psychology The branch of psychology that explains behavior in terms of adaptive advantages that specific behaviors provided during the evolution of a species. Evolutionary psychologists use natural selection as a guiding principle.
- **exemplar** A memory of a particular example of an object or an event that is used as the basis for a natural concept.
- **expectancy** The belief that a certain consequence will follow a certain action.
- experiential processing system The basis of rapid, mostly unconscious, and heuristic reasoning.
- experiment A study in which the researcher changes the value of an independent variable and observes whether this manipulation affects the value of a dependent variable. Only experiments can confirm the existence of cause-and-effect relations among variables.
- experimental ablation The removal or destruction of a portion of the brain of an experimental animal for the purpose of studying the functions of that region.
- **experimental group** The group of participants in an experiment that is exposed to a particular value of the independent variable, which has been manipulated by the researcher.
- explicit memory Memory that can be described verbally and of which a person is therefore aware.
- extinction Decrease in a learned behavior when the behavior is no longer followed by a reinforcer.
- extinction-induced aggression Aggression toward another organism when responding is extinguished.
- extrastriate body area (EBA) A region of the ventral stream in the human brain that is activated by images of bodies or body parts but not faces.
- extroversion The tendency to seek the company of other people, to engage in conversation and other social behaviors with them, and to be spontaneous.
- factor analysis A statistical procedure that identifies the factors that groups of data, such as test scores, have in common.
- false consensus The mistaken belief that our own attitude on a topic is representative of a general consensus.
- fetal stage The third and final stage of prenatal development, which lasts for about 7 months,

beginning with the appearance of bone tissue and ending with birth.

- **fight-or-flight response** Physiological reactions that help ready us to fight or to flee a dangerous situation.
- figure A visual stimulus that is perceived as an object.
- **five-factor model** A theory stating that personality is composed of five primary dimensions: neuroticism, extroversion, openness, agreeableness, and conscientiousness. This theory was developed using factor analyses of ratings of the words people use to describe personality characteristics.
- fixation A brief interval between saccadic eye movements during which the eye does not move; the brain accesses visual information during this time. Also, in Freudian theory, the continued attachment of psychic energy to an erogenous zone due to incomplete passage through one of the psychosexual stages.
- **flashbulb memories** Memories established by events that are highly surprising and personally of consequence.
- **fluid intelligence** According to Cattell, intellectual abilities that operate in relatively culturefree informational contexts and involve the detection of relationships or patterns, for example.
- forensic psychologist A psychologist who studies human behavior as it relates to the legal system and to matters involving criminal justice.
- **formal concept** A category of objects or events defined by a list of common essential characteristics, much as in a dictionary definition.
- **fossil** Remains of an animal or plant found in the Earth.
- **fovea** A small pit near the center of the retina containing densely packed cones; responsible for the most acute and detailed vision.
- free association A method of Freudian analysis in which the client is asked to relax and to speak freely in reporting any thoughts or images that come to mind without worrying about their meaning.
- **free nerve ending** An unencapsulated (naked) dendrite of somatosensory neurons.
- frontal lobe The front portion of the cerebral cortex, including the prefrontal cortex and the motor cortex; damage impairs movement, planning, and flexibility in behavioral strategies.
- **frustration** An emotional response produced when a formerly reinforced response is extinguished.
- **function word** A preposition, article, or other word that conveys little of the meaning of a sentence but is important in specifying its grammatical structure.
- **functional MRI (fMRI)** A modification of the MRI procedure that permits the measurement of regional metabolism in the brain.
- **functionalism** An approach to understanding species' behaviors and other processes in terms of their biological significance; this ap-

proach stresses the usefulness of such processes with respect to survival and reproductive success.

- **fundamental attribution error** Our tendency to overestimate the significance of dispositional factors and to underestimate the significance of situational factors in explaining other people's behavior.
- fundamental frequency The lowest, and usually most intense, frequency of a complex sound; most often perceived as the sound's basic pitch.
- **fusiform face area** A region of the ventral stream in the human brain containing face-recognizing circuits.
- **g factor** According to Spearman, a factor that is common to performance on all intellectual tasks; includes apprehension of experience, eduction of relations, and eduction of correlates.
- **GABA** The most important inhibitory neurotransmitter in the brain.
- ganglion cell A neuron in the retina that receives information from photoreceptors by means of bipolar cells, and from which axons proceed through the optic nerves to the brain.
- **gender identity** A person's private sense of being male or female.
- **gender role** Cultural expectations about the ways in which a male or a female should think and behave.
- **gender stereotypes** Beliefs about differences in the behaviors, abilities, and personality traits of males and females.
- gene Unit of heredity, inferred from Mendel's experiments.
- general adaptation syndrome The model proposed by Selye to describe the body's adaptation to prolonged exposure to severe stressors. The body passes through a sequence of three physiological stages: alarm, resistance, and exhaustion.
- **generalize** To extend the results obtained from a sample to the population from which the sample was taken.
- **genetic engineering** Procedures intended to alter an organism's genes to produce a more favorable phenotype.
- **genetic marker** A known nucleotide sequence that occurs at a particular location on a chromosome.
- **genetics** Study of the hereditary structures of organisms (genes).
- genital stage The final of Freud's psychosexual stages (from puberty through adolescence). During this stage the adolescent develops adult sexual desires.
- genome Total set of genetic material of an organism.
- genotype The genetic makeup of an organism.
- **germ cells** Reproductive cells, a collective term for the sperm and ovum taken together; have only one member of each pair of chromosome.
- **Gestalt psychology** A movement in psychology that emphasized that cognitive processes could be understood by studying their organization, not their elements.

- **Gestalt therapy** A form of therapy that emphasizes the unity of mind and body by teaching the client to "get in touch" with unconscious bodily sensations and emotions.
- **glia** (*glee ah*) Cells of the central nervous system that provide support for neurons and supply them with some essential chemicals.
- **glucocorticoid** A hormone, such as cortisol, that influences the metabolism of glucose, the main energy source of the body.
- **glucostatic hypothesis** The hypothesis that hunger is caused by a low level of glucose in the blood; glucose levels are assumed to be monitored by specialized sensory neurons called glucostats.
- **glutamate** The most important excitatory neurotransmitter in the brain and spinal cord.
- **glycogen** Insoluble carbohydrate synthesized from glucose and stored in the liver; can be converted back to glucose.
- **gray matter** The portions of the central nervous system that are abundant in cell bodies of neurons rather than axons. The color appears gray relative to white matter.
- **ground** A visual stimulus that is perceived as a background against which objects are seen.
- **group** Two or more individuals who generally have common interests and goals.
- **group polarization** The tendency for the initial position of a group to become more extreme during the discussion preceding a decision.
- group psychotherapy Therapy in which two or more clients meet simultaneously with a therapist, discussing problems within a supportive and constructive environment.
- **groupthink** Group members' tendency to avoid dissent in the attempt to achieve consensus in the course of decision making.

gustation The sense of taste.

- habituation Decrease in responding to a stimulus after that stimulus is repeatedly presented without an important consequence.
- hallucination A perceptual experience that occurs in the absence of external stimulation of the corresponding sensory organ; often accompanies schizophrenia.
- **haze** A monocular cue for depth perception; objects that are less distinct in their outline and texture are perceived as farther from the viewer.
- **health psychology** The branch of psychology involved in the promotion and maintenance of sound health practices.
- **heredity** Sum of the traits inherited from one's parents.
- **heritability** A statistical measure of the degree to which the variability of a particular trait in a population results from the genetic variability within the population; has a value from 0.0 to 1.0.
- hertz (Hz) The primary measure of the frequency of vibration of sound waves; cycles per second.
- heuristic A general rule that guides decision making.
- hippocampus A part of the limbic system of the brain, located in the temporal lobe; plays

important roles in episodic memory and spatial memory.

- **homeostasis** (*home ee oh stay sis*) The process by which important physiological characteristics (such as body temperature and blood pressure) are regulated so that they remain at their optimal levels.
- **hominids** The genus of bipedal apes ancestral to humans.
- **horizon proximity** A monocular cue for depth perception; objects closer to the horizon appear farther away that objects more distant from the horizon.
- **hormone** A chemical substance secreted by an endocrine gland that has physiological effects on target cells in other organs.
- hue A perceptual dimension of color, most closely related to the wavelength of a pure light. The effect of a particular hue is caused by the mixture of lights of various wavelengths.
- **humanistic approach** An approach to the study of personality that emphasizes the positive, fulfilling aspects of life.
- **humanistic psychology** An approach to the study of human behavior that emphasizes human experience, choice and creativity, selfrealization, and positive growth.
- **humanistic therapy** A form of psychotherapy focusing on the client's unique potential for personal growth and self-actualization.
- Huntington's disease Genetic disorder caused by a dominant lethal gene that produces progressive mental and physical deterioration after adulthood (also known as Huntington's chorea).
- **hypocretin** A neurotransmitter secreted by cells in the hypothalamus; helps regulate sleepwake cycles.
- **hypothalamus** A region of the brain located just above the pituitary gland; controls the autonomic nervous system and many behaviors related to regulation and survival, such as eating, drinking, fighting, shivering, and sweating.
- **hypothesis** A statement, usually designed to be tested by an experiment, that tentatively expresses a cause-and-effect relationship between two or more events.
- **iconic memory** A form of sensory memory that holds a brief visual image of a scene that has just been perceived; also known as visible persistence.
- id The unconscious reservoir of libido, the psychic energy that fuels instincts and psychic processes.
- **illusion of out-group homogeneity** A belief that members of out-groups are highly similar to one another.
- illusory correlation An apparent correlation between two distinctive elements that does not actually exist.
- imaginal exposure A method of behavior therapy for phobias in which the therapist describes the feared object in graphic terms, thereby inducing fear without direct exposure to the object.

- **imitation** Observational learning in which the behavior of an observer is similar to the behavior of the one being observed.
- **immune system** A network of organs and cells that protects the body from invading bacteria, viruses, and other foreign substances.
- **immunoglobulins** Disease-fighting antibodies that are released by B lymphocytes.
- implicit memory Memory that cannot be described verbally and of which a person is therefore not aware.
- **impression formation** The integration of information about another person's traits into a coherent sense of who the person is.
- in vivo exposure A form of behavior therapy that attempts to rid people of fears by arousing the fears intensely until clients' responses diminish through extinction; they learn that nothing bad happens.
- **inattention blindness** Failure to perceive an event when attention is diverted elsewhere.
- **inclusive fitness** Total reproductive success of those with whom the individual has genes in common, e.g., siblings.
- **incongruence** In Rogers' theory, a discrepancy between a client's perceptions of her or his real and ideal selves.
- independent variable The variable that is manipulated in an experiment as a means of determining cause-and-effect relations.
- indigenous healing Non-Western, culture-specific approaches to the treatment of psychological and medical problems.
- **inductive reasoning** The mental process by which people infer general principles or rules from specific information.
- inferential statistics Mathematical and logical procedures for determining whether relations or differences between samples are statistically significant.
- inflection A change in the form of a word (usually by addition of a suffix) to denote a grammatical feature such as tense or number.
- information processing A model used by cognitive psychologists to explain the workings of the brain; according to this model, information received through the senses is processed by systems of neurons in the brain.
- **informed consent** A person's agreement to participate in an experiment after he or she has received information about the nature of the research and any possible risks and benefits.
- inhibition of return A reduced tendency to perceive a target when the target's presentation is consistent with a cue, but the target is presented a few hundred milliseconds after the cue.
- insight therapy Therapy in which the therapist aids clients to achieve insight into the causes of maladaptive behavior, causes they were previously unaware of.
- insomnia A general category of sleep disorder related to difficulty in falling asleep and remaining asleep.
- instructional control Guidance of behavior by discriminative stimuli, especially verbal stimuli such as directions; also known as *rule-governed behavior*.

- **intelligence** A person's ability to learn and remember information, to recognize concepts and their relations, and to apply the information and recognition by behaving in an adaptive way.
- **intelligence quotient** (**IQ**) A simplified single measure of general intelligence; by definition, the ratio of a person's mental age to his or her chronological age.
- **intermittent (partial) reinforcement** Procedure in which not every occurrence of a behavior is followed by a reinforcer; increases resistance to the effects of extinction.
- interpersonal attraction People's tendency to approach each other and to evaluate each other positively.
- interposition A monocular cue for depth perception; an object that partially blocks another object is perceived as closer.
- interrater reliability The degree to which two or more independent observers agree in their ratings of an organism's behavior.
- interval schedules Procedures in which a reinforcer is dependent on the passage of time before the response is effective; may be either fixed or variable.
- intraspecific aggression An attack by an animal on another member of its species.
- introspection Literally, "looking within" in an attempt to describe memories, perceptions, cognitive processes, or motivations.
- **introversion** The tendency to avoid the company of other people, to be inhibited and cautious; shyness.
- ion A positively or negatively charged particle; produced when many substances dissolve in water.
- **ion channel** A special protein molecule located in the membrane of a cell; controls the entry or exit of particular ions.
- ion transporter A special protein molecule located in the membrane of a cell; actively transports ions into or out of the cell.
- **ipsilateral** Residing in the same side of the body as the reference point.
- **iris** The pigmented muscle of the eye that controls the size of the pupil.
- isolation aphasia Language disorder in which a person cannot comprehend speech or produce meaningful speech but is able to repeat speech and to learn new sequences of words.
- James-Lange theory Theory of emotion proposing that behavioral and physiological responses are directly elicited by situations; feelings of emotions are produced by feedback from these behavioral and physiological responses.
- just-noticeable difference (JND) The smallest difference between two similar stimuli that can be distinguished. Also called *difference threshold*.
- kin selection Selection that favors altruistic acts toward individuals with whom one has genes in common.
- **knockout mutations** Experimentally induced genetic sequence preventing gene expression.

- **language universal** A characteristic feature found in all natural languages.
- language-acquisition device (LAD) A theoretical endowment unique to humans that is postulated to account for the fact that, regardless of geographical location and often severely restricted environments, children tend to acquire a first language in highly similar fashion.
  language-acquisition support system (LASS) A
- cultural system that aids the child's acquisition of a first language by providing the forms of interaction conducive to acquisition.
- **latency period** In Freudian theory, the period between the phallic stage and the genital stage, during which sexual urges are submerged.
- **latent content** The hidden message of a dream produced by the unconscious.
- **latent learning** Facilitation of learning after the stimuli that guide behavior have been experienced but without the behavior being reinforced in their presence.
- **law of closure** A Gestalt law of perceptual organization; elements missing from the outline of a figure are "filled in" by the visual system.
- **law of common fate** A Gestalt law of perceptual organization; elements that move together give rise to the perception of a particular figure.
- **law of continuity** A Gestalt law of perceptual organization; given two or more possible interpretations of the elements that form the outline of a figure, the brain will adopt the simplest interpretation.
- law of effect Edward Thorndike's statement that stimuli that occur as a consequence of a response can increase or decrease the likelihood of an organism's making that response again.
- **law of proximity** A Gestalt law of perceptual organization; elements located closest to one another are perceived as belonging to the same figure.
- **law of similarity** A Gestalt law of perceptual organization; similar elements are perceived as belonging to the same figure.
- **law of symmetry** A Gestalt law of perceptual organization; symmetrical objects are perceived as belonging together even if a distance separates them.
- **learned helplessness** Reduced ability to learn a solvable avoidance task after exposure to an inescapable aversive stimulus; thought to play a role in depression.
- **learning** Long-lasting changes in the environmental guidance of behavior as a result of experience.
- **lens** The transparent organ situated behind the iris of the eye; helps focus an image on the retina.
- **libido** An insistent, instinctual force that is unresponsive to the demands of reality; the primary source of motivation.
- **liking** A feeling of personal regard, intimacy, and esteem toward another person.
- **limbic cortex** The cerebral cortex located around the edges of the cerebral hemispheres where they join with the brain stem; part of the limbic system.

- **limbic system** A set of interconnected structures of the brain important in emotional and species-typical behavior; includes the amygdala, hippocampus, and limbic cortex.
- **linear perspective** A monocular cue for depth perception; the arrangement of lines drawn in two dimensions such that parallel lines receding from the viewer are seen to converge at a point on the horizon.
- **linguistic relativity hypothesis** The hypothesis that the language a person speaks influences his or her thoughts and perceptions.
- **locus of control** An individual's beliefs that the consequences of his or her actions are controlled by internal, person variables or by external, environmental variables.
- **longitudinal study** A study of development in which observations of the same individuals are compared at different times of their lives.
- **long-term memory** Memory in which information is represented on a permanent or nearpermanent basis.
- **long-term potentiation (LTP)** Increase in the ease of firing a postsynaptic neuron by electrical stimulation of a presynaptic neuron; thought to be the neural basis of learning.
- **loving** A combination of liking and a deep sense of attachment to, intimacy with, and caring for another person.
- **LSD** Lysergic acid diethylamide; a hallucinogenic drug that blocks a category of serotonin receptors.
- Machiavellianism A personality trait measuring skill at manipulating other people for one's own ends.
- magnetic resonance imaging (MRI) A technique with a device that uses the interaction between radio waves and a strong magnetic field to produce images of slices of the interior of the body.
- magnetoencephalography (MEG) A method of brain study that measures the changes in magnetic fields that accompany action potentials in the cerebral cortex.
- maintenance rehearsal Rote repetition of information; repeating a given item over and over again.
- major depressive disorder Persistent and severe feelings of sadness and worthlessness accompanied by changes in appetite, sleeping, and other behavior.
- **mania** Abnormal and persistent elevation of an expansive or irritable mood.
- **manifest content** The apparent story line of a dream.
- **manipulation** Setting the values of an independent variable in an experiment to see whether the value of another variable is affected.
- **matching** Systematically selecting participants in groups in an experiment or (more often) a correlational study to ensure that the mean values of important participant variables of the groups are similar.
- matching principle In a choice situation, the proportion of responses occurring during a stimulus is the same as the proportion of reinforcers received during that stimulus.
- matching relation In concurrent reinforcement schedules, the equal relation between the pro-

portion of responses to a given alternative and the proportion of reinforcers received for those responses.

- **materialism** A philosophical belief that reality can be known only through an understanding of the physical world, of which the mind is a part.
- **maturation** Any relatively stable change in thought, behavior, or physical growth that is due to the aging process and not to experience.
- **mean** A measure of central tendency; the sum of a group of values divided by their number; the arithmetical average.
- means-ends analysis A general heuristical method of problem solving that involves looking for differences between the current state and the goal state and seeking ways to reduce the differences.
- **measure of central tendency** A statistical measure used to characterize the value of items in a sample of numbers.
- **measure of variability** A statistic that describes the degree to which scores in a set of numbers differ from one another.
- median A measure of central tendency; the midpoint of a group of values arranged numerically.
- medulla (*me doo la*) The part of the brain stem closest to the spinal cord; controls vital functions such as heart rate and blood pressure.
- **meiosis** Process of cell division by which germ cells are produced.
- **memory** The cognitive processes of encoding, storing, and retrieving information.
- Mendelian traits Traits showing a dominant, recessive, or sex-linked pattern of inheritance. Mendelian traits are not polygenic.
- meninges (men in jees) The three-layered set of membranes that enclose the brain and spinal cord.
- **mental age** A measure of a person's intellectual development; the average level of intellectual development that could be expected in a child of a particular age.
- **mental model** A cognitive representation of a possibility that a person can use to solve deductive problems.
- mental retardation Cognitive development that is substantially below normal; often caused by some form of brain damage or abnormal brain development. Also known as *cognitive disability* or *intellectual disability*.
- **mere exposure effect** The tendency to form a positive attitude toward a person, place, or thing based solely on repeated exposure to that stimulus.
- method of loci (low-sigh) A mnemonic system in which items to be remembered are mentally associated with specific physical locations or landmarks.
- **microelectrode** A thin electrode made of wire or glass that can measure the electrical activity of a single neuron.
- midbrain The part of the brain stem just anterior to the pons; involved in control of fighting and sexual behavior and in decreased sensitivity to pain during these behaviors.

- **minimally conscious state** A condition in which the individual shows occasional arousal and organized behavior but otherwise appears to be asleep.
- Minnesota Multiphasic Personality Inventory (MMPI) An objective test originally designed to distinguish individuals with psychological problems from normal individuals. The MMPI has since become popular as a means of attempting to identify personality characteristics of people in many everyday settings.
- mnemonic system A special technique or strategy consciously used in an attempt to improve memory.
- **model** In science, a relatively simple system that works on known principles and is able to do at least some of the things that a more complex system can do.
- **modeling** Behavior therapy in which the client is encouraging to behave in a manner similar to that of the therapist or other designated person.
- **module** An area of tissue in the primary visual cortex whose neurons receive their input from the same small region in the retina.
- **molecular genetics** The study of genetics at the level of the DNA molecule.
- monoamine (mahn o a meen) A category of neurotransmitters that includes dopamine, norepinephrine, and serotonin.
- **monocular cue** A cue for the perception of depth that requires the use of only one eye.
- **monogamy** Mating strategy of one female with one male.
- **mood disorders** A psychological disorder characterized by significant shifts or disturbances in mood that adversely affect normal perception, thought, and behavior. Mood disorders may be characterized by deep, foreboding depression or may involve a combination of depression and mania.
- **moral realism** The first stage of Piaget's model of moral development, which includes egocentrism and blind adherence to rules.
- morality of cooperation The second stage of Piaget's model of moral development, which involves the recognition of rules as social conventions.
- **morpheme** The minimal unit of meaning in a language, such as |p| + |in| to form *pin*.
- **motion parallax** A monocular cue for depth perception; as we pass by a scene, objects closer to us appear to move farther than those more distant.
- **motivation** A group of phenomena that affect the nature, strength, or persistence of an individual's behavior.
- motor association cortex Those regions of the cerebral cortex that control the primary motor cortex; involved in planning and executing behaviors.
- **motor neuron** A neuron whose terminal buttons form synapses with muscle fibers. When an action potential travels down its axon, the associated muscle fibers will twitch.
- **muscle spindle** A muscle fiber that functions as a stretch receptor; arranged parallel to the mus-

cle fibers responsible for contraction of the muscle, it detects muscle length.

- **mutation** Alterations in the nucleotides within a single gene. Can occur spontaneously or from experimental manipulation.
- **myelin sheath** The insulating material that encases most large axons.
- **naloxone** (*na lox own*) A drug that binds with and blocks opioid receptors, preventing opiate drugs or endogenous opioids from exerting their effects.
- **narcissism** A personality trait measuring grandiosity and feelings of superiority.
- narcolepsy A sleep disorder characterized by sleep attack—irresistibly falling asleep at inappropriate times.
- **narrative** A mnemonic system in which items to be remembered are linked together by a story.
- **natural concept** A category formed from a person's perceptions of and interactions with things in the world; based on exemplars.
- natural selection Process whereby the environment differentially favors organisms with characteristics that affect survival and production of offspring.
- **naturalistic observation** Observation of the behavior of people or other animals in their natural environments.
- **negative afterimage** The image seen after a portion of the retina is exposed to an intense visual stimulus; a negative afterimage consists of colors complementary to those of the physical stimulus.
- **negative symptoms** A symptom of schizophrenia that consists of the absence of normal behaviors; negative symptoms include flattened emotion, poverty of speech, lack of initiative and persistence, and social withdrawal.
- **neostigmine** (*nee o stig meen*) A drug that enhances the effects of acetylcholine by blocking the enzyme that destroys it.
- **nerve** A bundle of nerve fibers that transmit information between the central nervous system and the body's sense organs, muscles, and glands.
- **neural plasticity** The production of changes in the structure and functions of the nervous system, induced by environmental events.
- **neurogenesis** The process responsible for the production of a new neuron.
- **neuromodulator** A substance secreted in the brain that modulates the activity of neurons that contain the appropriate receptors.
- **neuron** A neural cell; consists of a cell body with dendrites and an axon whose branches end in terminal buttons that synapse with muscle fibers, gland cells, or other neurons.
- **neuroticism** The tendency to be anxious, worried, and full of guilt.
- Neuroticism, Extroversion, and Openness Personality Inventory (NEO-PI-R) The instrument used to measure the elements described in the five-factor model (neuroticism, extroversion, openness, agreeableness, and conscientiousness).

- **neurotransmitter** A chemical released by the terminal buttons that causes the postsynaptic neuron to be excited or inhibited.
- **neurotransmitter receptor** A special protein molecule located in the membrane of the postsynaptic neuron that responds to molecules of the neurotransmitter.
- **nicotine** A drug that binds with and stimulates acetylcholine receptors, mimicking the effects of this neurotransmitter.
- **night terrors** The experience of anguish without a clear memory of its cause; occurs during slow-wave sleep, usually in childhood.
- NMDA receptor Type of glutamate receptor that plays an important role in learning through changing synaptic efficacies.
- **nominal fallacy** The false belief that we have explained the causes of a phenomenon by identifying and naming it; for example, believing that we have explained lazy behavior by attributing it to "laziness."
- **nonmendelian trait** Characteristic when alleles do not have a dominant-recessive relation.
- **norepinephrine** (NE) (*nor epp i neff rin*) A monoamine neurotransmitter involved in alertness and vigilance and control of REM sleep.
- **norms** Data obtained from large numbers of individuals that permit the score of any one individual to be assessed relative to the scores of his or her peers.
- **object permanence** In Piaget's theory, the idea that objects do not cease existing when they are out of sight.
- **objective personality tests** Tests for measuring personality that can be scored objectively, such as a multiple-choice or true/false test.
- **object-relations theory** The theory that personality is the reflection of relationships that the individual establishes with others as an infant.
- **observational learning** Changes in the behavior of an observer after seeing another learner behave in that same situation; learning that takes place when we see the kinds of consequences others (called models) experience as a result of their behavior.
- **obsession** An involuntary recurring thought, idea, or image accompanied by anxiety or distress.
- **obsessive-compulsive disorder** Recurrent, unwanted thoughts or ideas and compelling urges to engage in repetitive ritual-like behavior, often abbreviated as OCD.
- **occipital lobe** (*ok sip i tul*) The rearmost portion of the cerebral cortex; contains the primary visual cortex.
- olfaction The sense of smell.
- olfactory bulb One of the stalklike structures located at the base of the brain that contain neural circuits that perform the first analysis of olfactory information.
- **olfactory mucosa** (*mew koh za*) The mucous membrane lining the top of the nasal sinuses; contains the cilia of the olfactory receptors.

- **operant procedure** Conditioning procedure in which a response (the operant) precedes an eliciting stimulus.
- **operation** In Piaget's theory, a logical or mathematical rule that transforms an object or concept into something else.
- **operational definition** Definition of a variable in terms of the operations the researcher performs to measure or manipulate it.
- **opponent process** The representation of colors by the rate of firing of two types of neurons: red/green and yellow/blue.
- **optic disk** A circular structure located at the exit point from the retina of the axons of the ganglion cells that form the optic nerve.
- **oral stage** The first of Freud's psychosexual stages, during which the mouth is the major erogenous zone because it appeases the hunger drive.
- **organizational effect (of hormone)** The effect of a hormone on tissue differentiation and development.
- organizational psychologist A psychologist who works to increase the efficiency and effectiveness of organizations.
- **orienting response** Response that facilitates detecting a stimulus (for example, turning toward the source of a sound).
- **ossicle** (*ahss i kul*) One of the three bones of the middle ear (the *hammer, anvil*, and *stirrup*) that transmit acoustical vibrations from the eardrum to the membrane behind the oval window of the cochlea.
- **oval window** An opening in the bone surrounding the cochlea. The stirrup presses against a membrane behind the oval window and transmits sound vibrations into the fluid within the cochlea.
- **overextension** The use of a word to denote a larger class of items than is appropriate; for example, referring to the moon as a *ball*.
- **overgeneralization** The creation of grammatical errors when a child uses an inferred syntactical rule to form the past tense of verbs.
- **overjustification effect** The undermining of intrinsic motivation by the application of extrinsic rewards to intrinsically motivated behavior.
- **overtone** A component of a complex tone; one of a series of tones whose frequency is a multiple of the fundamental frequency.
- Pacinian corpuscle (*pa chin ee un*) A specialized, encapsulated somatosensory nerve ending, which detects mechanical stimuli, especially vibrations.
- panic disorder Unpredictable attacks of acute anxiety that are accompanied by high levels of physiological arousal and that last from a few seconds to a few hours.
- **papilla** A small bump on the tongue that contains a group of taste buds.
- **parahippocampal place area** A region of the ventral stream in the human brain that is activated by visual scenes and backgrounds.
- **paranoid schizophrenia** A type of schizophrenia in which the person has delusions of persecution, grandeur, or control.

- **parasympathetic branch** The portion of the autonomic nervous system that activates functions that occur during a relaxed state.
- **parental investment** Resources that parents expend in procreating and nurturing off-spring.
- parietal lobe (*pa rye i tul*) The region of the cerebral cortex behind the frontal lobe and above the temporal lobe; contains the somatosensory cortex; is involved in spatial perception and memory.
- **Parkinson's disease** A neurological disorder characterized by tremors, rigidity of the limbs, poor balance, and difficulty in initiating movements; caused by degeneration of a system of dopamine-secreting neurons.
- **passionate love** An emotional, intense desire for sexual union with another person; also called romantic love.
- **peg-word method** A mnemonic system in which items to be remembered are associated with a set of mental pegs already in memory, such as key words of a rhyme.
- **peptide** A category of neurotransmitters and neuromodulators that consist of two or more amino acids, linked by peptide bonds.
- **perception** The brain's use of information provided by sensory systems to produce a response; the detection of the more complex properties of a stimulus, including its location and nature; involves learning.
- **perceptual constancy** The experience-based ability to recognize an object and certain of its characteristics—its form, size, color, and brightness—as invariant despite the shifting retinal images it produces.
- perceptual learning Process by which combinations of environmental stimuli acquire control of behavior.
- **period of concrete operations** The third period in Piaget's theory of cognitive development, lasting from age 7 to 11, during which children come to understand the conservation principle and other concepts, such as categorization.
- **period of formal operations** The fourth period in Piaget's theory of cognitive development, from age 11 onward, during which individuals first become capable of more-formal kinds of abstract thinking and hypothetical reasoning.
- **peripheral nervous system** (**PNS**) The cranial and spinal nerves; that part of the nervous system peripheral to the brain and spinal cord.
- **persistent vegetative state** A condition similar to coma except that the individual intermittently appears to be awake.
- **person variables** Individual differences in cognition, which, according to Mischel, include competencies, encoding strategies and personal constructs, expectancies, subjective values, and self-regulatory systems and plans.
- **personality** A particular pattern of behavior and thinking prevailing across time and situations that differentiates one person from another.

- **personality psychology** The branch of psychology that attempts to categorize and understand the causes of individual differences in temperament and patterns of behavior.
- **personality trait** An enduring personal characteristic that reveals itself in a particular pattern of behavior in a variety of situations.
- **personality types** Different categories into which personality characteristics can be assigned based on factors such as developmental experiences or physical characteristics.
- phallic stage The third of Freud's psychosexual stages during which the primary erogenous zone is the genital area and pleasure derives from both direct genital stimulation and general physical contact.
- **phantom limb** Sensations that appear to originate in a limb that has been amputated.
- **phenotype** The appearance or behavior of an organism; outward expression of the genotype.
- phenylketonuria (PKU) Genetic disorder caused by recessive genes that impair ability to break down phenylalanine; can cause mental retardation if untreated.
- phi phenomenon The perception of movement caused by the turning on and off of two or more lights, one at a time, in sequence; often used on theater marquees; responsible for the apparent movement of images in movies and television.
- phobia Unreasonable fear of specific objects or situations, such as insects, animals, or enclosed spaces, produced by stimulus reinforcer pairings.
- phobic disorder An unrealistic, excessive fear of a specific class of stimuli that interferes with normal activities. Phobic disorders include agoraphobia, social phobia, and specific phobia.
- **phoneme** The minimal unit of sound in a language, such as /p/.
- phonetic reading Reading by decoding the phonetic structure of letter strings; reading by "sounding out."
- phonological dyslexia A reading disorder in which people can read familiar words but have difficulty reading unfamiliar words or pronounceable nonwords because they cannot sound out words.
- **phonological short-term memory** Short-term memory for verbal information.
- **photopigment** A complex molecule found in photoreceptors; when struck by light, it splits apart and stimulates the membrane of the photoreceptor in which it resides.
- **photoreceptor** A receptive cell for vision in the retina; a rod or a cone.
- physiological psychology The branch of psychology that studies the physiological basis of behavior.
- **pituitary gland** An endocrine gland attached to the hypothalamus at the base of the brain.
- place cell A neuron that becomes active when the animal is in a particular location in the environment; most typically found in the hippocampal formation.

- placebo An ineffectual treatment used as the control substance in a single-blind or doubleblind experiment.
- **pleasure principle** The rule that the id obeys: Obtain immediate gratification, whatever form it may take.
- **polygenic control** Characteristic affected by more than one gene, as with most behavior.
- **polygraph** An instrument that records changes in physiological processes such as brain activity, heart rate, and breathing.
- **polygyny** Mating strategy of one male with more than one female.
- **pons** The part of the brain stem just anterior to the medulla; involved in control of sleep.
- **positive psychology** A program of psychology that examines the basis of optimal human functioning, with emphasis on the origins, processes, and mechanisms of human well-being.
- positive symptom A symptom of schizophrenia, including thought disorder, delusions, or hallucinations.
- **positron emission tomography (PET)** The use of a device that reveals the localization of a radioactive tracer in a living brain.
- **postconventional level** Kohlberg's third and final level of moral development, in which people come to understand that moral rules include principles that apply across all situations and societies.
- **posthypnotic amnesia** Failure to remember what occurred during hypnosis; induced by suggestions made during hypnosis.
- **posthypnotic suggestion** A suggestion made by a hypnotist that is carried out some time after the participant has left the hypnotic state and usually according to a specific cue.
- **postsynaptic neuron** A neuron with which the terminal buttons of another neuron form synapses and that is excited or inhibited by that neuron.
- **post-traumatic stress disorder (PTSD)** An anxiety disorder in which the individual has feelings of social withdrawal accompanied by atypically low levels of emotion; caused by prolonged exposure to a stressor, such as war or a natural catastrophe.
- **practical intelligence** In Sternberg's triarchic theory, intelligence that reflects the behaviors that were subject to natural selection: adaptation (initially fitting self to environment by developing useful skills and behaviors); selection (finding an appropriate niche in the environment); and shaping (changing the environment).
- **preconventional level** Kohlberg's first level of moral development, which bases moral behavior on external sanctions such as authority and punishment.
- **prefrontal cortex** The anterior part of the frontal lobe; contains the motor association cortex.
- prejudice A preconceived opinion or bias; especially, a negative attitude toward a group of people who are defined by their racial, ethnic, or religious heritage or by their gender, occupation, sexual orientation, level of education,

place of residence, or membership in a particular group.

- **prenatal period** The approximately 9 months between conception and birth. This period is divided into three developmental stages: the zygotic, the embryonic, and the fetal.
- **preoperational period** The second period in Piaget's theory of cognitive development, lasting from 2 years of age to 7, and representing a transitional period between symbolic and logical thought. During this stage, children become increasingly capable of speaking meaningful sentences.
- **preoptic area** An area of the hypothalamus that contains neurons that inhibit arousal neurons to produce sleep.
- presynaptic neuron A neuron whose terminal buttons form synapses with and excite or inhibit another neuron.
- preventive psychology Strategies that attempt to prevent the development of psychological problems by altering the sociocultural variables predictive of psychological distress.
- primacy effect The tendency to form an impression of a person based on the initial information one receives about her or him. In the memorization of a list of words, the primacy effect is evidenced by better recall of the words early in the list.
- **primary appraisal** The first stage of cognitive appraisal, during which we evaluate the seriousness of a threat (stressor).
- primary auditory cortex The region of the cerebral cortex that receives information directly from the auditory system; located in the temporal lobes.
- primary motor cortex The region of the cerebral cortex that directly controls the movements of the body; located in the posterior part of the frontal lobes.
- primary somatosensory cortex The region of the cerebral cortex that receives information directly from the somatosensory system (touch, pressure, vibration, pain, and temperature); located in the front part of the parietal lobes.
- primary visual cortex The region of the cerebral cortex that receives information directly from the visual system; located in the occipital lobes.
- proactive interference Interference in recall that occurs when previously learned information disrupts our ability to remember newer information.
- problem-focused coping Any coping behavior that aims to reduce stress by reducing or eliminating a stressor.
- progressive relaxation technique A stressreduction method in which a person learns to (1) recognize body signals that indicate the presence of stress; (2) use those signals as a cue to begin relaxing; and (3) relax groups of muscles, beginning with those in the head and neck and proceeding to those in the arms and legs.
- projective tests Unstructured personality measures in which a person is shown a series of

ambiguous stimuli, such as pictures, inkblots, or incomplete drawings. The person is asked to describe what he or she "sees" in each stimulus or to create stories that reflect the theme of the drawing or picture.

- **prosody** The use of changes in intonation and emphasis to convey meaning in speech besides that specified by the particular words.
- **prosopagnosia** A form of visual agnosia characterized by difficulty in the recognition of people's faces; may be accompanied by difficulty in recognizing other complex objects; caused by damage to the visual association cortex.
- protanopia A form of hereditary anomalous color vision; caused by defective "red" cones in the retina.
- prototype A hypothetical idealized pattern that resides in the nervous system and is used to perceive objects or shapes by a process of comparison; recognition can occur even when an exact match cannot be found.
- **protoword** A unique string of phonemes that an infant invents and uses as a word.
- psychoanalysis A form of psychotherapy aimed at providing the client with insight into his or her unconscious motivations and impulses; first developed by Sigmund Freud.
- **psychodynamic** Characterized by conflict among instincts, reason, and conscience; describes the mental processes envisioned in Freudian theory.
- **psychodynamic therapy** A therapeutic approach derived from psychoanalysis but typically deemphasizing psychosexual development in favor of emphasis on social and interpersonal experiences and the complexities of the ego.
- **psycholinguistics** A branch of psychology devoted to the study of verbal behavior and related cognitive abilities.
- **psychology** The scientific study of the causes of behavior; also, the application of the findings of psychological research to the solution of problems.
- **psychoneuroimmunology** Study of the interactions between the immune system and behavior as mediated by the nervous system.
- psychopathy A personality trait meauring impulsivity and lack of empathy or remorse for harm caused by one's actions.
- **psychophysics** A branch of psychology that measures the quantitative relation between physical stimuli and perceptual experience.
- psychosurgery Brain surgery used in an effort to relieve the symptoms of psychological disorders in the absence of obvious organic damage.
- **psychoticism** The tendency to be aggressive, egocentric, and antisocial.
- puberty The period during which people's reproductive systems mature, marking the beginning of the transition from childhood to adulthood.
- **punishing stimulus (punisher)** Stimulus that evokes escape and withdrawal responses that interfere with the behavior that produced it.
- punishment Process by which a stimulus decreases the strength of behavior by conditioning responses that interfere with the operant.

- **pursuit movement** The movement that the eyes make to maintain an image upon the fovea.
- **qualitative research** An alternative research strategy stressing the observation of variables that are not numerically measurable.
- **random assignment** Procedure in which each participant has an equally likely chance of being assigned to any of the conditions or groups of an experiment.
- **range** The difference between the highest score and the lowest score of a sample.
- rapid-eye-movement (REM) sleep A stage of sleep during which dreaming, rapid eye movements, and muscular paralysis occur and the EEG shows beta activity.
- ratio IQ A formula for computing the intelligence quotient: mental age divided by chronological age, multiplied by 100.
- ratio schedules Reinforcement schedules in which reinforcers are dependent on a designated number of responses; may be either fixed or variable.
- rational emotive behavior therapy A form of psychotherapy based on the belief that psychological problems are caused not by distressing experiences themselves but by how people think and feel about those experiences. rationalism The philosophical view that all
- knowledge is obtained through reason.
- **reality principle** The tendency to satisfy the id's demands realistically, which almost always involves compromising the demands of the id and superego.
- receiver-operating-characteristic curve (ROC curve) A graph of hits and false alarms of subjects under different motivational conditions; indicates people's ability to detect a particular stimulus.
- **recency effect** The tendency to recall later information. In the memorization of a list of words, the recency effect is evidenced by better recall of the last words in the list.
- **receptive field** That portion of the visual field in which the presentation of visual stimuli will produce an alteration in the firing rate of a particular neuron.
- receptor cell A neuron that directly responds to a physical stimulus, such as light, vibrations, or aromatic molecules.
- **recessive allele** A trait that is expressed only when both alleles of a gene are the same, a trait expressed homozygous cells.
- **reciprocal altruism** Altruism in which one individual benefits another when it is likely that the other will return the benefit at a later time.
- **reciprocal determinism** The idea that behavior, environment, and person variables interact to determine personality.
- **reflex** An automatic response to a stimulus, such as the blink reflex to the sudden unexpected approach of an object toward the eyes.
- **regulatory genes** Genes that govern genes that code for proteins.
- reinforcement Process by which a reinforcer increases the environmental guidance of behavior.
  reinforcing stimulus (reinforcer) Stimulus that strengthens responding in either the classical

or operant procedures, often called simply a *reinforcer*.

- **relative size** A monocular cue for depth perception based on the retinal size of an object.
- **reliability** The repeatability of a measurement; the likelihood that if the measurement were made again, it would yield the same value.
- **replication** Repetition of an experiment or observational study in an effort to see whether previous results will be obtained; ensures that incorrect conclusions are weeded out.
- representativeness heuristic A general rule for classifying a person, place, or thing into the category to which it appears to be the most similar.
- repression A defense mechanism responsible for actively keeping potentially threatening or anxiety-provoking memories from being consciously discovered.
- **reproductive strategies** Evolutionary effects on systems of mating and rearing offspring; these need not be conscious strategies.
- **residual schizophrenia** A type of schizophrenia that may follow an episode of one of the other types and is marked by negative symptoms but not by any prominent positive symptom.
- **resistance** A development during psychoanalysis in which the client becomes defensive, unconsciously attempting to halt further insight by censoring his or her emotions.
- resistant attachment A kind of attachment in which infants show mixed reactions to their mothers. In the Strange Situation test, when mothers return after being absent, such infants may approach their mothers but at the same time may continue to cry or even push their mothers away.
- **response bias** Responding to a questionnaire in a way that is not genuine or honest but in some other irrelevant way.
- **resting potential** The membrane potential of a neuron when it is not producing an action potential.
- retention Third component of evolution: the favored variations are retained through heredity.
- **retina** The tissue at the back inside surface of the eye that contains the photoreceptors and associated neurons.
- **retinal disparity** The fact that objects located at different distances from the observer will fall on different locations on the two retinas; provides a binocular cue for depth perception.
- **retrieval** The active processes of locating and using stored information.
- retrieval cues Contextual variables, including physical objects, or verbal stimuli, that improve the ability to recall information from memory.
- retroactive interference Interference in recall that occurs when recently learned information disrupts our ability to remember older information.
- retrograde amnesia Loss of the ability to retrieve memories of the past, particularly memories of episodic or autobiographical events.
- reuptake The process by which a terminal button retrieves the molecules of a neurotransmitter that it has just released; terminates the effect of the neurotransmitter on the receptors of the postsynaptic neuron.

rhodopsin The photopigment contained by rods. RNA Single-stranded nucleic acid that is involved in several functions within the cell.

- **rod** A photoreceptor that is very sensitive to light but cannot detect changes in hue.
- **Rorschach Inkblot Test** A projective test in which a person is shown a series of symmetrical inkblots and asked to describe what he or she thinks they represent.
- **round window** An opening in the bone surrounding the cochlea. Movements of the membrane behind this opening permit vibrations to be transmitted through the oval window into the cochlea.
- saccadic movement The rapid movement of the eyes that is used in scanning a visual scene, as opposed to the smooth pursuit movements used to follow a moving object.
- sample A selection of elements representative of a larger population—for example, a group of participants selected to participate in an experiment.
- saturation A perceptual dimension of color, most closely associated with purity of a color.
- **scaffolding** The matching of a mentor's efforts to a child's developmental level.
- **scatterplot** A graph of items that have two values; one value is plotted against the horizontal axis and the other against the vertical axis.
- schedule of reinforcement Reinforcement procedure that specifies the conditions necessary for reinforcement. Also, procedures that manipulate the temporal relation between stimuli, responses, and reinforcers.
- **schema** A mental framework or body of knowledge that organizes and synthesizes information about a person, place, or thing.
- **schizophrenia** A serious psychological disorder characterized by thought disturbances, hallucinations, anxiety, emotional withdrawal, and delusions.
- school psychologist A psychologist who deals with the behavioral problems of students at school.
- scientific method A set of rules that governs the collection and analysis of data gained through observational studies or experiments.
- sclera The tough outer layer of the eye; the "white" of the eye.
- script A person's knowledge about the characteristics typical of a particular type of event or situation; assists the comprehension of speech.
- **secondary appraisal** The second stage of cognitive appraisal, during which we evaluate the resources we have available to deal with a threat (stressor).
- secure attachment A kind of attachment in which infants use their mothers as a base for exploring a new environment. In the Strange Situation test, securely attached infants will venture out from their mothers to explore, but will return periodically.
- **segregation analysis** Correlational method to identify sections of chromosomes that are the same for individuals expressing a common trait.
- selection Second component of evolution, provides direction to the process.

- selectionism Explanation of complex outcomes as the cumulative effect of the three-component process identified by Darwin.
- selective attention The process that controls our awareness of, and readiness to respond to, particular categories of stimuli or stimuli in a particular location to the exclusion of others.
- **self-actualization** The realization of our true intellectual and emotional potential.
- **self-concept** One's knowledge, feelings, and beliefs about oneself.
- **self-control** Behavior that produces a larger, long-term reward when people are faced with the choice between it and a smaller, shortterm reward; also the tendency to be kind, considerate, and obedient of laws and rules.
- self-efficacy People's beliefs about how well or badly they will perform tasks.
- self-fulfilling prophecy An expectation that causes a person to act in a manner consistent with the expectation; the person's actions then cause the expectation to come true. Often seen in cases of stereotyping.
- **self-handicapping** Impairing one's performance so as to attribute failures situationally and successes dispositionally.
- self-perception theory The theory that we come to understand our attitudes and emotions by observing our own behavior and the circumstances under which it occurs.
- **self-schema** The cognitive representation of the self-concept.
- self-serving bias The tendency to attribute one's accomplishments and successes to dispositional factors and one's failures and mistakes to situational factors.
- **semantic memory** A type of long-term memory that contains data, facts, and other information, including vocabulary.
- semantic priming The facilitating effect of a word on the recognition of words having related meanings that are presented subsequently.
- **semantics** The meanings and the study of the meanings of words.
- semicircular canal One of a set of organs in the inner ear that responds to rotational movements of the head.
- **sensation** The detection of the elementary properties of a stimulus.
- **sensitive period** A period during which certain experiences have a greater effect on development than they would have if they had occurred at another time.
- sensorimotor period The first period in Piaget's theory of cognitive development, lasting from birth to 2 years, and marked by an orderly progression of increasingly complex cognitive development from reflexes to object permanence to deferred imitation and rudimentary symbolic thinking.
- **sensory association cortex** Those regions of cerebral cortex that receive information from the primary sensory areas.
- **sensory memory** Memory in which representations of the physical features of a stimulus are stored for very brief durations.
- sensory neuron A neuron that detects changes in the external or internal environment and

sends information about these changes to the central nervous system.

- **separation anxiety** A set of fearful responses, such as crying, arousal, and clinging to the caregiver, that an infant exhibits when its caregiver attempts to leave the infant.
- **serotonin** (*sair a toe nin*) A monoamine neurotransmitter involved in the regulation of mood; in the control of eating, sleep, and arousal; and in the regulation of pain.
- **set point** Optimal value of the system variable in a regulatory process. The set point for human body temperature is 98.6°F (37°C).
- sex chromosomes X or Y chromosomes that contain genes affecting sexual development.
- **sex-linked traits** Traits affected by genes located on the sex chromosomes.
- sexual reproduction Production of offspring by combining the germ cells of a male and female.
- sexual selection Preference for traits that are differentially expressed in the two sexes, for example, body size.
- shading A monocular cue for depth perception; the apparent light source determines whether the surface of an object is perceived as concave or convex.
- **shadowing** The act of continuously repeating verbal material aloud as soon as it is heard.
- shallow processing Analysis of the superficial characteristics of a stimulus, such as its size or shape.
- shaping Procedure in which successively closer approximations to a target behavior are reinforced; commonly used when acquiring complex behavior.
- short-term memory An immediate memory for stimuli that have just been perceived. It is limited in terms of both capacity (72 chunks of information) and duration (less than 20 seconds).
- signal-detection theory A mathematical theory of the detection of stimuli, which involves discriminating a signal from the noise in which it is embedded and which takes into account subjects' willingness to report detecting the signal.
- **single-blind study** An experiment in which the researcher knows the value of the independent variable but participants do not.
- **single-subject design** An alternative research strategy that examines the effects of a manipulation on an individual participant or subject.
- situational factors Physical and social stimuli that are found in an individual's environment and that can affect his or her behavior.
- situationism The view that the behaviors defining a certain personality are determined solely by the current situation rather than by any persevering traits.
- sleep-related eating disorder Occurs during sleepwalking as the individual seeks out food and consumes it, usually with no memory of having done so.
- sleepwalking The experience of walking during sleep without a clear memory of doing so; occurs during slow-wave sleep, usually in childhood.
- slow-wave sleep Sleep other than REM sleep, characterized by regular, slow waves on the electroencephalogram.

- Glossary
- **social cognition** The processes involved in perceiving, thinking about, and acting on social information.
- **social cognitive theory** The idea that both consequences of behavior and an individual's beliefs about those consequences determine personality.
- social facilitation The enhancement of task performance caused by the mere presence of others.
- **social loafing** The tendency of individuals to put forth decreased effort when performing a task together with other people.
- **social norms** Informal rules defining the expected and appropriate behavior in specific situations.
- social phobia An anxiety disorder characterized by an excessive and irrational fear of situations in which the person is observed by others.
- **social psychology** The branch of psychology devoted to the study of the effects people have on one another's behavior.
- **sociobiology** The study of genetic influences on social behavior, especially in animals.

soma A cell body; the largest part of a neuron.

- somatic nervous system The portion of the peripheral nervous system that transmits information from sense organs to the central nervous system and from the central nervous system to the muscles.
- somatosense Bodily sensations; sensitivity to such stimuli as touch, pain, and temperature.
- species-typical behavior A behavior seen in all or most members of a species, such as nest building, special food-getting behaviors, or reproductive behaviors.
- specific phobia An anxiety disorder characterized by an excessive and irrational fear of specific things, such as snakes, darkness, or heights.
- spinal cord A long, thin collection of neural cells attached to the base of the brain and running the length of the spinal column.
- spinal nerve A bundle of nerve fibers attached to the spinal cord; conveys sensory information from the body and carries messages to muscles and glands.
- split-brain operation A surgical procedure that severs the corpus callosum, thus abolishing the direct connections between the cortex of the two cerebral hemispheres.
- **spontaneous recovery** Increase in a previously extinguished response after the passage of time.
- standard deviation A statistic that expresses the variability of a measurement; square root of the average of the squared deviations from the mean.
- Stanford–Binet Scale An intelligence test that consists of various tasks grouped according to mental age; provides the standard measure of the IQ.
- statistical significance The likelihood that an observed relation or difference between two variables really exists rather than being due to chance factors.
- stem cell An undifferentiated cell that can divide and produce any one of a variety of differentiated cells.
- **stereotaxic apparatus** A device used to insert an electrode into a particular part of the brain for the purpose of recording electrical activ-

ity, stimulating the brain electrically, or producing localized damage.

- **stereotype** An overgeneralized and thus potentially false schema describing the characteristics of a particular group.
- stimulus discrimination Process by which the environmental guidance of behavior is restricted to the environment in which the behavior was reinforced; can be produced by extinguishing the response in other environments.
- stimulus generalization Process by which behavior occurs in an environment in which it has not been reinforced, but which is similar to that environment.
- **storage** The process of maintaining information in memory.
- **Strange Situation** A test of attachment in which an infant is exposed to different stimuli that may cause distress.
- stranger anxiety The wariness and fearful responses, such as crying and clinging to their caregivers, that infants exhibit in the presence of strangers.
- stress A pattern of physiological, behavioral, emotional, and cognitive responses to stimuli (real or imagined) that are perceived as endangering our well-being.
- stress inoculation training The stress management program developed by Meichenbaum to help people develop coping skills that increase their resistance to the negative effects of stress. stressors Stimuli that are perceived as endanger-
- ing our well-being.
- striving for superiority Our motivation to achieve our full potential. Adler argued that striving for superiority is born from our need to compensate for our inferiority.
- structural family therapy A form of family therapy in which the therapist infers the maladaptive relationships among family members from their behavior and attempts to help the family restructure these relationships for more desirable interactions.
- structuralism The system of experimental psychology that began with Wilhelm Wundt; it emphasized introspective analysis of sensation and perception.
- **subordinate concept** A more-specific concept that falls within a basic-level concept.
- substance-related disorders Psychological disorders that are characterized by addiction to drugs or alcohol or by abuse of drugs or alcohol.
- **subvocal articulation** An unvoiced speech utterance.
- successful intelligence According to Sternberg, the ability to analyze and manage personal strengths and weaknesses effectively; in Sternberg's scheme, successful intelligence draws on analytic, creative, and practical intelligence.
- superego The repository of an individual's moral values, divided into the conscience—the internalization of society's rules and regulations—and the ego-ideal—the internalization of the individual's goals.
- **superordinate concept** A general or overarching concept that includes basic-level concepts.

- **suprachiasmatic nuclei** An area of the hypothalamus that provides a biological clock for circadian rhythms.
- **surface dyslexia** A reading disorder in which people can read words phonetically but have difficulty reading irregularly spelled words by the whole-word method.
- **surface structure** The grammatical features of a sentence; its words and syntax.
- **survey study** A study of people's responses to standardized questions.
- syllogism A logical construction that contains a major premise, a minor premise, and a conclusion. The major and minor premises are assumed to be true, and the truth of the conclusion is to be evaluated by deductive reasoning.
- sympathetic branch The portion of the autonomic nervous system that activates functions that accompany arousal and expenditure of energy.
- **synapse** The junction between the terminal button of one neuron and the membrane of a muscle fiber, a gland, or another neuron.
- synaptic cleft A fluid-filled gap between the presynaptic and postsynaptic membranes; the terminal button releases a neurotransmitter into this space.
- **synaptic vesicle** (*vess i kul*) A small, hollow, beadlike structure found in terminal buttons; contains molecules of a neurotransmitter.
- **syntactical rule** A grammatical rule of a particular language for combining words to form phrases, clauses, and sentences.
- system variable The variable controlled in a regulatory process; for example, temperature in a heating system.
- systematic desensitization A form of behavior therapy in which the client is trained to relax in the presence of increasingly fearsome stimuli.
- T lymphocytes White blood cells that develop in the thymus gland and produce antibodies that defend the body against fungi, viruses, and multicellular parasites.
- tardive dyskinesia A serious movement disorder, distinguished by involuntary lip smacking, grimacing, and drooling, that may result from prolonged use of antipsychotic drugs.
- **target cell** A cell whose physiological processes are affected by a particular hormone; contains special receptors that respond to the presence of the hormone.
- targeted mutation A mutated gene (also called a "knockout gene") produced in the laboratory and inserted into the chromosomes of mice; abolishes the normal effects of the gene.
- **taste aversion** Conditioning in which a distinctive taste (or smell) is paired with an ingested food that produces nausea, effective even with long intervals between the taste and nausea.
- **taste bud** A small organ on the tongue that contains a group of gustatory receptor cells.
- **tectorial membrane** A membrane located above the basilar membrane; serves as a shelf against which the cilia of the auditory hair cells move.
- **temperament** An individual's pattern of behaviors and emotional reactions.
- **template** A hypothetical pattern that is stored in the nervous system and is used to perceive objects or shapes by a process of comparison.

- **temporal coding** A means by which the nervous system represents information; different features are coded by the pattern of activity of neurons.
- temporal contiguity Relation between two events that occur close together in time.
- **temporal lobe** (*tem por ul*) The portion of the cerebral cortex below the frontal and parietal lobes; contains the auditory cortex.
- **teratogens** Substances, agents, and events that can cause birth defects.
- **terminal button** The rounded swelling at the end of the axon of a neuron; releases a neuro-transmitter.
- **texture gradient** A monocular cue for depth perception; the relative fineness of detail present in the surfaces of objects or the ground or floor.
- **thalamus** A region of the brain near the center of the cerebral hemispheres. All sensory information except that of olfaction is sent to the thalamus and then relayed to the cerebral cortex.
- Thematic Apperception Test (TAT) A projective test in which a person is shown a series of ambiguous pictures that involve people. The person is asked to make up a story about what the people are doing or thinking. The person's responses are believed to reflect aspects of his or her personality.
- **theory** A set of statements designed to explain a set of phenomena; more encompassing than a hypothesis.
- theory of mind Expectations concerning how experience affects mental states, especially those of another.
- **theta activity** Electroencephalogram activity of 3.5 to 7.5 Hz; occurs during the transition between sleep and wakefulness.
- **threat gesture** Stereotyped gesture that signifies that one animal is likely to attack another.
- **threshold** The point at which a stimulus, or a change in the value of a stimulus, can just be detected.
- **timbre** (*tamm ber*) A perceptual dimension of sound that corresponds to its complexity.
- tip-of-the-tongue phenomenon An occasional problem with retrieval of information that we are sure we know but cannot immediately remember.
- token economy A form of behavior therapy often used in mental institutions; target behaviors are reinforced with tokens that are exchangeable for desirable goods or special privileges.
- **top-down processing** Perception based on information provided by the context in which a particular stimulus is encountered.
- **Tourette's syndrome** A neurological disorder characterized by tics and involuntary utterances, some of which may involve obscenities and the repetition of others' utterances.
- transcranial magnetic stimulation (TMS) Direct stimulation of the cerebral cortex induced by magnetic fields generated outside the skull.
- **transduction** The conversion of physical stimuli into changes in the activity of receptor cells of sensory organs.
- **transference** A process in which a client begins to project powerful attitudes and emotions onto a psychoanalyst.

- **transsexual** An individual who perceives himself or herself as belonging to a different sex than that which they were assigned at birth.
- **trephining** A surgical procedure in which a hole is made in the skull of a living person.
- **trichromatic theory** The theory that color vision is accomplished by three types of photodetectors, each of which is maximally sensitive to a different wavelength of light.
- tritanopia A form of hereditary anomalous color vision; caused by a lack of "blue" cones in the retina.
- two-point discrimination threshold The minimum distance between two small points that can be detected as separate stimuli when pressed against a particular region of the skin.
- **type A behavior pattern** A behavior pattern characterized by impatience, high levels of competitiveness and hostility, and an intense disposition; supposedly associated with an increased risk of CHD.
- **type B behavior pattern** A behavior pattern characterized by patience, relatively low levels of competitiveness and hostility, and an easygoing disposition; supposedly associated with a decreased risk of CHD.
- umami (oo mah mee) The taste sensation produced by glutamate; identifies the presence of amino acids in foods.
- unconditional positive regard In Rogers' approach, the therapist's assertion that a client's worth as a human being is not dependent on anything that he or she thinks, does, or feels; love and acceptance of an individual with no strings attached.
- **unconditioned response (UR)** Response that is elicited by the US in a classical procedure.
- **unconditioned stimulus (US)** Stimulus, such as food, that elicits a reflexive response, such as salivation, in a classical procedure.

unconscious The inaccessible part of the mind.

- underextension The use of a word to denote a smaller class of items than is appropriate; for example, referring only to one particular animal as a dog.
- undifferentiated schizophrenia A type of schizophrenia characterized by fragments of the symptoms of different types of schizophrenia.
- validity The degree to which the operational definition of a variable accurately reflects the variable it is designed to measure or manipulate.
- variable Anything capable of assuming any of several values.
- variation First component of evolution: individual members of a species differ from one another.
- ventral prefrontal cortex The region of the prefrontal cortex at the base of the anterior frontal lobes, involved in control of emotional behavior.
- ventral stream The flow of information from the primary visual cortex to the visual association area in the lower temporal lobe; used to form the perception of an object's shape, color, and orientation (the "what" system).
- **ventricular zone** A layer of cells that line the inside of the neural tube; contains founder cells

that divide and give rise to cells of the central nervous system.

- vergence movement The cooperative movement of the eyes, which ensures that the image of an object falls on identical portions of both retinas.
- vertebra (plural, vertebrae) One of the bones that encases the spinal cord and constitutes the vertebral column.
- vestibular apparatus The receptive organs of the inner ear that contribute to balance and perception of head movement.
- **vestibular sac** One of two sets of receptor organs in each inner ear that detect changes in the tilt of the head.
- visual agnosia The inability of a person who is not blind to recognize the identity or use of an object by means of vision; usually caused by damage to the brain.
- **voice-onset time** The delay between the initial sound of a consonant (such as the puffing sound of the phoneme /p/) and the onset of vibration of the vocal cords.
- wavelength The distance between adjacent waves of radiant energy; in vision most closely associated with the perceptual dimension of hue.
- Weber fraction The ratio between a just-noticeable difference and the magnitude of a stimulus; reasonably constant over the middle range of most stimulus intensities.
- Wechsler Adult Intelligence Scale (WAIS) An intelligence test for adults devised by David Wechsler; contains subtests divided into verbal and performance categories.
- Wechsler Intelligence Scale for Children (WISC) An intelligence test for children devised by David Wechsler; similar in form to the Wechsler Adult Intelligence Scale.
- Wernicke's aphasia A disorder caused by damage to the left temporal and parietal cortex, including Wernicke's area; characterized by deficits in the recognition of speech and by the production of fluent but essentially meaningless speech.
- Wernicke's area A region of the auditory association cortex located in the upper part of the left temporal lobe; involved in the recognition of spoken words.
- white matter The portions of the central nervous system that are abundant in axons rather than cell bodies of neurons. The color derives from the presence of the axons' myelin sheaths.
- whole-word reading Reading by recognizing a word as a whole; "sight reading."
- **working memory** Memory for new information and information retrieved from long-term memory; used in this text as another name for short-term memory.
- **zone of proximal development** In Vygotsky's theory, the increased potential for problemsolving and conceptual abilities that exists for a child if expert mentoring and guidance are available.
- **zygotic stage** The first stage of prenatal development, during which the zygote divides many times and the internal organs begin to form.

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# The Science of Psychology

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#### CHAPTER OUTLINE

What Is Psychology? Why Behavior Is Studied • Fields of Psychology

# The Growth of Psychology as a Science

Philosophical Roots of Psychology • Biological Roots of Psychology • Applications in Education and Therapy

#### Major Trends in the Development of Psychology

Structuralism • Functionalism • Freud's Psychodynamic Theory • Psychology in Transition • Behaviorism • Humanistic Psychology • Reaction against Behaviorism: The Emphasis on Cognition • Reaction against Behaviorism: The Emphasis on Neurobiology

#### The Brain's Future

The moment she entered the classroom, I (Don Heth) knew Laura had something she wanted to say. She sat down, looked at me, and said: "This book is freaking us out!"

I had to stifle a smile. "Oh?" I said, with as much innocence as I could muster.

"It isn't so much the part in the book that talks about replacing some of our nervous system with electronics . . . we realize that might be possible. But this guy says that we'll soon be able to replace all of it. And get this: He talks about actually having sex with a computer! Is this guy for real?"

"Well, that's your job to decide," was my rather unhelpful response. You see, Laura and three of her classmates had been

assigned to read a book by one of America's foremost authorities on technology, Raymond Kurzweil. He had entitled it *The Age* of Spiritual Machines: When Computers Exceed Human Intelligence, and in it he had engaged in some heady speculation about the future of technology. We're all familiar with devices that amplify our senses, such as hearing aids and night vi-



sion goggles. As computers get more sophisticated, Karzweil wrote, they will be capable of performing all the functions of our natural nervous system and humans will be able to "enhance" their brains with sophisticated implants. As our knowledge of the brain increases, we will, says Kurzweil in his most shocking prediction, be able to download our consciousness into a computer.

Laura's four years of studying psychology had given her a pretty good grounding in the biology of the brain. Now, she had to consider what it would mean to simulate this biology inside a computer program. She and her team had to review Kurzweil's book in a special way: As part of my class assignment, they were to work with our campus radio station and produce a thirty-minute radio documentary that would examine the plausibility of Kurzweil's predictions. And, it would be broadcasted.

In the weeks after our classroom exchange, I noticed that Laura's team was getting more and more involved in the project. I learned later that they had been spending long nights at each other's homes, working out a script and considering the interviews they had conducted with philosophers, psychologists, and computer scientists. One professor even complained to me that these students were spending too much time on *my* assignment and not enough on *hers*. Then, halfway through the term, the team asked me if they could produce a sixty-minute program. "This assignment has forced us to think about the meaning of everything we've learned about psychology," they said. "We can do something really special if we have the additional time." Thinking I had created some kind of monster, I said yes.

On the day the assignment was due, I stopped by the station and picked up the CD with the team's program. The station manager had reviewed it and had written a note on the CD. "Yikes!" was all it said.

Here are two facts about the world you live in:

- There is a man whose otherwise normal life is disturbed at night, when he suddenly leaps from his bed and prowls around his bedroom growling like a lion, his fingers curled into claws. In the morning he remembers nothing of these episodes.
- When atoms are placed in a strong magnetic field, the axes around which their electrons spin become aligned with that magnetic field. If a radio pulse is directed at the atoms, they will wobble like spinning tops and then return to their alignment. It takes different amounts of time for atoms of different elements to realign.

When you started college, you undoubtedly expected to learn facts like these and to understand how they relate to other facts. As you'll soon learn, both of these facts are of interest to psychologists.

Or consider this: If you asked your fellow students the question "What does it mean to study psychology?" you likely would receive several different answers. In fact, if you asked this question of several psychologists, you would still receive more than one answer. Psychologists are probably the most diverse group of people in our society to share the same title. Psychologists engage in research, teaching, counseling, and psychotherapy; they advise industry and governmental agencies about personnel matters, the design of products, advertising and marketing, and legislation; they devise and administer tests of personality, achievement, and ability. Psychologists study a wide variety of phenomena, including physiological processes within the nervous system, genetics, environmental events, personality characteristics, mental abilities, and social interactions. And yet psychology is a new discipline; the first person who ever called himself a "psychologist" was still alive in 1920, and professors he trained lived into the 1960s and 1970s.

Psychology is exciting partly because it is so diverse and many areas are changing so rapidly. But these aspects of the field may sometimes be confusing to you, a student faced with understanding this large and complex discipline. So this first chapter will give you an overview of what it means to be a psychologist. The sections that follow will describe the nature of psychology, its goals, and its history.





The research interests of psychologists vary widely. One researcher might be interested in the origins of aggression; another might be interested in childhood memory. Psychologists seek answers to innumerable research questions through the study of behavior.

# What Is Psychology?

In this chapter we will study the science of **psychology**—a science with a specific focus on behavior. The primary emphasis is on discovering and explaining the causes of behavior. Of course, we will describe the applications of these discoveries to such subjects as the treatment of mental disorders and the improvement of society—but the focus will be on the way psychologists discover the facts that make these applications possible. This is an important guide to understanding psychology as a science. As you read, you should concentrate on how this process of discovery works.

To help you, we should make a key distinction. The word *psychology* comes from two Greek words, *psukhe*, meaning "breath" or "soul," and *logos*, meaning "word" or "reason." The modern meaning of *psycho-* is "mind" and the modern meaning of *-logy* is "science"; thus, the word *psychology* literally means "the science of the mind." But this is a little bit misleading. Psychology is not the science of the mind, but the

**psychology** The scientific study of the causes of behavior; also, the application of the findings of psychological research to the solution of problems.

science of *behavior*. The distinction can be traced to the way psychologists have thought about the mind. Early in the development of psychology, people conceived of the mind as an independent, free-floating spirit. Later, they described it as a characteristic of a functioning brain whose ultimate role was to control behavior. Thus, the focus turned from the mind, which cannot be directly observed, to behavior, which can. And because the brain is the organ that controls behavior, psychology very soon incorporated the study of the brain. (It is this recognition, by the way, that relates the two facts cited at the start of this chapter. You will see how this is so in later chapters.)

## Why Behavior Is Studied

The ultimate goal of research in psychology is to understand human behavior: to explain why people do what they do. But how do we, as psychologists, provide an "explanation" of behavior? First, we must describe it. We must become familiar with the things that people (or other animals) do. We must learn how to categorize and measure behavior so that we can be sure that other psychologists in different places are observing the same phenomena. Next, we must discover the causes of the behavior we observe—the events responsible for a behavior's occurrence. If we can discover the events that caused the behavior, we have "explained" it. Events that cause other events (including behavior) to occur are called **causal events**.

As you will see through this book, different kinds of psychologists are interested in different kinds of behavior and in different levels of explanation. For example, one psychologist might be interested in how vision is coordinated with movement; another might be interested in courtship. But even when they are interested in the same behavior, psychologists may study different categories of causal eventswhat has been referred to as different "levels of explanation." Some look inside the organism in a literal sense, seeking physiological causes such as the activity of nerve cells or the secretions of glands. Others look inside the organism in a metaphorical sense, explaining behavior in terms of hypothetical mental states such as anger, fear, curiosity, or love. Still others look only for events in the environment (including things that other people do) that cause behavior to occur. The word levels does not mean that one approach is superior or is more fundamental than another. Rather, a level of analysis refers to a common choice of causes to study and methods of research to use. The use of different levels of explanation is one reason why psychology is such a diverse discipline.

What is the purpose of this quest for explanations? Intellectual curiosity is one answer. An essential part of human nature seems to be a need to understand what makes things work—and what could be more interesting than trying to understand our fellow human beings? But psychological research is more than an idle endeavor of curious scientists; it holds the promise of showing us how to solve our most important and pressing problems.

One reason for studying behavior is that it is one of the roots of many of the world's problems: poverty, crime, overpopulation, drug addiction, bigotry, pollution, oppression, terrorism, and war. If global warming adversely affects our planet, or if forests and lakes die because of acid rain, it will be because of our behavior. Many health-related problems-such as cardiovascular disease, some forms of cancer, and a large number of stress-related illnesses-are caused (or at least aggravated) by individuals' behavior. For example, heavy smoking, obesity, lack of exercise, poor diet, unsanitary personal habits, and stressful lifestyles are responsible for illnesses found around the world. But there are more positive reasons for studying behavior, too. There are strong relationships between behavior and health, and knowing what these are can improve your well-being. Knowing how people remember, make decisions, and evaluate outcomes can help in your business and commerce dealings. Knowing that your personal relationships with friends, relatives, and partners depend on behaviors and the way you each perceive them can help you understand yourself and others better. Knowing how learning occurs can help you study for that big test. We hope that while reading this book and learning what psychologists have discovered about human behavior, you will think about the contribution psychology could make to you and your society.

#### **Fields of Psychology**

Psychologists sometimes identify themselves in terms of their activities. Some of us are scientists, trying to discover the causes of behavior. Some of us are practitioners of *applied psychology*, applying what our scientific colleagues have learned to the solution of problems in the world outside the laboratory. And, of course, some psychologists perform both roles. The Bureau of Labor Statistics estimated that psychologists held about 106,000 jobs in 2006, with about 30,000 more employed as professors at colleges and universities across the United States (Bureau of Labor Statistics, 2006).

**Areas of Psychological Research** Most research psychologists work in colleges or universities or are employed by private or governmental research laboratories. Research psychologists differ from one another in two principal ways: in the *types of behavior* they investigate and in the *causal events* they analyze. That is, they describe different types of behavior, and they explain them in terms of different types of causes. For example, two psychologists might both be interested in memory, but they might attempt to explain memory in terms of different causal events—one may focus on physiological events, whereas the other may focus on environmental events.

causal event An event that causes another event to occur.

**Physiological psychology** examines the physiological basis of behavior. The organism's physiology, especially its nervous system, is considered to be the appropriate level of explanation. Physiological psychologists study almost all behavioral phenomena that can be observed in nonhuman animals, including learning, memory, sensory processes, emotional behavior, motivation, sexual behavior, and sleep. The phenomenon in nonhuman animals is considered a model that can help us understand the causal events in human behavior.

**Comparative psychology** is the study of the behavior of members of a variety of species in an attempt to explain behavior in terms of evolutionary adaptation to the environment. Comparative psychologists study behavioral phenomena similar to those studied by physiological psychologists. They are likely to study inherited behavioral patterns, such as courting and mating, predation and aggression, defensive behavior, and parental behavior.

Behavior genetics is the branch of psychology that studies the role of genetics in behavior. The genes we inherit from our parents include a blueprint for the construction of a human brain. Each blueprint is a little different, which means that no two brains are exactly alike. Therefore, no two people will act exactly alike, even in identical situations. Behavior geneticists study the role of genetics in behavior by examining similarities in physical and behavioral characteristics of blood relatives, whose genes are more similar than those of unrelated individuals. They also perform breeding experiments with laboratory animals to see what aspects of behavior can be transmitted to an animal's offspring. Using new techniques of molecular genetics, behavior geneticists can even alter parts of the gene during these experiments to determine how differences in the genetic code relate to behavioral differences among animals.

**Cognitive psychology** is the study of mental processes and complex behaviors such as perception, attention, learning and memory, verbal behavior, concept formation, and problem solving. To cognitive psychologists, the events that cause behavior consist of functions of the human brain that occur in response to environmental events. Cognitive researchers' explanations involve characteristics of inferred mental processes, such as imagery, attention, and mechanisms of language. Most cognitive psychologists do not study physiological mechanisms, but recently some have begun collaborating with neurologists and other professionals involved in brain scanning. The study of the biology of cognition has been greatly aided by the development of brain-scanning methods that permit us to measure the activity and structure of various parts of the human brain.

**Cognitive neuroscience** is closely allied with both cognitive psychology and physiological psychology. Researchers in this branch of psychology are generally interested in the same phenomena studied by cognitive psychologists, but they attempt to discover the particular brain mechanisms responsible for cognitive processes. One of the principal research techniques in cognitive neuroscience is to study the behavior



Methods that allow psychologists to scan the brain to show its structure and activity have greatly improved our understanding of the biology of cognition.

of people whose brains have been damaged by natural causes such as diseases, strokes, or tumors.

**Developmental psychology** is the study of the changes in behavioral, perceptual, cognitive, social, and emotional capacities of organisms as a function of age and experience. Some developmental psychologists study phenomena of adolescence or adulthood—in particular, the effects of aging. The causal events they study are as comprehensive as all of psychology: physiological processes, cognitive processes, and social influences.

**Social psychology** is the study of the effects people have on one another's behavior. Social psychologists explore phenomena such as perception (of oneself as well as of others); cause-and-effect relations in human interactions; attitudes

- **comparative psychology** The branch of psychology that studies the behavior of members of a variety of species in an attempt to explain behavior in terms of evolutionary adaptation to the environment.
- **behavior genetics** The branch of psychology that studies the role of genetics in behavior.
- **cognitive psychology** The branch of psychology that studies mental processes and complex behaviors such as perception, attention, learning and memory, verbal behavior, concept formation, and problem solving.
- **cognitive neuroscience** The branch of psychology that attempts to understand cognitive psychological functions by studying the brain mechanisms that are responsible for them.
- **developmental psychology** The branch of psychology that studies the changes in behavioral, perceptual, cognitive, social, and emotional capacities of organisms as a function of age and experience.
- **social psychology** The branch of psychology devoted to the study of the effects people have on one another's behavior.

**physiological psychology** The branch of psychology that studies the physiological basis of behavior.

| Type of Psychologist                         | Area of Application  | Typical Employment Setting  |
|--|--|---|
| Clinical neuropsychologists                  | Identification and treatment of the<br>behavioral consequences of nervous<br>system disorders and injuries | Hospitals, in association with specialists who treat diseases of the nervous system |
| Clinical psychologists                       | Identification, assessment, and treatment of mental disorders  | Private practice and hospitals  |
| Community psychologists                      | Welfare of individuals in the social<br>system, especially those who are<br>disadvantaged                  | Community organizations   |
| Consumer psychologists                       | Motivation, perception, learning, and<br>purchasing behavior of individuals in<br>the marketplace          | Corporations and advertising agencies   |
| Engineering psychologists<br>and ergonomists | Perceptual and cognitive factors in the<br>use of machinery  | Corporations and engineering agencies   |
| Forensic psychologists                       | Behavior as it relates to the legal and justice system   | Private law firms and public agencies in the justice system                         |
| Health psychologists                         | Behavior that affects health and lifestyle   | Hospitals, government agencies, and corporations                                    |
| Organizational psychologists                 | Behavior in industrial work processes  | Corporations and government agencies  |
| School psychologists                         | Behavioral issues of students in the school setting  | Educational agencies and institutions   |

[ TABLE 1 ] Some Applied Areas of Psychology

and opinions; interpersonal relationships; group dynamics; and emotional behavior, including aggression and sexual behavior.

**Personality psychology** is the study of individual differences in temperament and patterns of behavior. Personality psychologists look for causal events in a person's history, both genetic and environmental. Some personality psychologists are closely allied with social psychologists; others work on problems related to adjustment to society and hence study problems of interest to applied psychologists.

**Evolutionary psychology** seeks to explain cognitive, social, and personality aspects of psychology by looking at their adaptive significance during the evolution of modern species. Clearly, the discoveries of comparative psychologists and behavioral geneticists are of interest to evolutionary psychologists. However, evolutionary psychologists use the theory of evolution by means of natural selection as a guiding principle. The task of the evolutionary psycholo-

**personality psychology** The branch of psychology that attempts to categorize and understand the causes of individual differences in temperament and patterns of behavior.

**evolutionary psychology** The branch of psychology that explains behavior in terms of adaptive advantages that specific behaviors provided during the evolution of a species. Evolutionary psychologists use natural selection as a guiding principle.

**cross-cultural psychology** The branch of psychology that studies the impact of culture on behavior.

**clinical psychology** The branch of psychology devoted to the investigation and treatment of abnormal behavior and mental disorders.

gist is to trace the development of such differences and to explore how their adaptive advantages might explain the behavior of modern humans.

**Cross-cultural psychology** is the study of the impact of culture on behavior. Because the ancestors of people of different racial and ethnic groups lived in different environments that presented different problems and opportunities, different cultures developed different strategies for adapting to their environments. Today, these strategies show themselves in laws, customs, myths, religious beliefs, and ethical principles. The importance of cross-cultural research and the interaction between biological and cultural factors on people's behavior are explored throughout this book.

**Clinical psychology** is the study and treatment of mental disorders and problems of adjustment. Most clinical psychologists are practitioners who try to help people solve their problems, whatever the causes. The rest are scientists who look for a wide variety of causal events, including genetic and physiological factors as well as environmental factors such as parental upbringing, interactions with siblings, and other social stimuli. They also do research to evaluate and improve methods of psychotherapy.

Although discovering the causes of behavior is important, not all psychologists are involved in research. In fact, most psychologists work outside the laboratory, applying the findings of research psychologists to problems related to people's behavior. Their fields of application are still closely related to the research specialties we've just described, but their employment situations may be quite different. **TABLE 1** lists some of these applied areas.

**How Is Psychology Used?** Sometimes applications of psychology arise because other disciplines require the special knowledge about behavior that psychologists may provide. Here are two recent examples: one in the field of law enforcement and the other in rehabilitative medicine.

*Law Enforcement.* If you're familiar with any of the currently popular television shows on criminal investigation agencies, you know that technology plays a large role in police detective work. Eyewitnesses who have seen a crime perpetrator can be very helpful if they can produce a useful description of the person. In the past, police officers relied on sketch artists to help an eyewitness develop a picture that could be circulated to the wider public. However, since artists vary in their skills, it is more common nowadays to use computerized systems that compose a face from a set of isolated features. An eyewitness is given a menu of different depictions of noses, eyebrows, hairlines, and so on, and from the examples selected, a composite face is constructed (see FIGURE 1).

Are these constructions accurate? Gary Wells and Lisa Hasel (2007) from Iowa State University argue that they are not. Although it is difficult to come up with any single estimate of accuracy, Wells and Hasel point to many cases both in the laboratory and in real life where composite drawings have led to mistaken identifications. Why would this be? It's not just a case of poor memory on the part of eyewitnesses, because the errors occur even when well-known faces are constructed. Wells and Hasel argue that it is a consequence of the way the brain perceives and remembers faces. A number of research studies show that we remember faces as complete units rather than as isolated features. The use of composite drawing technology, then, works against the way we naturally remember a face we've seen. Wells and Hasel suggest that identification technology might become more accurate by taking into account the psychology of facial memory.

**Rehabilitative Medicine.** Although modern medicine has increased the survival rate of soldiers wounded in battlefields like those of Iraq and Afghanistan, it is often at the cost of the amputation of an arm or a leg. Technology can produce natural-looking prostheses, but these artificial limbs are capable of, at best, only gross and hard-to-control movement. The main impediment is that modern prostheses do not provide the sensory feedback that comes with moving a natural arm or leg.

Prompted by concern for these returning amputees, the United States Department of Defense has initiated a large project that brings together specialists in engineering with scientists who understand how the brain controls movement (Krause, 2007). The goal is to produce an artificial arm with the full function of a natural one by the year 2009. Using the knowledge of physiological psychology concerning how sensory and motor nerves work, the researchers of this project have begun efforts to "rewire" nerves from other parts of the body (such as the chest) to feel the position of an artificial arm and to control it. If this project succeeds, the knowledge of physiological psychologists and neuroscientists will have



**FIGURE 1** An example of reconstructing the memory for a face using a computerized composite system (Faces 3.0 by IQBiometrics). In this case, the eyewitness chooses a hairline at the start and then fills in the rest of the face by choosing individual features.

(From Wells, G. L. & Hasel, L. E. [2007]. Facial composite production by eyewitnesses. *Current directions in psychological science*, *16*, 6–10.)



A participant tests an artificial arm controlled by direct neural impulses.

been put to use to replace, through technology, a part of a person's nervous system. (It was, by the way, this possibility that was discussed in Ray Kurzweil's book that led to my student Laura's reaction. Perhaps his future scenario is a lot closer than we might think.)

#### QUESTIONS TO CONSIDER

- Before you read this section, how would you have answered the questions "What is psychology?" and "What do psychologists do?" Would your answer be different now?
- 2. What problems would you like psychologists to work on?
- **3.** If you were a psychologist, which field do you think you would be most interested in? What questions might you want to answer?

# The Growth of Psychology as a Science

As mentioned earlier, psychology is a young science; it started in the late 1800s in Germany. However, humans have certainly been curious about psychological issues for much longer than that. To understand how psychology as a science came into being, we can trace its roots back through philosophy and the natural sciences, because these disciplines provided the methods we now use to study human behavior; through the needs of society at the time, psychology became an independent science. These roots took many centuries to develop. Let's examine them and see how they set the stage in the late nineteenth century for the emergence of psychology as a science.

## **Philosophical Roots of Psychology**

Perhaps the most notable part of our mental experience is that each of us is conscious of our own existence. Furthermore, we are aware of this consciousness and tend to relate it to our own behavior. That is, although we may sometimes find ourselves engaged in things we had not planned to do, we generally have the impression that our conscious mind controls our behavior. We consider alternatives, make plans, and then act. We get our bodies moving; we engage in behavior.

It is ironic that, although consciousness is a private experience, we give it such importance in our public lives. Even though we can experience only our own consciousness directly, we assume that our fellow human beings also are conscious; and, to at least some extent, we attribute consciousness to other animals as well. To the degree that our behavior is similar to that of others, we tend to assume that our mental states, too, resemble one another. Much earlier in the history of our species, it was common to attribute a life-giving *animus*, or spirit, to anything that seemed to move or grow independently. Because our ancestors believed that the movements of their own bodies were controlled by their minds or spirits, they inferred that the sun, moon, wind, and tides were similarly animated. This primitive philosophy is called **animism** (from the Latin *animare*, "to



Animism attempts to explain natural phenomena by supernatural means. This painting, from the tomb of Ramses VI, depicts the ancient Egyptian belief that the sun was a god, borne across the heavens on a special boat, to be swallowed each evening by Nut, the goddess of the sky.

**animism** The belief that all animals and all moving objects possess spirits controlling their movements and thoughts.



René Descartes (1596–1650)

quicken, enliven, endow with breath or soul"). Even gravity was explained in animistic terms: Rocks fell to the ground because the spirits within them wanted to be reunited with the earth.

Obviously, our interest in animism is historical. Scientific understanding of our natural world requires that we reject such notions as the idea that rocks fall because they "want to." Rather, we refer to the existence of natural forces inherent in physical matter, even if these forces are not completely understood.

Psychology as a science must be based on the assumption that behavior is strictly subject to physical laws, just like any other natural phenomenon. This assumption allows us to discover these laws objectively, using the scientific method. The rules of scientific research impose discipline on humans, whose natural inclinations might lead them to incorrect conclusions. It seemed natural for our ancestors to believe that rocks had spirits. In contrast, the idea that feelings, emotions, imagination, and other private experiences are the products of physical laws of nature did not come easily; it was developed by thinkers and scholars through many centuries.

The ancient Greeks were the first to develop rational speculation about nature and to systematize this speculation using laws of logic and mathematics. But although the history of Western philosophy properly begins with them, we will begin here with René Descartes (1596–1650), a seventeenth-century French philosopher and mathematician. Descartes has been called the father not only of modern philosophy but also of a biological tradition that led to modern physiological psychology. He advocated a rationalistic approach—the sober, impersonal investigation of natural phenomena by means of sensory experience and human reasoning. He assumed that the world was a purely mechanical entity that, having once been set in motion by God, ran its course without divine interference. To understand the world, people had only to understand how it was constructed. This stance challenged the established authority of the Roman Catholic Church, which believed that the purpose of philosophy was to reconcile human experiences with the truth of God's revelations.

To Descartes, animals were creatures of the natural world only; accordingly, their behavior was controlled by natural causes and could be understood by the methods of science. His view of the human body was much the same: It was a machine affected by natural causes that produced natural effects. For example, the application of a hot object to a finger would cause an almost immediate withdrawal of the arm from the source of stimulation. Reactions like this did not require participation of the mind; they occurred automatically. Descartes called these actions **reflexes** (from the Latin *reflectere*, "to bend back upon itself"). Energy coming from the outside source would be reflected back through the nervous system to the muscles, which would contract (see **FIGURE 2**). The term *reflex* is still in use today, though of course we now explain the phenomenon differently.



**FIGURE 2** Descartes's diagram of a withdrawal reflex. The energy from the fire would be transmitted physically to the brain, where it would release a type of fluid that would inflate the muscles and cause movement

(Stock Montage, Inc.)

**reflex** An automatic response to a stimulus, such as the blink reflex to the sudden unexpected approach of an object toward the eyes.

What set humans apart from the rest of the world, according to Descartes, was their possession of a mind. The mind was not part of the natural world, and therefore it obeyed different laws. Thus, Descartes was a proponent of **dualism**, the belief that all reality can be divided into two distinct entities: mind and matter. He distinguished between "extended things," or physical bodies, and "thinking things," or minds. Physical bodies, he believed, do not think; so minds could not be made of ordinary matter. Although Descartes was not the first to propose dualism, his thinking differed from that of his predecessors in one important way: He suggested that a causal link existed between the mind and its physical housing.

Although later philosophers pointed out that this theoretical link actually contradicted the belief in dualism, the proposal of causal interaction between mind and matter was absolutely vital to the development of a psychological science. Descartes reasoned that the mind controlled the movements of the body and that the body, through its sense organs, supplied the mind with information about what was happening in the environment. He hypothesized that this interaction between mind and body took place in the pineal body, a small organ situated on top of the brain stem, buried beneath the large cerebral hemispheres of the brain. When the mind decided to perform an action, it tilted the pineal body in a particular direction, causing fluid to flow from the brain into the proper set of nerves. This flow of fluid caused the appropriate muscles to inflate and move.

How did Descartes come up with this mechanical concept of the body's movements? Western Europe in the seventeenth century was the scene of great advances in the sciences. It was not just the practical application of science that impressed Europeans; it was the beauty, imagination, and fun of it as well. Craftsmen constructed many elaborate mechanical toys and devices during this period. The young René Descartes was greatly impressed by the moving statues in the French royal gardens at Saint-Germain-en-Laye (Jaynes, 1970). These devices served as models for Descartes as he theorized about how the body worked. He conceived of the muscles as balloons. They became inflated when a fluid passed through the nerves that connected them to the brain and spinal cord, just as water flowed through pipes to activate the statues. This inflation was the basis of the muscular contraction that causes us to move.

Descartes's explanation was one of the first to use a technological device as a model of the nervous system. In science, a **model** is a relatively simple system that works on known principles and is able to do at least some of the things that a more complex system can do. For example, after scientists discovered that elements of the nervous system communicate by means of electrical impulses, researchers developed models of the brain initially based on telephone switchboards and later on computers. Abstract models, which are completely mathematical in their properties, also have been developed.

It was an English philosopher, John Locke (1632–1704), who took Descartes's analysis one step farther. Locke did not exempt the mind from the laws of the material universe. In place of Descartes's **rationalism** (pursuit of truth through reason), Locke advocated **empiricism**—the pursuit of truth through observation and experience. Locke rejected the belief, prevalent in the seventeenth century, that ideas were innately present in an infant's mind. Instead, he proposed that all knowledge must come through experience; it is empirically derived. (In Greek, *empeiria* means "experience.") His model of the mind was the *tabula rasa* or "cleaned slate"—the ancient method of writing on waxed tablets that were scraped clean before use. Locke proposed that at birth infants' minds were empty and ready to accept the writings of experience.

Locke believed that knowledge developed through linkages of primary sensations: simple ideas combined to form complex ones. Amending this notion somewhat, the Irish bishop, philosopher, and mathematician George Berkeley (1685-1753) suggested that our knowledge of events in the world also required inferences based on the accumulation of past experiences. For example, our visual perception of depth involves several elementary sensations, such as observing the relative movements of objects as we move our heads and the convergence of our eyes (turning inward toward each other or away) as we focus on near or distant objects. Although our knowledge of visual depth seems to be immediate and direct, it is actually a secondary, complex response constructed from a number of simple elements. Our perceptions of the world can also involve integrating the activity of different sense organs, such as when we see, hear, feel, and smell the same object.

As philosophers, Locke and Berkeley were speculating on the origins of knowledge and dealing with the concept of learning. (In fact, modern psychologists are still concerned with the issues that Berkeley raised.) But although they rejected Descartes's version of the mind, they still were trying to fit a nonquantifiable variable—reason—into the equation.

With the work of the Scottish philosopher James Mill (1773-1836), speculation about the mind completed an intellectual swing from animism (physical matter animated by spirits) to materialism-mind composed entirely of matter. Materialism is the belief that reality can be known only through an understanding of the physical world, of which the mind is a part. Mill did not invent materialism, but he developed it into a complete system for looking at human nature. He worked on the assumption that humans were fundamentally the same as other animals. Like other species, humans were thoroughly physical in their makeup and were completely subject to the physical laws of the universe. Essentially, Mill agreed with Descartes's approach to understanding the human body, but rejected the concept of an immaterial mind. Mind, to Mill, was as passive as the body. It responded to the environment in precisely the same way. The mind, no less than the body, was a machine.

dualism The philosophical belief that reality consists of mind and matter.

**model** In science, a relatively simple system that works on known principles and is able to do at least some of the things that a more complex system can do.

**rationalism** The philosophical view that all knowledge is obtained through reason.

**empiricism** The philosophical view that all knowledge is obtained through observation and experience.

**materialism** A philosophical belief that reality can be known only through an understanding of the physical world, of which the mind is a part.



## How Scientific Is Psychology, Really?

Researchers who study psychology have tried hard to earn and demonstrate its scientific reputation. There are no such problems with chemistry, physics, and biol-

ogy: Their history is testament to their status as a science. A new study, however, suggests that psychology is gaining on its scientific elders.

Simonton (2004) compared the scientific status of psychology with that of physics, chemistry, sociology and biology. He identified a number of characteristics that typified a general science:

- the number of theories and laws mentioned in introductory textbooks (the higher the ratio of theory to law, the "softer"—i.e., less scientific—the discipline)
- publication rate (the more frequent, the more scientific the discipline)
- the appearance of graphs in journal papers (the "harder" the discipline, the greater the number of graphs)
- the impact made by young researchers (the more scientific the discipline, the greater the agreement that a researcher's contribution is significant)
- how peers evaluated 60 of their colleagues in their own disciplines, and how often single papers are cited (referred to in research papers).

Simonton also looked at secondary measures of scientific standing: "lecture disfluency" (the number of pause words such as "uh," "er" and "um": these are more common in less formal, structured, and factual disciplines); the extent to which references in journal articles were recent; age at receipt of the Nobel prize; and perceived difficulty of the discipline. Simonton combined these measures to provide a composite measure of scientific status.

Based on the first set of indicators, Simonton found that the natural sciences were judged to be more "scientific" than the social sciences. Psychology fell right on the mean—at the junction between natural and social sciences (see FIGURE 3). However, psychology's score was much closer to biology than to sociology—the biggest gap in scores was found between psychology and sociology, suggesting that the discipline is closer to its natural science cousins than its social science acquaintances. A gap also separated chemistry and biology, suggesting that the sciences might be grouped according to three clusters: the physical sciences (chemistry and physics), life sciences (biology and psychology) and social science (sociology).

Simonton concludes with an interesting observation. He argues that psychology's position in this hierarchy does not really reflect its scientific approach but its subject matter: Because the subject matter of psychology can be viewed as not directly controllable or manipulable, it can be perceived, despite its adoption of the scientific method, erroneously as neither scientific fish nor fowl.

# **FIGURE 3** According to Simonton's study, psychology's scientific status was more similar to that of biology than another discipline traditionally associated with it, such as sociology.

(From D. K. Simonton (2004). Psychology's status as a scientific discipline: Its empirical placement within an implicit hierarchy of the sciences. *Review of General Psychology*, *8*, p. 65 [Fig. 2].)



# **Biological Roots of Psychology**

René Descartes and his model of muscular physiology were the beginning of the biological roots of psychology. Descartes's concept was based on an actual working model (the moving statue) whose movements seemed similar to those of human beings. However, Descartes relied on simple similarity as "proof" of his theory; he did not have the means to offer a scientific proof. But technological development soon made experimentation and manipulation possible in the biological realm as well. For example, Descartes's hydraulic model of muscular movement was shown to be incorrect by Luigi Galvani (1737-1798), an Italian physiologist who discovered that he could make muscles contract by applying an electrical current either directly to them or to the nerves attached to them. The muscles themselves contained the energy needed to contract; they did not have to be inflated by pressurized fluid. Indeed, an English physician, Francis Glisson (1597-1677), made the same assertion even more pointedly when he demonstrated, by having a man flex his arm in a barrel of water, that his muscles did not increase in volume as Descartes's theory would have predicted.

The work of the German physiologist Johannes Müller (1801–1858) clearly shows the way emerging biological knowledge shaped the evolution of psychology. Müller was a forceful advocate of applying experimental procedures to the study of physiology. He recommended that biologists should do more than observe and classify; they should remove or isolate animals' organs, test their responses to chemicals, and manipulate other conditions to see how the



Johannes Müller (1801–1858)

organism worked. His most important contribution to what would become the science of psychology was his **doctrine of specific nerve energies,** that different nerve fibers convey specific information from one part of the body to the brain or from the brain to one part of the body. Müller noted that the basic message sent along all nerves was the same—an electrical impulse—regardless of whether the message concerned, for example, a visual perception or an auditory sensation. What, then, accounts for the brain's ability to distinguish different kinds of sensory information? Why do we see what our eyes perceive, hear what our ears detect, and so on? After all, the optic nerves and the auditory nerves both send the same kind of message to the brain.

Müller's answer was that the messages are sent over different channels. Because the optic nerves are attached to the eyes, the brain interprets impulses received from these nerves as visual sensations. You have probably noticed that rubbing your eyes causes sensations of flashes of light. When you rub your eyes, the pressure against them stimulates visual receptors located inside them. As a result of this stimulation, messages are sent through the optic nerves to the brain. The brain interprets these messages as sensations of light.

Müller's doctrine had important implications. If the brain recognizes the nature of a particular sensory input by means of the particular nerve that brings the message, then perhaps the brain is similarly specialized, with different parts having different functions. In other words, if different nerves convey messages about different kinds of information, then those regions of the brain that receive these messages must have different functions.

Pierre Flourens (1774–1867), a French physiologist, provided experimental evidence for the implications of Müller's doctrine of specific nerve energies. Flourens operated on animals, removing various parts of the nervous system. He found that the resulting effects depended on which parts were removed. He observed what the animal could no longer do and concluded that the missing capacity must have been the function of the part removed. For example, if an animal could not move its leg after part of its brain was removed, then that region must normally control leg movements. This method of removal of part of the brain, called **experimental ablation** (from the Latin *ablatus*, "carried away"), was soon adopted by neurologists, and it is still used by scientists on animals today. Through experimental ablation, Flourens claimed to have discovered the regions of the brain that control heart rate and breathing, purposeful movements, and visual and auditory reflexes.

Paul Broca (1824–1880) applied Müller's logic, although not his method, to humans. In 1861 Broca, a French surgeon, performed an autopsy on the brain of a man who had had a stroke several years previously. The stroke (damage to the brain caused in this case by a blood clot) had robbed the man of the ability to speak. Broca discovered that the stroke had damaged part of the cerebral cortex on the left side of the man's brain. He suggested that this region of the brain is a center for speech.

Although subsequent research has found that speech is not controlled by a single "center" in the brain, the area that Broca identified (now known as *Broca's area*) is indeed necessary for speech production. The comparison of postmortem anatomical findings with patients' behavioral and intellectual deficits has become an important means of studying the functions of the brain.

In 1870 the German physiologists Gustav Fritsch and Eduard Hitzig introduced the use of electrical stimulation as a tool for mapping the functions of the brain. The results of this method complemented those produced by the experimental destruction of nervous tissue and provided some answers that experimental ablation could not. For example, Fritsch and Hitzig discovered that applying a small electrical shock to different parts of the cerebral cortex caused movements of different parts of the body. In fact, the body appeared to be "mapped" on the surface of the brain (see FIGURE 4). Decades later, when





**doctrine of specific nerve energies** Johannes Müller's observation that different nerve fibers convey specific information from one part of the body to the brain or from the brain to one part of the body.

**experimental ablation** The removal or destruction of a portion of the brain of an experimental animal for the purpose of studying the functions of that region.

techniques of human brain surgery had advanced to the point where painless surgery could be performed on conscious patients, the Canadian neurosurgeon Wilder Penfield would be able to show that highly specific sensory experiences and even memories could be mapped in a similar way.

The work of the German physicist and physiologist Hermann von Helmholtz (1821–1894) did much to demonstrate that mental phenomena could be explained by physiological means. This extremely productive scientist made contributions to both physics and physiology. He actively disassociated himself from natural philosophy, from which many assumptions about the nature of the mind had been derived. Müller, under whom Helmholtz had conducted his first research, believed that human organs were endowed with a vital immaterial force that coordinated physiological behavior, a force that was not subject to experimental investigation. Helmholtz would allow no such assumptions about unproved (and unprovable) phenomena. He advocated a purely scientific approach that would base conclusions on objective investigation and precise measurement.

Before Helmholtz's work, the transmission of impulses through nerves was thought to be as fast as the speed of electricity in wires; under this assumption, transmission would be virtually instantaneous, considering the small distances that impulses have to travel within the human body. Helmholtz successfully measured the speed of the nerve impulse and found that it was only about 90 feet per second, which is considerably slower than the speed of electricity in wires. This finding suggested to later researchers that the nerve impulse is more complex than a simple electrical current passing through a wire, which is indeed true.

Helmholtz next sought to measure the speed of a person's reaction to a physical stimulus. Here, however, he encountered a difficulty that no amount of careful measurement could solve: He discovered that there was too much variability from person to person to formulate the kind of scientific laws that were common in physics. This variability interested scientists who followed him and who tried to explain individual differences in behavior. Because both the velocity of nerve impulses and individuals' reactions to stimuli could be measured, researchers theorized that mental events themselves could be the subject of scientific investigation. Perhaps, if the proper techniques could be developed, it would be possible to investigate what went on within the human brain. Thus, Helmholtz's research was very important in setting the stage for the science of psychology.

In Germany, a contemporary of Helmholtz's, Ernst Weber (1795–1878), began work that led to the development of a method for measuring the magnitude of human sensations. Weber, an anatomist and physiologist, found that people's ability to distinguish between two similar stimuli—such as the brightness of two lights, the heaviness of two objects, or the loudness of two tones—followed orderly laws. This regularity suggested to Weber and his followers that perceptual phenomena could be studied as scientifically as physics or biology. The study of the relation between the physical characteristics of a stimulus and the perceptions produced is called **psychophysics**.



Hermann von Helmholtz (1821–1894)

#### **Applications in Education and Therapy**

Descartes believed that the mind had *free will*—the ability to make decisions for which it was morally responsible. This view-point fit very well with Descartes's Catholic faith, which taught that the individual's soul had to choose between good and evil. But it stood in opposition to a very different, even older, conception—that individual decisions were determined by outside forces, such as the Greek concept of *fate*, the Buddhist concept of *karma*, and the human desires mentioned in the poetic musings of the Persian mathematician Omar Khayyám.

As scientific knowledge expanded, scientists studying the physical world became increasingly precise in predicting phenomena from their antecedent causes. Philosophers began to recognize that a commitment to empiricism and materialism might also imply a commitment to determinism-the doctrine that behavior is the result of prior events. Most psychologists assume some form of determinism, in part because of the philosophical and biological developments we've discussed. A third source of this assumption can be found in the political efforts that took place in the nineteenth century to reform society and improve individual well-being. These reformers believed that societal ills could be traced to root causes. They sought to strengthen the factors that caused beneficial effects and eliminate the ones that caused illnesses, ignorance, or unhappiness. This program makes sense only if such cause-and-effect relationships exist in human society.

**Producing Change through Education.** The period from Descartes's life to that of Helmholtz saw immense changes in Western politics and culture. The American and French revolutions (partly inspired by Locke's writings) ushered in a

**psychophysics** A branch of psychology that measures the quantitative relation between physical stimuli and perceptual experience.

**determinism** In psychology, the doctrine that behavior is the result of prior events.

new conception of government as an institution to improve the life of its citizens. Education was recognized as an important means of improvement, suggesting a role for the public in an area where such issues had previously been addressed by individuals, churches, or charities. At the same time, medical advances arising from the knowledge of biology promised cures for many diseases, including diseases of the mind.

The notion of change, of betterment, was to become an important topic of study in the 1800s. Educators and physicians began to consider the factors that cause change—whether it be in either a young pupil or a patient. Much of this speculation began with the following incident that, had it occurred in our own times, would have made the headlines of many a supermarket tabloid.

-[ CASE STUDY ] In January of 1800, a boy about 12 years old was found living alone in the forests around Aveyron, France. Captured by the authorities, the boy seemed completely divorced from human contact and unable to speak or understand language. His description seemed to match reports from a neighboring district of a boy living alone in the fields; if so, he had been living without human support for two or three years, getting what food he could by raiding village vegetable patches. He was wearing a tattered shirt when found, but refused all attempts by the villagers to clothe him. He seemed mainly interested in food and a place to sleep. He seemed not to care about human company or any kind of social interaction. One of his caretakers showed him a mirror; the boy tried several times to reach through the mirror to grab the object he saw reflected there (Shattuck, 1980).

The village commissioner, who had been active in the French Revolution, must have found something unique about him, for he arranged to house the boy in an orphanage and recommended that the authorities in Paris be contacted. Eventually, the boy was brought to Paris, where he quickly became the object of observation and debate among French scholars. Some assumed that he had grown up in the wild and saw him as an untainted example of the natural state of humanity. Others claimed that he suffered from a mental disorder. When the argument died down, the poor boy was confined to a Parisian institute for the deaf. He was to live there, or in the company of one of its caretakers, until his death in 1828.

The "Wild Boy of Aveyron" is one of the most famous case studies in the history of psychology. Although it was clear that he was not deaf, the Parisian institute seemed to be the only place where he could be housed. There, his case was taken up by a young physician, Jean-Marc Gaspard Itard (1774–1838), who had just been hired by the institute a few months before. Itard worked with the boy (whom he named "Victor") for about five years. Those who had studied Victor before merely observed his reactions and recorded his deficiencies of language and habits. Itard sought to discover what Victor could learn. He devised a number of procedures to teach the boy words and recorded his progress. His reports charted the successes and failures of different methods. Itard proceeded, in other words, on the assumption "that what the boy *was* hinged on what he could *become*" (Benzaquén, 2006, p. 167). His description was couched in terms of Victor's development in response to this intervention.

Unfortunately, Victor's deficits in language improved only slightly under Itard's teaching. But Itard's efforts had profound consequences beyond his single pupil. Itard had approached the problem of educating Victor much as a doctor would approach a patient: by identifying the problem and devising a procedure to cure it. Itard stressed the identification of factors that could bring about change and inspired a new approach in Europe in the education of individuals with cognitive disabilities. More broadly, educators began to discuss whether *all* children should be educated by methods suited to their individual needs.

Child education had become an important issue in the United States at about this time. Most states had adopted a system known as the "American Common School" by the late-1800s. Reformers centralized school administration, organized classes according to age, and sought the best curriculum for a given age. Educators, such as Booker T. Washington (1856-1915), and philosophers, such as John Dewey (1859-1952), advocated reforms based on the needs and faculties of children. Dewey, in particular, argued that education must match the way children's abilities developed. He argued that children learned activities that were organized around goals; instruction should match this natural way of learning. A staunch empiricist and a passionate defender of the American idea of democracy, Dewey felt that one aim of education should be to establish habits that integrate the child into the community. His views helped shape the movement in the United States known as Progressive Education.

**The Law of Effect.** It fell to one of Dewey's professional colleagues to suggest how such habits might be learned. Edward Thorndike (1874–1949) originally studied the behavior of animals, looking at responses that might indicate intelligence. Thorndike noticed that some events, usually those that one would expect to be pleasant, seemed to "stamp in" a response that had just occurred, thereby making it more likely to occur again. Noxious events seemed to "stamp out" the response, or make it less likely to occur. (Nowadays, we call these processes *reinforcement* and *punishment*.) Thorndike defined the **law of effect** as follows:

Any act which in a given situation produces satisfaction becomes associated with that situation, so that when the situation recurs the act is more likely than before to recur also. Conversely, any act which in a given situation produces discomfort becomes disassociated from that situation, so that when the situation recurs the act is less likely than before to recur. (Thorndike, 1905, p. 203)

**law of effect** Edward Thorndike's statement that stimuli that occur as a consequence of a response can increase or decrease the likelihood of an organism's making that response again.

The law of effect seemed to provide a universal principle by which habits might be learned: Goals produced satisfaction and caused the action to recur more frequently. Larger activities could be built up from these activities; therefore, an ideal curriculum would be based on identifying the discrete units that make up the task to be learned. Extensive tests some of which Thorndike himself developed and sold to school boards across the nation—would measure how well these units had been acquired (Kremer, 1976).

If this sounds to you like a step backward from Itard's progressive ideas of individual diagnosis and treatment, you're probably correct. Thorndike's emphasis on "stamping in" responses implied that learning was automatic and inevitable. To be sure, Thorndike did acknowledge the role of instinct and individual differences in behavior. But, he was so fond of his Law of Effect that he had the words *stimulus* and *response* carved above the door of his laboratory, so that students would be reminded of how he connected them.

An alternative view of children's learning was, meanwhile, being developed in Italy by Maria Montessori (1870–1952). At a time when teaching was virtually the only profession open to women, Montessori decided to enter medical school and become a doctor, an accomplishment that must have taken extraordinary perseverance. For example, it was considered improper for a woman student to see a naked body in the presence of males, so Montessori was banished from the classroom during dissections; she had to do them herself, alone, at night, surrounded by cadavers. Despite such hardships and harassments, Montessori became the first woman in Italy to earn a medical degree (Kremer, 1976).

Ironically, it is as a teacher that she is best known today. Appointed to administer an institution for children with de-



Maria Montessori (1870-1952)

velopmental disabilities, Montessori discovered Itard's work with Victor. She applied Itard's approach to individualized instruction with considerable success. Reflecting on these results, Montessori wondered whether children without such disabilities would also benefit from this approach. She received a chance to test these theories when she was asked to organize a school for poor preschool children near Rome. Montessori added some innovations of her own and developed a system now known as the Montessori Method. This method was based on her belief that children matured through stages: They were sensitive to different kinds of instruction at specific age ranges. Education was best when it provided exercises that matched the competency of the child at that stage. And, in contrast to Thorndike's emphasis on rewards as the basis for learning, Montessori felt that extrinsic rewards actually interfered with a child's natural incentive to learn. Montessori also believed that movement was closely related to thought, and encouraged her pupils to move around in the classroom.

Montessori attracted considerable attention in Europe, but her work had little effect on American educational practices. Montessori herself may have been part of the problem: She was a bit of an autocrat and insisted that only she could train teachers in her methods. But it's also the case that Thorndike's philosophy of learning fit better with developing trends in psychology. We'll examine these in the next section. As a consequence, it's likely that the school system you experienced from elementary grade to high school was shaped more by Thorndike than by Montessori (Lillard, 2005).

Regardless of her lack of success in North America, Montessori may have had an influence on a very important figure in psychology, Jean Piaget (1896–1980). Piaget was born in the French-speaking region of Switzerland and studied biology as a young man. In the early years of his life in Switzerland, he taught children at a school that used a modified Montessori approach. Like Montessori, he was struck by the way a child's competency to understand depended on his or her age. It wasn't just that a younger child made errors that an older child would not; what impressed Piaget was that younger children made the same *kinds* of errors. Piaget's immense influence on developmental psychology resulted from his ability to explain these systematic errors by a theory of cognitive development.

**Producing Change through Psychotherapy** Before Itard took responsibility for the care of Victor, the boy had been examined by Phillippe Pinel (1745–1826). Also a physician, Pinel influenced how psychology thought about change, but in a different direction: He is now widely regarded as the father of psychiatry, the medical specialty that treats mental disorders.

Prior to Pinel's time, the care of people with mental illness was largely considered a responsibility of their family. Their treatment, typically by family members who feared or loathed their illness, could be abominable. Visitors to such households often told of how relatives would lock "the insane" in filthy cages, or chain them in pigsties. These reports eventually prompted activist governments to look for solutions, and to build asylums where persons with mental illness could be centrally cared for. Pinel was hired by the Revolutionary government of France to administer one such facility, the Salpêtrière hospital in Paris.

Pinel introduced some limited humanitarian reforms to the Salpêtrière, but his main influence was to propose that an asylum could, with proper practices, become a therapeutic institution. He and his followers tried new approaches to restore the cognitive abilities of an inmate. Mostly, these approaches were social interventions, such as long conversations with a therapist or poetry readings. They were based on the belief that mental illness had a social cause and could be cured by similar factors.

For a number of reasons, the number of asylums grew rapidly during the 1800s, along with the number of people committed to them (Shorter, 1997). It could be argued that many of these people did not truly have a mental illness, but were placed there for other reasons. Among this suspect category were the women of one ward of the Salpêtrière who were admitted with a collection of symptoms such as memory loss, intermittent paralysis, and insensitivity to painful stimuli. These women were considered to be suffering from a nervous disorder which had been given the label hysteria. Beginning in 1862, a neurologist by the name of Jean-Martin Charcot (1825-1893) developed a clinical practice based on observations from the ward. Neurology as a medical specialty deals with the treatment of diseases of the nervous system and is closely allied with psychiatry. Charcot proposed that hysteria was closely related to the condition produced by hypnosis and treated his patients by hypnotizing them. Although "hysteria" is no longer recognized as a disorder (its symptoms are now ascribed to other mental illnesses), Charcot's linking of hypnosis to the treatment of a mental illness was to have important consequences.

#### QUESTIONS TO CONSIDER

- 1. Explaining things, whether scientifically or through myths and legends, seems to be a human need. Can you think of an occasion in your recent experience where either you or someone talking to you used an animistic explanation? Do you think these are more common in everyday speech than the scientific explanations we have discussed?
- 2. Which of the philosophers, scientists, educators, or therapists described in this section appeal to you the most? Would you like to know more about any of them and their times? What questions would you like to ask these people if it were possible to meet them?
- **3.** Thorndike exerted immense influence on the development of schools in America during the early 1900s. Do you see any vestiges of his beliefs about habits and the law of effect in your own schooling experience?

# focus 🖯 n

# What Are the Roots of Psychology Within Chinese Culture?

Even though much of psychology's historical milestones took place in the western hemisphere, scholars of the eastern hemisphere have also reflected on human behavior, its causes, and its normal development. China possesses one of the old-

est civilizations on earth, so it is not surprising that there is much speculation on psychological matters in its history. Like Western psychology, many aspects of Chinese understanding of human nature derived from philosophical systems; however, in the case of China, these were primarily concerned with moral philosophy rather than the philosophy of knowledge.

One of the earliest classical texts in Chinese philosophy, the *I Ching*, is traditionally ascribed to teachings and practices from about 2800 BCE. Although it is usually regarded by Westerners as a system for telling the future, the Swiss psychologist Carl Jung (1875–1961) argued that it reflects a profoundly different world view than that of Western science. In contrast to the Western preoccupation with causal factors, the *I Ching* seeks to link the individual to the random, chance factors present at the time the prediction was made (Jung, 1967). If so, then much of Chinese philosophical speculation on human nature can be seen as a way of reconciling humans to the potential conflict and chaos around them. There have been three distinct systems that have influenced Chinese intellectual development, each associated with an Asian philosophy: Confucianism, Taoism, and Buddhism.

Confucius (551–479 BCE) developed guidelines for human relationships according to a hierarchical social structure: the authoritarian patriarchal family. The key to order and harmony in the midst of conflict and change, said Confucius, was in learning, throughout a lifetime, the habits by which one adapted oneself to the family. He believed that all people were born naturally identical, but that, through education, they reached their proper station in life. The habits they learned adjusted both individuals and societies to a utopian ideal. Confucius's psychology, therefore, identified certain traits as characteristics of the fully developed human being: "As a philosophy of life, we have generally associated with Confucianism the quiet virtues of patience, pacifism, compromise, the golden mean, reverence for ancestors, the aged, and the learned" (Jing & Fu, 2001, p. 408).

Taoism can be traced to the writings of two philosophers, Lao Tzu (298–212 BCE) and Chuang Tzu (369–286 BCE). Similar to the way many Greek philosophers described the world, Taoism taught that underneath the natural world of chaos there was a unifying principle of reconciliation: the *Tao*. Through the practice of meditation and suppression of violent emotions one could order one's life according to the Tao.

The third system originated with the Nepali teacher Siddhartha Gautama (ca. 566–486 BCE). As his followers believe, while meditating on the nature of suffering,



The Buddha's teaching emphasized proper living and respect for sentient beings as the desired conduct of human behavior.

Gautama achieved enlightenment, becoming a being known as the Buddha. The Buddha described his achievement as a recognition of four "noble truths": (1) that suffering is universal; (2) that it arises from desire; (3) that eliminating desire can eliminate suffering; and (4) that meditation and wisdom can eliminate desire. The Buddha's teachings reached China in several distinctive forms (e.g., Tibetan Buddhism can be markedly different from Zen Buddhism), but like Confucianism and Taoism, it stressed a particular mode of conduct, called the Eightfold Path: right understanding, thought, speech, action, livelihood, effort, mindfulness, and concentration (Lawson, Graham, & Baker, 2007). The Buddha taught that proper living and the respect for all sentient beings would achieve a permanent state of emptiness and a release from the cycle of suffering present in the world.

These three systems were moral philosophies. Unlike most Western philosophies that influenced psychology, Confucianism, Taoism, and Buddhism were based on an ideal goal to be achieved: For Confucianism, it was a harmonious society; for Taoism, reconciliation of contradiction; and for Buddhism, emptiness. Conduct, whether it was in action or in thought, was considered in terms of its purpose-to achieve those goals. Western psychology, by and large, considered questions of morality to be secondary to questions of origin and causation. Purpose was a result of other factors, such as the Law of Effect. Nevertheless, it is interesting to note that, by the late 1800s and early 1900s, Western psychology, through the work of Montessori and Thorndike, had begun to recognize the significance of education and habit formation in the development of the individual. When it became known in China, John Dewey's work was quite popular. Higgins and Zheng (2002) have also suggested that the Confucian system of examinations to determine one's place in the Chinese civil service sector may have been the origin of the mass testing movement in the United States.

# **Major Trends in the Development of Psychology**

Psychology as a science, as distinct from philosophy and biology, began in Germany in the late nineteenth century with Wilhelm Wundt (1832-1920). Wundt was the first person to call himself a psychologist. He shared the conviction of other German scientists that all aspects of nature, including the human mind, could be studied scientifically. His book Principles of Physiological Psychology was the first textbook of psychology; and Wundt is generally considered to have started, in 1879, the first laboratory devoted to the study of psychological phenomena.

You may have already noted the high preponderance of German scholars in our survey of early influences on psychology. The fact that Germany was the birthplace of psychology had as much to do with social, political, and economic influences as with the abilities of the nation's scientists and scholars. The German university system was well established, and professors were highly respected members of society. The academic tradition in Germany emphasized a scientific approach to a large number of subject areas, such as history, phonetics, archaeology, aesthetics, and literature. Thus, in contrast to French and British scholars, who adopted the more traditional, philosophical approach to the study of the human mind, German scholars were open to the possibility that the human mind could be studied scientifically. German science also emphasized the importance of classification. We will see the significance of this to psychology shortly. Experimental physiology, one of the most important roots of experimental psychology, was well established in Germany. It was in this climate that Müller, Helmholtz, and Wundt conducted their research.



Wilhelm Wundt (1832–1920)

## Structuralism

Wundt defined psychology as the "science of immediate experience." This approach was labeled **structuralism** by one of his students. Its subject matter was the *structure* of the mind, a structure built from the elements of consciousness, such as ideas and sensations. The raw material of structuralism was supplied by trained observers who described their own experiences. The observers were taught to engage in **introspection** (literally, "looking within"); they observed stimuli and described their experiences. Wundt and his associates made inferences about the nature of mental processes by seeing how changes in the stimuli caused changes in trained observers' verbal reports.

Like George Berkeley, Wundt was particularly interested in the way basic sensory information gave rise to complex perceptions. His trained observers attempted to ignore complex perceptions and to report only the elementary data. For example, the sensation of seeing a patch of red is immediate and elementary, whereas the perception of an apple is complex.

Wundt was an ambitious and prolific scientist who wrote many books and trained many other scientists in his laboratory. Many of these brought the new conception of psychology to North America, where it created quite a sensation. For example, in 1889, one of Wundt's protégés, James Mark Baldwin (1861–1934), was appointed professor of psychology at the University of Toronto. His employment was quite controversial: Students and prominent faculty members petitioned against his appointment, a newspaper denounced his psychological training in an editorial, and the matter almost caused a political scandal (Hoff, 1992). Baldwin survived this controversy, however, and later joined the faculty of Princeton University. There he helped start a journal, Psychological Review, that today is one of the premier journals in psychology. Other psychologists trained by Wundt, such as Edward Bradford Titchener, also became leaders of American psychology. However, Wundt's method did not survive the test of time; structuralism died out in the early twentieth century. The major problem with his approach was the difficulty of reporting the raw data of sensation, unmodified by experience. Also, the emphasis of psychological investigation shifted from the study of the mind to the study of behavior. More recently, psychologists have resumed the study of the human mind, but better methods are now available for studying it. Although structuralism has

#### **Functionalism**

The next major trend in psychology was known as **functionalism**. This approach was in large part a reaction against the structuralism of Wundt. Structuralists were interested in what they called the *components* of consciousness (ideas and sensations); functionalists focused on the *processes* of conscious activity (perceiving and learning). Functionalism grew from the new perspective on nature supplied by Charles Darwin (1809–1882) and his followers. Proponents stressed the biological significance (the purpose, or *function*) of natural processes, including behavior. The emphasis was on overt, observable behavior, not on private mental events.

Darwin's theory, which said that evolution occurred in response to the natural selection of inheritable traits, was important to psychology because it suggested that scientists could best explain behavior, like other biological characteristics, by understanding its role in the adaptation of an organism to its environment. Thus, behavior has a biological context. Darwin assembled evidence that behavior could be inherited. In The Expression of the Emotions in Man and Animals, published in 1872, he proposed that the facial gestures animals make in expressing emotions were descended from movements that previously had other functions. New areas of exploration were opened for psychologists by the ideas that an evolutionary continuity existed among various animal species and that behaviors, like parts of the body, had evolutionary histories. Darwin's cousin, Francis Galton, was one of these pioneers. He was one of the first to measure human traits objectively. The public's interest in measuring human abilities was so strong that Galton was able to set up a booth at an international exhibition in the 1880s and charge people for the privilege of being tested. (See FIGURE 5.)

The most important psychologist to embrace functionalism was the American scholar William James (1842–1910). As James said, "My thinking is first, last, and always for the sake of my doing." That is, thinking was not an end in itself; its function was to produce useful behavior. Although James did not produce any important experimental research during his tenure as professor of philosophy (later, professor of psychology) at Harvard University, his teaching and writing influenced those who followed him. His theory of emotion is one of the most famous and durable psychological theories. It is still quoted in modern textbooks. Psychologists still find it worthwhile to read James's writings; he supplied ideas for experiments that continue to sound fresh and new today.

**structuralism** The system of experimental psychology that began with Wilhelm Wundt; it emphasized introspective analysis of sensation and perception.

**introspection** Literally, "looking within" in an attempt to describe memories, perceptions, cognitive processes, or motivations.

**functionalism** An approach to understanding species' behaviors and other processes in terms of their biological significance; this approach stresses the usefulness of such processes with respect to survival and reproductive success.

**FIGURE 5** Galton advertised his project to collect data on human abilities. Interest was so keen that he even charged people for their participation.

# ANTHROPOMETRIC LABORATORY

For the measurement in various ways of Human Form and Faculty. Entered from the Science Collection of the S. Kensington Muscum.

This laboratory is established by Mr. Francis Galton for the following purposes:--

I. For the use of those who desire to be accurately measured in many ways, either to obtain timely warning of remediable faults in development, or to learn their powers.

2. For keeping a methodical register of the principal measurements of each person, of which he may at any future time obtain a copy under reasonable restrictions. His initials and date of birth will be entered in the register, but not his name. The names are indexed in a separate book.

3. For supplying information on the methods, practice, and uses of human measurement.

4. For anthropometric experiment and research, and for obtaining data for statistical discussion.

Charges for making the principal measurements: THREEPENCE each to those who are already on the Register. FOURPENCE each, to those who are not-- one page of the Register will thenceforward be assigned to them, and a few extra measurements will be made, chiefly for future identification.

The Superintendent is charged with the control of the laboratory and with determining in each case, which, if any, of the extra measurements may be made, and under what conditions.

Unlike structuralism, functionalism was not supplanted. Functionalist textbooks were widely used in departments of psychology during their early years, and the tenets of functionalism strongly influenced the development of psychological explanations. One functionalist, James Angell (1869– 1949), described its basic principles:

- 1. Functional psychology is the study of mental operations, not of mental structures. (For example, the mind remembers; it does not contain a memory.) It is not enough to compile a catalogue of what the mind does; we must try to understand what the mind accomplishes by this doing.
- 2. Mental processes must be studied not as isolated and independent events but as part of the biological activity of the organism. These processes are aspects of the organism's adaptation to the environment and are a product of its evolutionary history. For example, the fact that we are conscious implies that consciousness has adaptive value for our species.
- **3.** Functional psychology studies the relation between the environment and the response of the organism to the environment. There is no meaningful distinction between mind and body; they are part of the same entity.

Consider these points when you read the section on behaviorism.

# Freud's Psychodynamic Theory

While psychology was developing as a fledgling science, Sigmund Freud (1856–1939) was formulating a theory of human behavior that would greatly affect psychology and radically influence intellectuals of all kinds. Freud began his career as a neurologist, so his work was firmly rooted in biology. He soon became interested in behavioral and emotional problems and even attended one of Charcot's demonstrations on hypnosis at the Salpêtrière hospital. Freud was impressed with Charcot's demonstration of how a psychological event like hypnosis could cause a presumably neurological disorder like hysteria.

We discuss Freud here only to mark his place in the history of psychology. His theory of the mind included structures, but his structuralism was quite different from Wundt's. Freud devised his concepts of ego, superego, id, and other mental structures through talking with his patients, not through laboratory experiments. His hypothetical mental operations included many that were unconscious and hence not available to introspection. And unlike Wundt, Freud emphasized function; his mental structures served biological drives and instincts and reflected our animal nature.

# **Psychology in Transition**

Psychology as a science was to take a radical turn in the early decades of the twentieth century. Before we consider this change, it might help you to see how the different intellectual contributions of the structuralists and the functionalists had shaped the way psychology was practiced at universities in North America.

The controversy over James Mark Baldwin's appointment at Toronto quickly died down, helped in part when Baldwin's rival for the job was appointed to a similar position. Baldwin was given a rather handsome budget of \$1,550 for equipment, which he promptly used to create one of the first psychological laboratories in North America



James Mark Baldwin (1861-1934)



Mary Whiton Calkins (1867-1930)

(Baldwin, 1892). Like the laboratories of Wundt in Germany and James at Harvard University, the Toronto facility was designed for the experimental investigation of the mind, with attention to the control of noise and light. Baldwin went immediately to work in his new environment, even publishing a paper on handedness based on observations of his infant daughter.

The new emphasis on experimentation and observation was becoming prominent in the classroom as well. Mary Whiton Calkins (1867–1930), for example, wrote a lengthy description of the psychology course she taught to seniors at Wellesley College (Calkins, 1892). Her students studied the anatomy of the brain and received laboratory exercises in the dissection of lamb brains, the measurement of sensation, and the comparison of associations to simple words. Calkins reported that the experiments on taste "were so unpopular that I should never repeat them in a general class of students who are not specializing in the subject." This leads the modern reader to wonder just what it was that she asked her students to taste.

Through the efforts of both researchers and instructors, psychology became part of university curricula throughout the United States. Professors of psychology joined academic societies and became recognized as members of an emerging scientific discipline. Wundt had founded the science of psychology on the assumption that it should describe the contents of the mind. By the beginning of the twentieth century, however, psychologists like James and Baldwin had returned to the problem that vexed Descartes: How do we understand the actions that the mind supposedly determines?

#### **Behaviorism**

The next major trend that we will consider, behaviorism, likewise reflected this concern with action. Behaviorists went farther than James or Baldwin, however, by rejecting the special nature of mental events and by denying that unobservable and unverifiable mental events were properly the subject matter of psychology. Behaviorists believe that because psychology is the study of observable behavior, mental events, which cannot be observed, are outside the realm of psychology. **Behaviorism** is thus the study of the relation between people's environments and their behavior, without appeal to hypothetical events occurring within their heads.

We have already examined one of the first behaviorists— Edward Thorndike, who formulated the law of effect. The law of effect is certainly in the functionalist tradition. It asserts that the consequences of a behavior act back upon the organism, affecting the likelihood that the behavior will occur again. This process is very similar to the principle of natural selection that is the basis of Darwin's theory of evolution. Just as organisms that successfully adapt to their environments are more likely to survive and breed, so behaviors that cause useful outcomes become more likely to recur.

Thorndike insisted that the subject matter of psychology was behavior. But his explanations contained mentalistic terms. For example, in his law of effect he spoke of "satisfaction," which is certainly not a phenomenon that can be directly observed. Later behaviorists recognized this contradiction and replaced terms such as *satisfaction* and *discomfort* with more objective concepts that reflected only the behavior.

Another major figure in the development of the behavioristic trend was not a psychologist at all but a physiologist: Ivan Pavlov (1849–1936), a Russian who studied the physiology of digestion (for which he later received a Nobel Prize). In



Ivan Pavlov (1849–1936) in his laboratory with some of his collaborators. His research revealed valuable information about the principles of learning.

**behaviorism** A movement in psychology that asserts that the only proper subject matter for scientific study in psychology is observable behavior.



John B. Watson (1878-1958)

the course of studying the stimuli that produce salivation, Pavlov discovered that hungry dogs would salivate at the sight of the attendant who brought in their dishes of food. Although first labeling this phenomenon a "psychic reflex," Pavlov soon traced it to the experience the dog had received. Pavlov found that a dog would salivate at a completely arbitrary stimulus, such as the sound of a bell, if the stimulus was quickly followed by the delivery of a bit of food into the animal's mouth.

Pavlov's discovery had profound significance for psychology. He showed that through experience, an animal could learn to make a response to a stimulus that had never caused this response before. This ability might explain how organisms learn cause-and-effect relations in the environment. In contrast, Thorndike's law of effect suggested an explanation for the adaptability of an individual's behavior to its particular environment. So, from Thorndike's and Pavlov's studies, two important behavioral principles had been discovered.

Behaviorism as a formal school of psychology began with the publication of a book by John B. Watson (1878– 1958), *Psychology from the Standpoint of a Behaviorist*. Watson, a professor of psychology at Johns Hopkins University, was a popular teacher and writer and a very convincing advocate of the behavioral perspective. Even after leaving Johns Hopkins for a highly successful career in advertising, he continued to lecture and write magazine articles about psychology.

According to Watson, psychology was a natural science whose domain was restricted to observable events: the behavior of organisms. Watson believed that the elements of consciousness studied by the structuralists were too subjective to lend themselves to scientific investigation. He defined psychology as the objective study of stimuli and the behavior they produced. He reduced even thinking to a form of behavior—"talking to ourselves":

Now what can we observe? We can observe behavior *what the organism does or says.* And let us point out at once: that saying is doing—that is, behaving. Speaking overtly or to ourselves (thinking) is just as objective a type of behavior as baseball. (Watson, 1930, p. 6) Behaviorism is still very much in evidence today in psychology. Its renowned advocates have included B. F. Skinner (1904–1990), one of the most influential psychologists of the twentieth century. But psychologists, including modern behaviorists, have moved away from the strict behaviorism of Watson; mental processes such as imagery and attention are again considered to be proper subject matter for scientific investigation.

In this sense, modern psychologists have moved more toward a view expressed by Margaret Floy Washburn (1871-1939) early in the debate over behavior. Although Washburn (1922) advocated her own version of structuralism, she suggested to behaviorists that they regard introspection itself as a form of behavior that could help them understand the inaccessible processes of mental life. Today, as Washburn would have wished, Watson's emphasis on objectivity in psychological research remains. Even those modern psychologists who most vehemently protest against what they see as the narrowness of behaviorism use the same principles of objectivity to guide their research. As research scientists, they must uphold the principles of objectivity that evolved from empiricism to functionalism to behaviorism. A psychologist who studies private mental events realizes that these events can be studied only indirectly, by means of behavior-verbal reports of inner experiences. Unlike Wundt, present-day psychologists realize that these reports are not pure reflections of these mental events; like other behaviors, these responses can be affected by many factors. Consequently, they strive to maintain an objective stance to ensure that their research findings will be valid and capable of being verified.



Margaret Floy Washburn (1871-1939)

### Humanistic Psychology

For many years philosophers and other intellectuals have been concerned with what they see as the special attributes of humanity-free will, spontaneity, creativity, and consciousness. As the science of psychology developed, these phenomena received less attention than others, because researchers could not agree on objective ways to study them. Humanistic psychology developed during the 1950s and 1960s as a reaction against both behaviorism and the psychodynamic approach of Freud. Although psychodynamic theory certainly dealt with mental phenomena that could not be objectively measured, it viewed people as products of their environment and of innate, unconscious forces. Humanistic psychologists insist that human nature goes beyond environmental influences, and they argue that psychologists should study conscious processes, not unconscious drives. In addition, they note that psychoanalytical theory seems preoccupied with disturbed people, ignoring positive phenomena such as happiness, satisfaction, love, and kindness.

Humanistic psychology is an approach to the study of human behavior that emphasizes human experience, choice and creativity, self-realization, and positive growth. Humanistic psychologists emphasize the positive sides of human nature and the potential we all share for personal growth. In general, humanistic psychologists do not believe that we will understand human consciousness and behavior through scientific research. Thus, the humanistic approach has not had a significant influence on psychology as a science. Its greatest impact has been on the development of methods of psychotherapy that are based on a positive and optimistic view of human potential.

### Reaction against Behaviorism: The Emphasis on Cognition

Proponents of behaviorism restricted the subject matter of psychology to observable behavior. And, despite their differences from the structuralists, they also tended to analyze behavior by dividing it into smaller elements. Even as behaviorism became the dominant trend in psychology, a contrasting school of thought began to emphasize how unobservable factors influence larger patterns of human consciousness.

This movement began when a German psychologist, Max Wertheimer (1880–1943), bought a toy that presented a series of pictures in rapid succession. Each picture was slightly different from the preceding one, resulting in the impression of continuous motion—like a movie. Wertheimer and his colleagues suggested that psychological processes provided the continuity. They therefore attempted to discover the *organization* of cognitive processes, not their elements. They called their approach **Gestalt psychology**. *Gestalt* is a German word that roughly translates into "unified form." Gestalt psychologists insisted that perceptions resulted from patterns of interactions among many elements, in the same way we recognize a song by the relations between the notes rather than by the individual notes themselves.

Although the Gestalt school of psychology no longer exists, its insistence that the elements of an experience are organized into larger units was very influential. These organizational processes are not directly observable, yet they still determine behavior. Since the 1960s, many psychologists likewise have begun to reject the restrictions of behaviorism and have turned to the study of consciousness, feelings, imagery, and other private events.

Much of *cognitive psychology* (described in the first section of this chapter) analyzes mental activities in terms of **information processing.** According to this approach information received through the senses is "processed" by various systems of neurons in the brain. Some systems store the information in the form of memory; other systems control behavior. Some systems operate automatically and unconsciously, whereas others are conscious and require effort. Because the information processing approach was first devised to describe the operations of complex physical systems such as computers, the modern model of the human brain is, for most cognitive psychologists, the computer. However, another model—the artificial neural network—is beginning to replace the computer.

Although cognitive psychologists now study mental structures and operations, they have not gone back to the introspective methods that structuralists such as Wundt employed. They use objective research methods, just as behaviorists do. For example, several modern psychologists have studied the phenomenon of imagery. If you close your eyes and imagine what the open pages of this book look like, you are viewing a mental image of what you have previously seen. This image exists only within your brain, and it can be experienced by you and no one else. We have no way of knowing whether your images are like ours any more than we know whether the color red looks the same to you as it does to us. The experience of imagery cannot be shared in a scientific sense.

But behaviors that are based on images can indeed be measured. For example, one researcher (Kosslyn, 1973, 1975) asked a group of people to memorize several drawings. Then he asked the participants to imagine one of the drawings, focusing their attention on a particular feature of the image. Next, he asked a question about a detail of the image that was either "near" the point they were focusing on or "far" from it. For example, if they were picturing a boat, he might ask them to imagine that they were looking at its stern (back). Then he might ask whether the boat had a rudder at the stern, or whether a rope was fastened to its bow (front).

**humanistic psychology** An approach to the study of human behavior that emphasizes human experience, choice and creativity, self-realization, and positive growth.

**Gestalt psychology** A movement in psychology that emphasized that cognitive processes could be understood by studying their organization, not their elements.

**information processing** A model used by cognitive psychologists to explain the workings of the brain; according to this model, information received through the senses is processed by systems of neurons in the brain.

# **FIGURE 6** A drawing used in the imagery study by Kosslyn.

(From Kosslyn, S. M. [1973]. *Perception and Psychophysics*, 14, 90–94. Reprinted with permission.of Psychonomic Society.)



Kosslyn found that people could very quickly answer a question about a feature of the boat that was near the place they were focusing on, but that they took longer to answer a question about a part that was farther away. It was as if they had to scan their mental image to get from one place to the other. (See FIGURE 6.)

Because we cannot observe what is happening within a person's head, the concept of imagery remains hypothetical. However, this hypothetical concept very nicely explains and organizes some concrete results—namely, the time it takes for a person to give an answer. Although the explanation for the results of this experiment is phrased in terms of private events (mental images), the behavioral data (how long it takes to answer the questions) are empirical and objective.

## Reaction against Behaviorism: The Emphasis on Neurobiology

Although the first scientific roots of psychology were in biology and physiology, the biological approach to behavior has become so prevalent since the early 1990s that it can properly be called a revolution. During the early and mid-twentieth century, the dominance of behaviorism led to a de-emphasis of biological factors in the study of behavior. At the time scientists had no way of studying what went on in the brain, but that did not prevent people from spinning elaborate theories of how the brain controlled behavior. Behaviorists rejected such speculation. They acknowledged that the brain controlled behavior but argued that because we could not see what was happening inside the brain, we should refrain from inventing physiological explanations that could not be verified.

One of the few dissenters from the prevailing behaviorist view of the time was a Canadian psychologist, Donald Hebb (1904–1985). Hebb had graduated from Dalhousie University with aspirations of being a novelist. After a brief stint teaching in Quebec, he was admitted as a part-time student at McGill University. Hebb was inspired by the physiological approach to psychology then taught at McGill by a professor who had worked with Pavlov. Challenging the behaviorists, Hebb argued that behavioral and mental phenomena could be related directly to brain activity. In his most



Donald Hebb (1904-1985)

influential work, he suggested several simple principles by which the nervous system organized itself into special "circuits" that could represent mental activity (Hebb, 1949).

Cognitive psychologists had inherited from early behaviorists a suspicion of the value of biology in explaining behavior. Thus, the cognitive revolution did not lead to a renewed interest in biology. But the extraordinary advances in neurobiology in the late twentieth century revolutionized psychology and vindicated Hebb's viewpoint (Klein, 1999). And many of Hebb's students and associates were at the forefront of subsequent developments in psychology (Adair, Paivio, & Ritchie, 1996).

Neurobiologists (biologists who study the nervous system) and scientists and engineers in allied fields have developed ways to study the brain that were unthinkable just a few decades ago. We can study fine details of nerve cells, discover their interconnections, analyze the chemicals they use to communicate with one another, produce drugs that block the action of these chemicals or mimic their effects, see the internal structure of a living human brain, and measure the activity of different parts of the brain—regions as small as a few cubic millimeters—while people are watching visual displays, listening to words, or performing various kinds of cognitive tasks. In addition, it seems as though every day we learn of new genes that play roles in particular behaviors, and drugs that are designed to duplicate or block the effects of these genes.

#### QUESTIONS TO CONSIDER

- 1. Although the science of psychology began in Germany, it soon migrated to the United States, where it flourished. Can you think of any characteristics of American society that might explain why psychology developed faster here than elsewhere in the world?
- **2.** As you have learned, psychologists study a wide variety of behaviors. Do you think that there are any behaviors that psychologists cannot explain (or should not try to explain)?



## **The Brain's Future**

For Laura and her group, reading Kurzweil's book accomplished what I had hoped. Kurzweil attempted to construct a utopian vision of the future based on the scientific assumptions that have shaped contemporary psychology: historical themes such as materialism, empiricism, and determinism. It's a challenging notion to push the working assumptions of a science into a prescription for the future. Laura and her partners in this project had to consider whether our current knowledge from the science of behavior is up to the task.

Ironically, fifty years before Kurzweil, the behaviorist B.F. Skinner had likewise written a utopian book (a novel, in this case) in which he proposed that psychology could revolutionize human society (Skinner, 1948). Kurzweil's work extends Skinner's by introducing the concept of replicating our nervous system with machinery, but the issue is the same and goes all the way back to Descartes: How far can we generalize our knowledge? If you want to hear the answer that Laura's group reached, you can hear their program at http//www.cjsr.ualberta.ca/news/news.php?s=p400

#### CHAPTER SUMMARY

#### What Is Psychology?

Psychology is the science of behavior, and psychologists study a large variety of behaviors in humans and other animals. They attempt to explain these behaviors by studying the events that cause them. Different psychologists are interested in different behaviors and in different categories of causes.

This section identified 11 different approaches to understanding the causes of behavior. Physiological psychologists study the role of the brain in behavior. Comparative psychologists study the evolution of behavior by comparing the behavioral capacities of various species of animals. Behavior geneticists study the role of genetics in behavior. Cognitive psychologists study complex human behaviors such as perception, memory, and attention. Cognitive neuroscientists study the brain mechanisms responsible for cognition. Developmental psychologists study the development of behavior throughout the life span. Social psychologists study the effects people have on one another's behavior. Personality psychologists study individual differences in temperament and patterns of behavior. Evolutionary psychologists study the influence of natural selection on behavior. Cross-cultural psychologists study the impact of culture on behavior. Clinical psychologists study the causes and treatment of mental disorders and problems of adjustment.

In addition to thinking of psychology as a scientific discipline, we can also consider it as a profession, in which psychologists apply their knowledge of behavior to the solution of certain kinds of problems. Two recent applications discussed here were the problem of constructing facial drawings from eyewitness reports and the design of artificial limbs for amputees.

#### The Growth of Psychology as a Science

By the mid-nineteenth century, philosophy had embraced two concepts that would lead to the objective investigation of the human mind: the principles of materialism and empiricism. Materialism maintained that the mind was made of matter. Thus, all natural phenomena, including human behavior, could be explained in terms of physical entities: the interaction of matter and energy. Empiricism emphasized that all knowledge was acquired by means of sensory experience; no knowledge was innate. By directing attention to the tangible, sensory components of human activity, these concepts laid the foundation for a scientific approach in psychology. At this time, the divisions between science and philosophy were still blurred. Subsequent developments in the natural sciences, especially in biology and physiology, provided the necessary ingredients that, united with the critical, analytical components of philosophy, formed the scientific discipline of psychology. These ingredients were experimentation and verification.

Materialism implies the doctrine of determinism, which is opposed to the concept of free will. Determinism makes possible the prediction that an outcome will follow some cause.

Education and psychiatry became matters of public concern during the early 1800s. Both fields emphasized the causal factors that can produce change. Progressive education stressed the natural development of the child and sought methods of teaching that would match the way children normally learned. Thorndike proposed the law of effect as a principle of this learning, while Montessori argued that different methods were appropriate to different ages of a child. Psychiatry saw mental illness as possibly having social causes and explored therapies that relied either relied on either normal human discourse or specialized techniques such as hypnosis.

#### Major Trends in the Development of Psychology

Psychology has come a long way in a relatively short time. The first laboratory of experimental psychology was established in 1879, less than one and a half centuries ago. Wilhelm Wundt established psychology as a discipline that was independent of philosophy. Wundt's approach was based on the premise that, through introspection, the mind's contents could be described. Even though Wundt's structuralism did not last, interest in psychology continued to grow. The discipline took on added breadth and scope with the emergence of functionalism, which stressed the adaptive value of biological phenomena. Functionalism gave rise to the objectivity of behaviorism, and scientific objectivity still dominates the way we do research.

The cognitive revolution began because some psychologists believed that a strict emphasis on observable behavior missed the complexity of human cognition and behavior an opinion that modern behaviorists contest. The biological revolution in psychology is manifested in the increased interest of psychologists in all fields—not just physiological psychology—in the role of biological factors in behavior.

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- Kurzweil, R. (1999). The age of spiritual machines: When computers exceed human intelligence. New York: Viking Penguin.
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The book by Lawson, Graham, and Baker is an excellent history of psychology. Particularly notable is its inclusiveness: There are special chapters on the role of women in the history of psychology, the contribution of black Americans, and the development of psychology outside Europe and America. Reese's book is not centrally concerned with psychology, but you may find it of interest to know why your elementary, junior high, and high schools were organized the way they were. Shorter's work is a history of the medical profession of psychiatry. It skips around, but provides some interesting anecdotes on major figures.

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# The Ways and Means of Psychology

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# The Ways and Means of Psychology



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#### CHAPTER OUTLINE

## The Scientific Method in Psychology

Types of Research • Identifying the Problem: Getting an Idea for Research • Designing an Experiment • Performing an Experiment • Performing a Correlational Study • Reporting and Generalizing a Study

#### Ethics

Research with Human Participants • Research with Animals

#### Understanding Research Results

Descriptive Statistics: What Are the Results? • Inferential Statistics: Distinguishing Chance from Significance •

# Prologue

#### **Justine's Experiment**

Justine's parents operate a small company that employs five people. The employees assemble custom equipment for oil exploration companies. The summer after her first year of college, Justine decided to put her skills to work by trying to increase the company's productivity. She reasoned that if the employees could complete more pieces of equipment per day, the company would be more profitable for her parents and the workers themselves would benefit through their profit-sharing plan.

One evening Justine stayed at the assembly laboratory to work on one of the devices herself. After a couple of hours, her neck was strained and her arms and hands tingled from maintaining a bent position over the bench at which she was working. Justine convinced her parents to invest in height-adjustable chairs to replace the existing stationary seats. When the new chairs arrived, she adjusted them so that each employee seemed to be at a comfortable position. Justine held a meeting with the employees and told them that she thought the new chairs would reduce discomfort and therefore permit them to be more productive. She said that she would keep track of how many units they finished over the next several days and would let them know if the chairs had helped. At the end of the week, the employees eagerly asked Justine how they had done. Justine proudly announced that they had completed 20% more of the testing units than they had during the same

amount of time before the chairs arrived. The workers congratulated her for her insight and help.

Over the next week Justine continued to check in with the employees and to collect data. She then got together with her friend Lawrence, who had recently taken a statistics course. Lawrence helped her conduct a formal statistical test to compare the production figures for the seven workdays before Justine introduced the new chairs and the seven workdays afterward. They found that productivity had increased significantly more than would be expected by chance. Her intervention had worked. or so it appeared. Justine stopped her daily visits with the employees.

A few weeks later, though, Justine happened to look at the employees' production figures and was Peter Hvizdak/The Image Works



Is it a change in the type of chair that can improve productivity, or the prospect of any change?

disappointed to find that productivity had fallen to the same level as before the new chairs arrived. Justine decided to start over with the old chairs, monitor the employees' output, and then reintroduce the adjustable chairs to see what would happen. After a week with the old chairs, productivity inexplicably increased 20% again. Justine was understandably perplexed. Increased productivity with the old chairs? Justine gave up on her project. What had happened? Justine was sure that she had diligently applied the scientific method and that her intervention should have had clear-cut results.

he goal of psychology as a science is the explanation of behavior. As scientists, the vast majority of psychologists believe that behavior, like other natural phenomena, can be studied objectively. The scientific method permits us to discover the nature and causes of behavior. This chapter will show you how the scientific method is used in psychological research. What you learn here will help you understand further psychological research. But even more than that, what you learn here can be applied to everyday life. Knowing how a psychologist can be misled by the results of improperly conducted research can help us all avoid being misled by more casual observations. We'll see, for example, that Justine made a common, but fundamental, mistake by failing to take into account that her actions as an experimenter could be a causal factor in the behavior of her parents' employees. Understanding the scientific method can also help us, as consumers of information, distinguish worthwhile from flawed research reported in the mass media.

# The Scientific Method in Psychology

To explain behavior we must use a method that is both precise enough to be clearly understood by others and general enough to apply to a wide variety of situations. We hope to be able to make general statements about the events that cause phenomena to occur.

Scientists use an agreed-upon approach to discovery and explanation—the scientific method. The **scientific method** consists of a set of rules that dictate the general procedure for collecting and analyzing data that a scientist must follow in his or her research. These rules are not arbitrary; as we will see, they are based on logic and common sense. The rules were originally devised by philosophers who were attempting to determine how we could understand reality. By nature, we are all intuitive psychologists, trying to understand why others do what they do—so it is important to realize how easily we can be fooled about the actual causes of behavior. Thus, everyone, not just professional psychologists, should know the basic steps of the scientific method.

The scientific method employs a set of rules that apply to a form of research that identifies cause-and-effect relations; this form is called an **experiment**, and it consists of five steps. Some new terms introduced here without definition will be described in detail later in this chapter.

1. Identify the problem and formulate hypothetical causeand-effect relations among variables. This step involves identifying variables (particular behaviors and particular environmental and physiological events) and describing the relations among them in general terms. For example, your own history of late-night studying might have convinced you of the helpful effects of caffeine on fatigue. But does caffeine help when you're about to take a test? You form the hypothesis: Coffee consumption improves recall of learned information. The hypothesis states that something about the first affects the second.

2. Design the experiment. Experiments involve the manipulation of independent variables and the observation of dependent variables. For example, if we wanted to test the hypothesis about the relation between caffeine and test performance, we might arrange an experiment in which volunteers agreed to consume a controlled amount of caffeine before being tested on some previously learned material. Each variable must be *operationally defined*; and the independent variable (caffeine consumption) must be controlled so that only it, and no other variable, is responsible for any changes in the dependent variable (recall of learned information).

**3.** *Perform the experiment.* The researcher must organize the material needed to perform the experiment, train the people who will perform the research, recruit volunteers whose behavior will be observed, and randomly assign each of these volunteers to an experimental group or a control group. The experiment is performed and the observations are recorded.

4. Evaluate the hypothesis by examining the data from the study. Do the results support the hypothesis, or do they suggest that it is wrong? This step often involves special mathematical procedures used to determine whether an observed effect is statistically significant. These procedures will be discussed in the Understanding Research Results section later in this chapter.

5. Communicate the results. Once the experimenters have learned something about the causes of a behavior, they must tell others about their findings. In most cases

**scientific method** A set of rules that governs the collection and analysis of data gained through observational studies or experiments.

**experiment** A study in which the researcher changes the value of an independent variable and observes whether this manipulation affects the value of a dependent variable. Only experiments can confirm the existence of cause-and-effect relations among variables.

psychologists write an article that includes a description of the experiment's procedure and results and a discussion of their significance. They send the article to one of the many journals that publish results of psychological research. Journal editors and expert reviewers determine which research is methodologically sound and important enough to publish. In addition, researchers often present their findings at conferences or professional conventions. As a result, other psychologists can incorporate the findings into their own thinking and hypothesizing.

Following these steps decreases the chances that we will be misled by our observations or form incorrect conclusions in our research. We as humans have a tendency to accept some types of evidence even though the rules of logic indicate that we should not. This tendency sometimes serves us well in our daily lives, but it can lead us to make the wrong conclusions when we try to understand the true causes of natural phenomena, including our own behavior.

## **Types of Research**

Psychologists conduct three major types of scientific research. These classes of research are common across many of the sciences. The first type includes naturalistic observation (observation of people or animals in their natural environment) and clinical observation-(observation of people or animals while they are undergoing treatment or diagnosis for a psychological condition). These methods are the least formal and are constrained by the fewest rules. Naturalistic observations provide the foundations of the biological and social sciences. For example, Charles Darwin's observation and classification of animals, plants, and fossils during his voyage around the world provided him with the raw material for his theory of evolution. Maria Montessori formed many of her ideas about child development by watching children in a classroom. And Paul Broca suggested that language was located in a specific region of the brain after treating a man who had lost his ability to speak. As these examples illustrate, a researcher might perceive new facts following careful observation.

The second type, **correlational studies**, are observational in nature, but they involve more formal measurement—of environmental events, of individuals' physical and social characteristics, and of their behavior. Researchers examine the relations of these measurements in an attempt to explain the observed behaviors. At the conclusion of a correlational study, a researcher might conclude that some of the phenomena measured are related in a particular way.

Finally, experiments go beyond mere measurement. A psychologist performing an experiment makes things happen and observes the results. As you will see, following a properly designed experiment, a researcher can positively identify the causal relations among events.



Researchers communicate their results to other scientists through professional journals or conferences.

## Identifying the Problem: Getting an Idea for Research

Like most professions, science is a very competitive enterprise. Most scientists want to be recognized for their work. They want to discover and explain interesting phenomena and to have other scientists acknowledge their importance. They may hope that the fruits of their research will affect the public at large. They certainly need to be hardworking and dedicated—perhaps even obstinate and relentless.

**naturalistic observation** Observation of the behavior of people or other animals in their natural environments.

**clinical observation** Observation of the behavior of people or animals while they are undergoing diagnosis or treatment.

correlational study The examination of relations between two or more measurements of behavior or other characteristics of people or other animals.

Often, science that achieves some breakthrough result is the cumulative work of many scientists who are part of a larger collective (and often international) endeavor. It often occurs in institutional settings such as universities, where scientists, students, and technicians all are involved in the effort. Such projects require financial support. Psychological research in the United States has historically been supported by major federal agencies such as the National Science Foundation and the National Institute of Mental Health. Before providing funding, these agencies rigorously review the merits of a proposed research program and its potential for long-term scientific value. They provide an independent evaluation of the worth of a scientific idea.

In this environment of competition and rigorous evaluation, a research program must be based on *good ideas*. Where do the ideas come from?

**Hypotheses** A hypothesis is the starting point of any study. It is an idea, phrased as a general statement, that a scientist wishes to test through research. In the original Greek, *hypothesis* means "suggestion," and the word still conveys the same meaning. When scientists form a hypothesis, they are suggesting that a relation exists among various phenomena. Thus, a **hypothesis** is a tentative statement about a cause-andeffect relation between two or more events.

**Theories** A theory is a set of statements that describes and explains known facts, proposes relations among variables, and makes new predictions. For example, a public safety advocate might notice an increase in traffic accidents and propose the theory that this is the result of increased cell phone use by drivers. In a sense, then, a theory is an elaborate form of hypothesis. A scientific theory operates within the scientific method to organize a system of facts and related hypotheses to explain some larger aspect of nature. A good theory fuels the creation of new hypotheses. A good theory is one that generates *testable hypotheses*—hypotheses that can potentially be supported or proved wrong by scientific research. Some theories are so general or so abstract that they do not produce testable hypotheses and hence cannot be subjected to scientific rigor. For example, if someone tells you they have a theory that UFO sightings have increased in America because people are disenchanted with organized religions, you could justifiably object that her proposed cause was not useful: She hasn't told you what disenchantment is or how you could tell if someone had it. Because she hasn't told you what it is, you cannot change "disenchantment" or perform an experiment in-



A theory connecting cell phone use with increased chance of a traffic accident would need to identify the causal factors responsible.

volving it. So, the theory doesn't provide a hypothesis that is testable.

The ability to test a hypothesis is one of the most important aspects of science. Natural phenomena can have many potential causes. If there is no way to choose among them, then we cannot build a consistent explanation of why the phenomenon occurs. So, a theory that does not generate testable hypotheses—either because it uses factors that cannot be observed or manipulated or because it is hopelessly vague as to what those factors are—cannot be a part of science.

Testability is particularly important to psychology, because it is often the case that psychological explanations rely on causal factors that are not directly observable. In the pages of this book that follow, there will be many instances where psychologists have found it useful to refer to such things as "memory," "attention," and "personality trait." We can't observe these directly, but we can, through a good theory, make predictions about how these factors will influence behavior.

Theories can generate testable hypotheses and still be difficult to work with. The earlier example of cell phone use and traffic accidents is a case in point, since the proposed cause—using a cell phone—contains many possible factors: Using a phone takes one of your hands off the wheel; it makes you think of situations other than driving; it blocks out other sounds, and so on. A theory that is vague is usually a poor one. In the next section, we'll see how to approach this problem.

Many, but not all, research endeavors in psychology are directed toward making some particular theory stronger. They try show that the evidence is consistent with the hypothesis, or they explore the relationship between concepts within the theory. Sometimes research stimulates us to think about old problems in new ways by showing how findings that did not appear to be related to each other can be explained by a single concept. There is even a scientific journal, *Psychological Review*, devoted to articles of this type.

**hypothesis** A statement, usually designed to be tested by an experiment, that tentatively expresses a cause-and-effect relationship between two or more events.

**theory** A set of statements designed to explain a set of phenomena; more encompassing than a hypothesis.



An important feature of naturalistic observation is that the observer remains in the background.

**Naturalistic and Clinical Observations as Sources of Hypotheses and Theories** Psychology is about behavior. To understand human behavior, or the behavior of other animals, we first have to know something about that behavior. Much of what we know about behavior comes from ordinary experience: from observing other people, listening to their stories, watching films, reading novels. In effect, we perform observations throughout our lives. But systematic observations permit trained observers to discover subtly different categories of behavior and to develop hypotheses about their causes.

Psychologists who are also naturalists apply observational procedures to questions of behavior. The important feature of naturalistic observations is that the observer remains in the background, trying not to interfere with the people (or animals) being observed. For example, suppose we are interested in studying the social behavior of preschoolers. We want to know under what conditions children share their toys or fight over them, how children react to newcomers to the group, and so on. The best way to begin to get some ideas is to watch groups of children. We would unobtrusively start taking notes, classifying behaviors into categories and seeing what events provoked them-and what the effects of these behaviors might be. These naturalistic observations would teach us how to categorize and measure the children's behavior and would help us develop hypotheses that could be tested in experiments or in correlational studies.

Clinical observations are different. In the course of diagnosis or treatment, clinical psychologists can often observe important patterns of behavior. They can then report the results of their observations in detailed descriptions known as **case studies.** As with naturalistic observations, these clinical observations could form the basis of hypotheses about the causes of behavior. Unlike a naturalist, however, a clinical psychologist most likely does *not* remain in the background, because the object of therapy is to change the patient's behavior and to solve problems. Indeed, the psychologist is ethically constrained to engage in activities designed to benefit the patient; he or she cannot arbitrarily withhold some treatment or apply another just for the sake of new observations. So, like the naturalist, a clinician is bound by certain rules that limit the kinds of observations that can be made: The clinician cannot interfere with the treatment regime prescribed for the patient.

In some cases, psychologists *do* interfere with a situation in a natural or clinical setting. They may, for example, ask questions at job sites or on the street—places that we might regard as naturalistic settings. In one common procedure, a **survey study**, researchers may ask people specially designed and controlled questions, perhaps about their beliefs, opinions, or attitudes. Survey studies are designed to elicit a special kind of behavior—answers to the questions. The observations, then, are usually descriptions of the classes of responses to these questions. Many people may participate in a survey study, but they all are given the same, *standardized*, questions. As these questions become more specific and precise, they allow the same formal measurement of relations that underlies correlational studies.

A clinical psychologist, too, may manipulate the treatment given to a patient, with the desire of producing a more beneficial response. The psychologist may report the result in the manner of a case study, but such manipulation would make the process an experiment, not an observational study.



Much can be learned through careful observation of animals in their natural environment. The results of such observations often suggest hypotheses to be tested by subsequent studies.

**case study** A detailed description of an individual's behavior during the course of clinical treatment or diagnosis.

survey study A study of people's responses to standardized questions.





#### **Designing an Experiment**

Although naturalistic observations enable a psychologist to classify behaviors into categories and to offer hypothetical explanations for these behaviors, only an experiment can determine whether these explanations are correct. Let us see how to design an experiment. We will examine experimental variables and their operational definition and control.

**Variables** The hypothesis proposed earlier—"Cell phone distraction while driving increases the likelihood of a traffic accident"—describes a relation between distraction and the likelihood of a driving mistake. Scientists refer to these two components as **variables**: things that can vary in value. Thus, temperature is a variable, and so is happiness. Virtually anything that can differ in amount, degree, or presence versus absence is a variable.

Scientists either manipulate or measure the values of variables. Manipulation literally means "handling" (from manus, "hand"). Because of abuses in the history of human research (described later), the term manipulation is sometimes incorrectly understood to mean something that researchers do to participants. Psychologists use the word, however, to describe setting the values of a variable in order to examine that variable's effect on another variable. In the cell phone experiment, one value of the distraction variable might be "a cell phone call every minute" and another might be "complete absence of cell phone calls." Measuring variables means exactly what you think it does. Just as we measure the variable of temperature with a thermometer, so psychologists devise instruments to measure psychological variables. The results of experimental manipulations and measurements of variables help us evaluate hypotheses.

To test the cell phone distraction hypothesis with an experiment, we would assemble two groups of volunteers to serve as participants. We would ask them to perform some activity that measures driving ability. We could, for example, have them use a video game that simulates driving. We would present participants in the experimental group with a certain level of distraction, such as a high rate of cell phone calls. We would not give participants in the control group such an experience, and they therefore would have no distraction. We would then measure the ability of participants in both groups to avoid driving errors; from these results, we could then determine whether the outcomes in the two groups differed. Provided that we had randomly assigned the volunteers to make sure that our two groups were alike at the start of the experiment, we could attribute any differences in driving ability to the experimental manipulation of distraction. (See FIGURE 1.)

Our imaginary experiment examines the effect of one variable on another. The variable that we manipulate (distraction from a cell phone) is called the **independent variable**. The variable that we measure (likelihood of driver error) is the **dependent variable**. An easy way to keep the names of these variables straight is to remember that a hypothesis describes how the value of a dependent variable. Our hypothesis proposes that a high frequency of cell phone distraction causes a high likelihood of driving errors. (See FIGURE 2.)

Scientists want to understand the causes of behavior in more than one specific situation. Thus, the variables that hypotheses deal with are expressed in general terms. Independent and dependent variables are *categories* into which various behaviors are classified. For example, we would probably classify hitting, kicking, and throwing objects at someone within the category of "interpersonal aggression." Pre-

**dependent variable** The variable measured in an experiment and hypothesized to be affected by the independent variable.



**FIGURE 2** Independent and dependent variables

variable Anything capable of assuming any of several values.manipulation Setting the values of an independent variable in an experiment to see whether the value of another variable is affected.

**experimental group** The group of participants in an experiment that is exposed to a particular value of the independent variable, which has been manipulated by the researcher.

**control group** A comparison group used in an experiment, the members of which are exposed to the naturally occurring or zero value of the independent variable.

**independent variable** The variable that is manipulated in an experiment as a means of determining cause-and-effect relations.

sumably, these forms of aggression would have very similar causes. A psychologist must know enough about a particular type of behavior to be able to classify it correctly.

Even though one of the first steps in psychological research involves naming and classifying behaviors, however, we must be careful to avoid committing the nominal fallacy. The **nominal fallacy** is the erroneous belief that we have explained an event merely by naming it. (*Nomen* means "name.") Classifying a behavior does not explain it; classifying only prepares us to examine and discover events that cause a behavior.

For example, suppose that we see a man frown and shout at other people without provocation, criticize their work when it is really acceptable, and generally act unpleasantly toward everyone around him. Someone says, "Wow, he's really angry today!" Does this statement explain his behavior? No; it only describes the behavior. Instead of saying he is angry, we might better say that his behavior is hostile and aggressive. This statement does not claim to explain why he is acting the way he is. To say that he is angry suggests that an internal state is responsible for his behavior-that anger is causing his behavior. But all we have observed is his behavior, not his internal state. Even if he is experiencing feelings of anger, these feelings are not a full account of his behavior. What we really need to know is what events made him act the way he did. Perhaps he has a painful toothache. Perhaps he just learned that he failed to get a job he wanted. Perhaps he just read a book that promoted assertiveness. Events like these are causes of both behavior and feelings. Unless the underlying events are discovered and examined, we have not explained the behavior in a scientifically meaningful way.

Yet identifying causes is not as simple as merely identifying preceding events. Many internal and external events may precede any behavior. Some of these events are causal, but some almost certainly will be completely unrelated to the observed behavior. For example, you get off your commuter train because your stop is announced, not because someone coughs or someone else turns the page of a newspaper, even though all of these events may happen just before you stand up and leave the train. The task of a psychologist is to determine which of the many events that occurred before a particular behavior caused that behavior to happen.

The cell phone example, up to now, has this problem. There are many things that happen when you answer a call. Similarly, driving ability is a complex behavior with many components. A good theory would provide more detail about both independent and dependent variables. Let's look at a possible candidate.

Driving is clearly dependent on our ability to recognize the changing conditions ahead of us on the road. **FIGURE 3** An example of our ability to detect a change in a traffic scene. Study this picture for about 3 seconds. Then turn to Figure 4.



Courtesty of Neil Carlson

*Change blindness*, as the name implies, is an insensitivity to a changed scene. For example, look at **FIGURE 3**, which depicts a traffic scene. Now look at **FIGURE 4**, which depicts the same scene—but with one detail missing. Can you tell what it is?

Most likely, you would have had trouble spotting the difference. Because the two figures were on separate pages, there's a visual interruption as you looked from one to the other. Psychologists who study change blindness feel that this interruption interferes with our ability to compare two scenes (Rensink, 2002). We could possibly generalize this to any interruption, including an auditory one. So, perhaps cell phone conversations cause accidents because they increase change blindness.

Notice that we've expanded our theory about traffic accidents considerably. Our explanation for the distracting effects of a call says that they are similar to a more general phenomenon. We can therefore understand a practical problem like preventing accidents by studying a psychological process that occurs in other situations too. Our theory about cell phones and traffic accidents suggests that factors that increase our resistance to distractions will decrease change blindness.

**Operational Definitions** Hypotheses are phrased in general terms, but when we design an experiment (step 2 of the scientific method) we need to decide what *particular* variables we will manipulate and measure. For example, remember our hypothesis about caffeine and test-taking? Caffeine seems to improve alertness and reaction time (e.g., Smith, 2005). Perhaps it can improve our resistance to distractions and thereby increase our ability to detect changes like those between Figures 3 and 4. Our hypothesis, then, is that caffeine consumption will decrease change blindness. To test this particular hypothesis, we must carefully describe how much caffeine we will administer to participants in our experiment and under what conditions. Similarly, we must also describe how we will measure change blindness.

**nominal fallacy** The false belief that we have explained the causes of a phenomenon by identifying and naming it; for example, believing that we have explained lazy behavior by attributing it to "laziness."

[ **FIGURE 4** ] How does this photograph differ from the previous one?



This translation of generalities into specific operations is called an **operational definition:** the definition of independent variables and dependent variables in terms of the operations a researcher performs in order to set their values or to measure them. In our proposed experiment, a rudimentary operational definition of the independent and dependent variables and the setting in which they were studied might be the following:

- Setting: Participants in the experiment are comfortably seated in front of a computer screen. Participants receive 20 change detection tests. Each test consists of a sequence in which an image like Figure 3 is shown for three seconds, followed by a blank white screen for a half-second, and then followed by a changed version of the first figure for three seconds. Changed versions are computer-modified versions of the first image, with one randomly selected component erased, as in Figure 4. The original and the changed versions alternate back and forth in this way until the participant presses a button to indicate that he or she has detected the change.
- *Independent variable:* Two hours before the test, each participant is given a standard-sized coffee cup containing a hot decaffeinated coffee drink. For participants in the experimental group, this drink contains 0.2 grams of caffeine; for participants in the control group, the drink is not altered.
- Dependent variable: On each test, change detection is measured by the time elapsed between the first appearance of the original image and the participant's pressing the response button. All participants were asked to be reasonably confident they had detected the object before pressing the button.

**operational definition** Definition of a variable in terms of the operations the researcher performs to measure or manipulate it.

**validity** The degree to which the operational definition of a variable accurately reflects the variable it is designed to measure or manipulate.

Any general concept can be operationalized in many different ways. By selecting one particular operational definition, the researcher may or may not succeed in manipulating the independent variable or in measuring the dependent variable. For example, there are many sources of caffeine (coffee, soft drinks, condiments, and so on) and several ways of administering it (e.g., through a fluid, an injection, taken after a meal, taken four hours after a meal, and so on). Which operational definition is correct? Which set of results should we believe? To answer these questions, we need to address the issue of *validity*.

The validity of operational definitions has to do with how appropriate they are for testing the researcher's hypothesishow accurately they represent the variables whose values have been manipulated or measured. Obviously, only experiments that use valid operational definitions of their variables can yield meaningful results. Let's consider this operational definition of detection: the length of the time interval between initial presentation of the original image and the pressing of the response button. How can we know that the participant has actually seen the change? Even with the best of intentions, a person in an experiment like this might be reacting to his or her own imagination rather than actual visual perception. As one possible check, we could ask each participant to point to the location of the change and to describe it. Using only those times that were associated with correct points would increase the validity of our measure.

**Control of Independent Variables** We have seen that a scientist performs an experiment by manipulating the value of the independent variable and then observing whether this change affects the dependent variable. If an effect is seen, the scientist can conclude that there is a cause-and-effect relation between the variables. That is, changes in the value of the independent variable cause changes in the value of the dependent variable.

When conducting an experiment, the researcher must manipulate the value of the independent variable—and *only* the independent variable. For example, if we want to determine whether background environmental noise has an effect on people's reading speed, we must choose our source of noise carefully. If we used the sound track from a television show to supply the noise and found that it slowed people's reading speed, we could not conclude that the effect was caused purely by "noise." We might have selected an interesting show, thus distracting the participants' attention from the material they were reading because of the content of the TV program rather than because of "noise." If we want to do this experiment properly, we should use noise that is neutral and not a source of interest by itself—for instance, noise like the *sssh* sound that is heard when a radio is tuned between stations.

If we used a TV program sound track as our manipulation of noise, we would inadvertently cause **confounding of variables**—we would introduce the effects of another variable besides noise on reading speed. One of the meanings of the word *confound* is "to fail to distinguish." If a researcher inadvertently introduces one or more extra, unwanted, independent

**confounding of variables** Inadvertent simultaneous manipulation of more than one variable. The results of an experiment in which variables are confounded permit no valid conclusions about cause and effect.

variables that vary along with the intended independent variable, he or she will not be able to distinguish the effects of any one of them on the dependent variable. That is, the effects of the variables will be confounded. In our example, the noise of the TV program would be mixed with the content of the program in the experimental condition, whereas in the control condition there would be neither noise nor content. You can see that any effect of the manipulation on reading could be due to either noise or content or even to their combination. It would be impossible to reach any conclusion about the experimental hypothesis.

It is often difficult to be sure that independent variables are not confounded. Sometimes even experienced researchers overlook a possible problem, as is illustrated in the following case.

**CASE STUDY** A visitor to a zoology department of a well-known university described research he had conducted in a remote area of South America. He was interested in determining whether a particular species of bird could recognize a large bird that normally preys on it. He had constructed a set of cardboard models that bore varying degrees of resemblance to the predator: They ranged from a perfect representation, to two models of noncarnivorous birds, to a neutral stimulus (such as a triangle). The researcher restrained each bird he was testing and suddenly presented it with each of the test stimuli, in decreasing order of similarity to the predator-that is, from predator to harmless birds to triangle. He observed a relation between the amount of alarm that the birds showed and the similarity that the model bore to the predator. The most predator-like model produced the greatest response. (See FIGURE 5.)

It was pointed out—to the embarrassment of the speaker—that the study contained a fatal flaw that made it impossible to conclude whether a relation existed between the independent variable (similarity of the model to the predator) and the dependent variable (amount of alarm).



It's a fairly subtle but important problem. Can you figure it out? Reread the previous paragraph, consult Figure 5, and think about the problem before you read on.

Now, the answer: When testing the birds' responses to the models, the investigator presented each model at a different time *but always in the same order*. Very likely, even if the birds had been shown the *same* model again and again, they would have exhibited less and less of a response. We very commonly observe this phenomenon, called *habituation*, when a stimulus is presented repeatedly. The last presentation produces a much smaller response than the first. Consequently, we do not know whether the decrease in signs of alarm occurred because the stimuli looked less and less like the predator or simply because the birds became habituated to the stimuli.

Could the zoologist have carried out his experiment in a way that would have permitted him to infer a causal relation? Yes, and perhaps the solution has occurred to you already: The researcher should have presented the stimuli in different orders to different birds. Some birds would see the predator first, others would see the triangle first, and so on. Then he could have calculated the average amount of alarm that the birds showed to each of the stimuli, without contaminating the results by habituation. This type of procedure is called **counterbalancing**. To *counterbalance* means to "weigh evenly," and counterbalancing would have been accomplished if the investigator had made sure that each of the models was presented equally often (to different participant birds, of course) as the first, second, third, or fourth stimulus. The effects of habituation would thus be spread equally among all the stimuli. (See FIGURE 6.)



**FIGURE 6** Counterbalancing in the predator experiment. The predator experiment could be improved by changing the order of presentation of the models.

**counterbalancing** Systematic variation of conditions in an experiment, such as the order of presentation of stimuli, so that different participants encounter the conditions in different orders; prevents confounding of independent variables with time-dependent processes such as habituation or fatigue.



# Response Bias in Different Cultures

**Response bias**—responding to a questionnaire in a way that is not genuine or honest but in some other irrelevant way—is an im-

portant concept in research methods because it can skew results and tell researchers something that is not very meaningful. A Dutch study of six European countries has found examples of response bias that is specific to certain cultures.

Van Herk, Poortinga, & Verhallen (2005) from The Netherlands used existing data from a multinational marketing questionnaire survey to examine response bias in participants from Greece, Italy, Spain, France, Germany, and the United Kingdom. They found that contrary to participants from northwestern European countries, those from Mediterranean countries showed an abnormally high tendency to agree with answers (acquiescence), and a greater likelihood to choose extreme response categories (e.g., selecting 1 or 5 on a five-point scale). Greek participants, in particular, significantly exhibited these response biases. Participants from Spain and Italy scored higher on these two biases than did participants from the United Kingdom, France, and Germany. The British were the least acquiescent.

The authors suggest that such differences might reflect the different types of cultures in these countries: collectivistic vs. individualistic—whether they value the skills necessary to work together or the effort of people working as individuals. The more individualistic the societies were, the less acquiescent they seemed.

### Performing an Experiment

After designing a study with due regard for the dangers of confounds, we must decide how best to conduct it. We are now at step 3 of the scientific method: Perform the experiment. We must decide who will participate, what instructions to give, and what equipment and materials to use. We must ensure that the data collected will be accurate; otherwise, all effort will be in vain.

**Reliability of Measurements** A procedure described by an operational definition that produces consistent results under consistent conditions is said to have high **reliability**. For example, measurements of people's height and weight are extremely reliable. Measurements of their academic aptitude (by means of standard commercial tests) also are reliable, but somewhat less so. Suppose that we operationally define detection of changed image as the time it takes before the participant blinks. Eyeblink measurements can be made reliably and accurately, but it is problematic to consider this as a valid or true measure of image detection, because there are many reasons for a participant to blink other than having detected the hidden image. Achieving reliability is usually much easier than achieving validity. Reliability is mostly a result of care and diligence on the part of researchers in the planning and execution of their studies.

Let's look at an example of a factor that can decrease the reliability of an operationally defined variable. Suppose that in our study on the effects of change detection, we select the images to be presented to each participant by randomly drawing 20 images from a large collection of digital photographs. However, some of the images were poorly scanned, so they are out of focus when projected. You can easily appreciate how this extraneous factor would affect our measurement of detection and would add to the differences we observe among the participants.

Careful researchers can identify and control most of the extraneous factors that might affect the reliability of their measurements. Conditions throughout the experiment should always be as consistent as possible. For example, the same instructions should be given to each person who participates in the experiment, all equipment should be in good working order, and all assistants hired by the researcher should be well trained in performing their tasks. Noise and other sources of distraction should be kept to a minimum.

The subjectivity of the experimenters who are taking a measurement is another factor that affects reliability. Our definition of inducing an expectation is *objective*; that is, even a non-expert could follow our procedure and obtain the same results. But researchers often attempt to study variables whose measurement is subjective; that is, it requires judgment and expertise. For example, suppose that a psychologist wants to count the number of friendly interactions that a child has with other children in a group. This measurement requires that someone watch the child and note each time a friendly interaction occurs. But it is difficult to be absolutely specific about what constitutes a friendly interaction and what does not. What if the child looks at another child and their gazes meet? One observer may say that the look conveyed interest in what the other child was doing and so should be scored as a friendly interaction. Another observer may disagree.

The solution in this case: First, to make the measurement as objective as possible, try to specify as precisely as possible the criteria to be used for defining an interaction as "friendly." Next, two or more people should watch the child's behavior and score it independently; that is, neither person should be aware of the other person's ratings. If the two observers' ratings agree, we can say that the scoring system has high **interrater reliability.** If they disagree, interrater reliability is low, and there is no point in continuing the study. Instead, the rating system should be refined, and the raters should be trained to apply it consistently. Any investigator who performs a study in which measuring the dependent

**response bias** Responding to a questionnaire in a way that is not genuine or honest but in some other irrelevant way.

**reliability** The repeatability of a measurement; the likelihood that if the measurement were made again, it would yield the same value.

**interrater reliability** The degree to which two or more independent observers agree in their ratings of an organism's behavior.

variables requires some degree of skill and judgment must do what is necessary to produce high interrater reliability.

Selecting the Participants Suppose a professor wants to determine which of two teaching methods works best. She teaches two courses in introductory psychology, one that meets at 8:00 A.M. and another that meets at 4:00 P.M. She considers using one teaching method for the morning class and the other for the afternoon class. She speculates that at the end of the term, the final examination scores will be higher for her morning class. If her surmise proves correct, will she be able to conclude that the morning teaching method is superior to the method used in the afternoon? No; a good researcher would understand that the method considered here would produce a significant interpretation problem. There likely would be differences between the two groups of participants other than the teaching method they experienced. People who sign up for a class that meets at 8:00 A.M. are likely, for many reasons, to differ in some ways from those who sign up for a 4:00 P.M. class. Some people prefer to get up early; others prefer to sleep late. Perhaps the school schedules athletic practices in the late afternoon, which means that athletes will not be able to enroll in the 4:00 P.M. class. Therefore, the professor would not be able to conclude that any observed differences in final examination scores were caused solely by the differences in the teaching methods. Personal characteristics of the participant groups would be confounded with the two teaching methods.

The most common way to avoid confounding participant characteristics with the manipulated values of an independent

variable is random assignment. Random assignment means that each participant has an equal chance of being assigned to any of the conditions or groups of the experiment. Typically, random assignment is made by computer or by consulting a list of random numbers. We can expect people to have different abilities, personality traits, and other characteristics that may affect the outcome of the experiment. But if people are randomly assigned to the experimental conditions, these differences should be equally distributed across the groups. Randomly assigning students to two sections of a course meeting at the same time of day would help solve the problem faced by the professor who wants to study different teaching methods.

Even after researchers have designed an experiment and randomly assigned participants to the groups, they must remain alert to the problem of confounding participant characteristics with their independent vari-

able manipulations. Some problems will not emerge until the investigation is actually performed. Suppose that we wish to learn whether anger decreases a person's ability to concentrate. As we'll see in the next part of this chapter, any experiment to test this would require careful consideration of the ethics of making someone angry and would be approved only if the benefits of the results were clear. Assuming that the experiment was approved, one of the researchers might begin by acting very rudely toward the participants in the experimental group, which presumably makes them angry, but treating the participants in the control group politely. After the rude or polite treatment, the participants watch a video that shows a constantly changing display of patterns of letters. Participants are instructed to press a button whenever a particular letter appears. This vigilance test is designed to reveal how carefully participants are paying attention to the letters.

The design of this experiment seems sound. Assuming that the participants in the experimental group are really angry and that our letter identification test is a good dependent measure of concentration, we should be able to draw conclusions about the effects of anger on concentration. However, the experiment, as performed under real conditions, may not work out the way we expect. Suppose that some of our "angry" participants simply walk away. All researchers must assure participants that their participation is voluntary and that they are free to leave at any time; some angry participants may well exercise this right and withdraw from the experiment. If they do, we will now be comparing the behavior of two groups of participants that have a different mix of personal characteristics-one group composed of people who are willing to submit to the researcher's rude behavior (because the objectors have withdrawn) and another group of randomly selected people, some of whom would have left had they been subjected to the rude treatment. Now the experimental group and the control group are no longer equivalent. (See FIGURE 7.)



**FIGURE 7** A possible problem with the anger and concentration experiment: unequal loss of participants with specific characteristics from the comparison group.

random assignment Procedure in which each participant has an equally likely chance of being assigned to any of the conditions or groups of an experiment.

**Expectancy Effects** Research participants are not passive beings whose behavior is controlled solely by the independent variables manipulated by the researcher. This is a basic concept in the sciences: Observation can change that which you observe. This is what is known as the Hawthorne effect. Back in the 1930s, the managers of the Hawthorne plant of the Western Electric company wondered whether increasing the level of lighting in the plant would increase productivity. It did, but the managers found that the increase in productivity was short-lived. They went on to do some more investigating and found that productivity actually went up when they subsequently lowered the level of lighting. The commonly accepted explanation of these findings is based on the fact that the workers knew that an experiment was being conducted and that they were being monitored. That knowledge may have made them work harder regardless of whether lighting levels were increased or decreased. The workers may even have been pleased-and motivated-by the fact that management was obviously trying to improve their work environment, and may have tried to return the favor. Of course, the effect did not last indefinitely, and eventually production returned to normal. Adair (1984) provides a detailed analysis of these original studies and the methods that have evolved in field experiments to counter the Hawthorne effect.

One way to think about the Hawthorne effect is that the participants were trying to help the researchers confirm their expectation that changes in lighting would improve productivity. There is compelling evidence that this type of cooperation with researchers can occur even in very sophisticated laboratory research: If research participants figure out the researcher's hypothesis, they will sometimes behave as if the hypothesis is true, even if it is not. For example, one issue in the design of virtual reality displays is that they can sometimes make people seasick. Many designers now test their equipment for this possibility. But, if people are given a motionsickness questionnaire before they test the display, they report more motion sickness (Young, Adelstein, & Ellis, 2007).

The possibility that a researcher's expectations can be guessed by a participant is a dangerous state of affairs for good science. For this reason, researchers routinely keep the details of their hypotheses to themselves when dealing with participants, at least until after the independent variable is manipulated and the dependent variable measured. But the situation is more troublesome when participants manage to figure out not only the researcher's hypothesis but also the independent variable manipulations on their own. You may have heard that deception is relatively rare. When it is used, however, the sole reason is to disguise the nature of an independent variable manipulation (and perhaps the dependent measure). If researchers mislead participants about the reason for the experimental events, the intention is to prevent the participants from acting as if the hypothesis were true when it might in fact not be. When deception is used, researchers take great pains to disclose the truth to participants at the earliest possible moment and to reestablish a trusting relationship. Interestingly, people who actually have participated in deception experiments are generally quite accepting of the rationale for the use of this technique (Sharpe, Adair, & Roese, 1992). Let's turn now to other techniques that have been developed to reduce the likelihood that research participants will become aware of the investigator's expectations.

*Single-Blind Experiments.* Suppose that we want to study the effects of a stimulant drug on a person's ability to perform a task that requires good motor control. We will administer the drug to one group of participants and leave another group untreated. (Of course, the experiment will have to be supervised by a physician, who will prescribe the drug.) We will count how many times each participant can thread a needle in a 10-minute period (our operational definition of fine manual dexterity). We will then see whether taking the drug had any effect on the number of needle threadings.

But there is a problem in our design. Can you see what it is? For us to conclude that a cause-and-effect relation exists, the treatment of the two groups must be identical except for the single variable that is being manipulated. In this case the mere administration of a drug may have effects on behavior, independent of its pharmacological effects. The behavior of participants who know that they have just taken a stimulant drug is very likely to be affected by this knowledge as well as by the drug circulating in their bloodstreams.

To solve this problem we would give pills to the members of both groups. People in one group would receive the stimulant; those in the other group would receive an identicallooking pill that contained no active drug—a **placebo** pill. Participants would not be told which type of pill they were taking, but they would know that they had a 50–50 chance of receiving either the stimulant or the inactive substance. By using this improved experimental procedure, called a **singleblind study**, where the participants are kept unaware of their assignment to a particular experimental group, we could infer that any observed differences in needle-threading ability of the two groups were produced solely by the pharmacological effects of the stimulant drug.

**Double-Blind Experiments.** Now let us look at an example in which it is important to keep both the researchers and the participants in the dark. Suppose we believe that if patients with mental disorders take a particular drug, they will be more willing to engage in conversation. This would be an important outcome, because enhanced communicativeness could facilitate their therapy. So we give the real drug to some patients and administer a placebo to others. We talk with all the patients afterwards and rate the quality of the conversation. But "quality of conversation" is a difficult dependent variable to measure, and the rating is therefore likely to be

placebo An ineffectual treatment used as the control substance in a single-blind or double-blind experiment.

**single-blind study** An experiment in which the researcher knows the independent variable but participants do not.

subjective. The fact that we, the researchers, know who received the drug and who received the placebo leaves open the possibility that we may, unintentionally, give higher conversation quality ratings to those who took the drug.

The solution to this problem is simple. Just as the participants should not know whether they are receiving a drug or a placebo, neither should the researchers. That is, we should use a **double-blind study**. Either another person should administer the pills, or the researchers should be given a set of identicallooking pills in coded containers so that both researchers and participants are unaware of the nature of the contents. Now the researchers' ratings of conversation quality cannot be affected by any preconceived ideas they may have. Keep in mind that someone who has no direct contact with the participants is keeping track of who gets which pills so that the effect of the independent variable manipulation can be tested.

The double-blind procedure can be used in other experiments also. Suppose that the experiment just described attempted to evaluate the effects of a new form of psychotherapy, not a drug, on the willingness of a participant to talk. If the same person does both the psychotherapy and the rating, that person might tend to see the results in the light most favorable to his or her own expectations. In this case, then, one person should perform the psychotherapy and another person should evaluate the quality of conversation with the participants. The evaluator will not know whether a particular participant has just received the new psychotherapy or is a member of the control group that received the old standard therapy.

## **Performing a Correlational Study**

To be sure that a cause-and-effect relation exists between variables, we must perform an experiment in which we manipulate an independent variable and measure its effects on a dependent variable. But there are some variables—especially variables intrinsic to an individual—that a psychologist cannot manipulate. For example, a person's gender, genetic history, income, social class, family environment, and personality are obviously not under the researcher's control. Because these variables cannot be manipulated, they cannot be investigated by means of an experiment. Nevertheless, such variables are important and interesting, because they often affect people's behavior. A different method must therefore be used to study them: a correlational study.

The design and conduct of a correlational study is relatively simple: For each member of a group of people we measure two or more variables as they are found to exist, and we determine whether the variables are related by using a statistical procedure called *correlation*. Correlational studies often investigate the effects of personality variables on behavior. For example, we may ask whether shyness is related to daydreaming. Our hypothesis is that shy people tend to daydream more than less shy people. We decide how to assess a person's shyness and the amount of daydreaming he or she engages in each day, and we then measure these two variables for a random group of people. Some people will be very shy and some not shy at all. Some people will daydream a lot and others will hardly daydream at all. If we find that relatively shy people tend to daydream more (or less) than relatively less shy people, we can conclude that the variables are related.

Suppose that we do, in fact, find that shy people spend more time daydreaming. Such a finding tells us that the variables are related—we say they are *correlated*—but it does not permit us to make any conclusions about cause and effect. Shyness may have caused the daydreaming, or daydreaming may have caused the shyness, or perhaps some other variable that we did not measure caused both shyness and an increase in daydreaming. In other words, *correlations do not necessarily indicate cause-and-effect relations*. (See FIGURE 8.) An experiment is necessary to prove a cause-and-effect relation.

A good illustration of this principle is provided by a correlational study that attempted to determine whether membership in the Boy Scouts would affect a man's subsequent participation in community affairs (Chapin, 1938). The investigator compared a group of men who had once been Boy Scouts with a group of men who had not. He found that the men who had been Boy Scouts tended to join more community affairs groups later in life.

The investigator concluded that the experience of being a Boy Scout increased a person's tendency to join community organizations. However, this conclusion was not warranted. All we can say is that people who join the Boy Scouts in their youth tend to join community organizations later in life. It could be that people who, for one reason or another, are "joiners" tend to join the Boy Scouts when they are young and community organizations when they are older. To determine cause and effect, we would have to perform an experiment. For example, we would make some boys join the Boy Scouts and prevent others from doing so, and then see how many organizations they voluntarily joined later in life. But because we cannot interfere in people's lives in such a way, we can never be certain that being a Boy Scout increases a person's tendency to join community organizations later.

The news media often report the results of correlational studies as if they implied causal relations. For example, one newspaper routinely points out the high incomes earned by its subscribers, implying that by subscribing you can cause your own income to rise. But correlation does not prove causation. It could be that having a high income causes you to buy the newspaper (perhaps for the specific news of your profession). You might think of this logic when you receive that seductive recruiting brochure from some business school showing that its graduates earn 40% more than those of other schools.

**double-blind study** An experiment in which neither the participants nor the researchers know the value of the independent variable.

**FIGURE 8** An example of a correlation. Correlations do not necessarily indicate causeand-effect relations: Daydreaming could cause shyness, or shyness could cause daydreaming.



Daydreaming keeps a person from making many contacts with other people; experiences in fantasies are more successful and gratifying than those in real life.



Person has poor social skills; finds contacts with other people uncomfortable.

Can anything be done to reduce some of the uncertainty inherent in correlational studies? The answer is yes. When attempting to study the effects of a variable that cannot be altered (such as gender, age, socioeconomic status, or personality characteristics), we can use a procedure called matching. Rather than selecting participants randomly, we match the participants in each of the groups on all of the relevant variables except the one being studied. For instance, if we want to study the effects of shyness on daydreaming, we might select two groups of participants: one group composed of people who score very high on the shyness test and another group composed of people who score very low. We could then place further restrictions so that the effects of other variables are minimized. We could make sure that average age, intelligence, income, and personality characteristics (other than shyness) of people in the two groups are the same. If we find that the shy group is, on average, younger than the non-shy group, we will replace some of the people in the shy group with older shy people until the average age is the same.

If, after following this matching procedure, we find that shyness is still related to daydreaming, we can be more confident that the differences between the two variables are not caused by a third variable. The limitation of the matching



He does not know how to respond in the company of other people.



He turns to daydreaming because he receives no gratification from social contacts.

procedure is that we may not know all the variables that should be held constant. If, unbeknownst to us, the two groups are not matched on an important variable, the results will be misleading. In any case, even the matching procedure does not permit us to decide which variable is the cause and which is the effect; we still do not know whether shyness causes daydreaming or daydreaming causes shyness.

The strengths and limitations of correlational studies will become evident in subsequent chapters in this book. For example, almost all studies that attempt to discover the environmental factors that influence personality character-



To study possible causes of daydreaming when we cannot manipulate variables, we could use a matching procedure.

**matching** Systematically selecting participants in groups in an experiment or (more often) a correlational study to ensure that the mean values of important participant variables of the groups are similar.

istics or the relation between these characteristics and people's behavior are correlational.

## **Reporting and Generalizing a Study**

Scientists in all disciplines report the details of their research methods in professional publications known as journals, using sufficient detail that other investigators can repeat, or *replicate*, the research. The **replication** process is one of the great strengths of science; it ensures that erroneous results and incorrect conclusions are weeded out. When scientists publish a study, they know that if the findings are important enough, others will try to replicate their work to be sure that the results were not just a statistical fluke-or the result of errors in the design or execution of the original study. Statistical anomalies and incompetently conducted research usually will be uncovered through unsuccessful attempts to replicate. The insistence on replicability of research results also helps inhibit fraud in science, because the unreliability of falsified findings is likely to be discovered.

When we carry out an experiment or a correlational study, we probably assume that our participants are representative of the larger population. In fact, a representative group of participants is usually referred to as a **sample** of the larger population. For example, if we study the behavior of a group of five-year-old children, we want to make conclusions about five-year-olds in general. We want to be able to **generalize**, or extend, our specific results to the population as a whole—to conclude that the results tell us something about human nature in general, not simply about our particular participants.

Many researchers recruit their participants from introductory courses in psychology. The results of studies that use these students as participants can be best generalized to other groups of students who are similarly recruited. But in the strictest sense, the results cannot be generalized to students in other courses, to adults in general, or even to all students enrolled in introductory psychology—after all, students who volunteer to serve as participants may be different from those who do not. Even if we used truly random samples of all age groups of adults in our area, we could not generalize the results to people who live in other geographical regions. If our ability to generalize is really so limited, is it worthwhile to do psychological research?

The answer is that we are not so strictly limited. Most psychologists assume that a relation among variables that is observed in one group of humans also will be found in other groups, as long as the sample of participants is not especially unusual. For example, we may expect data obtained from prisoners to have less generality than data obtained from university students. One feature of the scientific method we have discussed before helps achieve generalizability: replication. When results are replicated with different samples of people, we gain confidence in their generalizability.

# FOCUS ON Cross-Cultural Research

*Cross-cultural psychologists* are interested in studying the similarities and differences in behavjor between cultures. (As an

aside, comparative psychologists study the similarities and differences across species.) The term *culture* traditionally referred to a group of people who live together in a common environment, who share customs and religious beliefs and practices, and who often resemble one another genetically. However, definitions of culture now vary widely. For example, "American culture" includes people of diverse ethnic and religious backgrounds, political beliefs, sexual orientation, and economic statuses, while "Fore people" includes a small, fairly homogeneous group of people living in the highlands of Papua New Guinea. Within a broadly defined culture, we can identify subcultures based on ethnicity, age, political beliefs, and other characteristics by which people define themselves. Keep in mind that "culture" is not synonymous with country or continent. Many cultures can exist within a single geographic zone.

Cross-cultural research lets psychologists test the generality of the results of a study performed with members of a particular culture. If similar studies performed with members of different cultures produce similar results, we can be more confident that we have discovered a general principle that applies broadly to members of our species. On the other hand, if the studies yield different results in different cultures, we need to carry out further research. The cross-cultural approach also lends itself to questions of immense political and economic importance. For example, think of the many issues that arise when people migrate from one culture to another (Berry, 2001).

Cultures differ with respect to two major classes of variables: biological and ecological. Biological variables include such factors as diet, genetics, and endemic diseases. Ecological variables include such factors as geography, climate, political systems, population density, religion, cultural myths, and education.

Identifying the cultural variables responsible for behavioral differences is a difficult process, for culture can be viewed as affecting behavior in different ways (Lonner & Adamopoulos, 1997). In cross-cultural research, culture is considered to be a *treatment variable*—analyzed as if it were an independent variable (Berry et al., 2002). But cultures,

**replication** Repetition of an experiment or observational study in an effort to see whether previous results will be obtained; ensures that incorrect conclusions are weeded out.

sample A selection of elements representative of a larger population—for example, a group of participants selected to participate in an experiment.

**generalize** To extend the results obtained from a sample to the population from which the sample was taken.



Anna Zuckerman-Vdovenko/ PhotoEdit Inc.

The term *culture* can refer to a large and diverse population, or to a small homogeneous group, such as the Fore people living Papua New Guinea.

like people, differ in many ways, and people are born into their cultures, not assigned to them by psychologists performing experiments. Thus, cross-cultural comparisons are subject to the same limitations we discussed when we examined correlational studies—we cannot attribute causality to a cultural factor until we have ruled these other variables out. For example, a hunting and gathering culture living in a marginal environment may show a higher level of altruism than a technological culture like ours. Does the poverty of their environment make them more attentive to each other? Or is it that the scarcity of resources brings people physically closer than in other cultures, making sharing easier to do?

Psychologists who do cross-cultural research have investigated social behaviors, personality differences, approaches to problem solving, intellectual abilities, perceptual abilities, and aesthetics. (Segall et al., 1999, provide an engaging overview.) Behind research endeavors in psychology is a guiding aim: to discover a psychological universal. According to Norenzayan & Heine (2005), psychological universals are "core mental attributes shared by humans everywhere." That is, they are conclusions from psychological research that can be generalized across groups-ways of reasoning, thinking, making decisions, interpreting why people behave in the way that they do, recognizing emotions and so on. All of these are examples of core mental attributes. A strong case for a psychological universal can be made if a phenomenon exists in a large variety of different cultures.

Cross-cultural psychologists have argued that some behaviors may be universal. They cite the recognition of basic emotions as one example (although this has been challenged; such is the argumentativeness of psychologists). A variety of behaviors, however, is not seen, or is seen to a lesser extent, across cultures and nations. TABLE 1 summarizes those that have been found to vary across cultures.

One way of demonstrating a psychological universal is to examine a behavior in three or more cultures, two of which are very different, with a third falling between them. A better way, however, may be to examine a variety of cultures. This is what Daly and Wilson (1988) did, for example, when they examined sex differences in the international rates of homicide (they found that men were more likely to kill men than women were to kill women). Debate then ensues as to why this universal should exist (and that debate is often heated, as most in psychology are). A related approach is to examine the degree to which a psychological phenomenon is present-personality type is a good example of this. The dominant approach in personality views us as differing along five major personality dimensions. Cross-cultural research has highlighted not only the universality of these five dimensions but also the differences or "variation" that exist between cultures within each dimension—some cultures may express more or less of a personality type such as extraversion or conscientiousness, for example.

#### [ TABLE 1 ] Behaviors That Have Been Reported to Vary across Cultures, or That May Be Less Evident in Certain Cultures.

| Memory for and categorization of focal colors    |
|--|
| Spatial reasoning                                |
| Some types of category-based inductive reasoning |
| Some perceptual illusions                        |
| Some ways of approaching reasoning               |
| Aspects of numerical reasoning                   |
| Risk preferences in decision-making              |
| Self-concept                                     |
| Similarity-attraction effect                     |
| Approach-avoidance motivation                    |
| The fundamental attribution error                |
| Predilection for aggression                      |
| Feelings of control                              |
| High subjective well-being and positive affect   |
| Communication style                              |
| Prevalence of major depression                   |
| Prevalence of eating disorders                   |
| Mental illness                                   |
| Noun bias in language learning                   |
| Moral reasoning                                  |
| Prevalence of different attachment style         |
| Disruptive behavior in adolescence               |
| Personality types                                |
| Response bias                                    |
| Recognition of emotion                           |

Source: Adapted from Norenzayan & Heine (2005).

#### QUESTIONS TO CONSIDER

- 1. Global warming is an obvious problem, with the key issue being the contribution of human activity to the problem. But is the evidence for this correlational or experimental? To the extent that some evidence is correlational, at what point do you think world leaders would be willing to accept correlational evidence as conclusive?
- 2. How might you apply the five steps of the scientific method to a question of your own—for example, the question of whether occasionally taking time out from studying for stretching and a little exercise affects your grades?
- 3. What is the relation between theories and hypotheses?
- **4.** Suppose that you were interested in studying the effects of sleep deprivation on learning ability. Which of these two variables would be the independent variable and which would be the dependent variable? How might you operationally define these variables?
- 5. What is the difference between description and explanation in psychology?
- **6.** In what ways might an operational definition be reliable yet not valid? Valid yet not reliable?

# **Ethics**

The objective study of behavior means that people and animals are the focus of psychological research. Psychologists must therefore apply the methods of science while retaining the sensitivity that is necessary to study living beings. Now that we have examined the details of the scientific method, it is important to understand how psychologists maintain this balance.

Most psychological research takes place in universities or within institutions that receive support from government agencies. Consequently, researchers do not work in the isolated environment of their own laboratory or research group. They receive the advice of their peers on how to conduct their research ethically and they are accountable for their actions. This is true of research for both human and animal behavior. In this section we'll look at the principles that guide ethical research practices.

#### **Research with Human Participants**

Great care is needed in the treatment of human participants, because we can hurt people in very subtle ways. Title 42 of the United States Code requires that every institution receiving research support funds have an institutional review board (IRB) that will review the ethics of human research and ensure that researchers comply with ethical principles and guidelines. But in addition to this regulatory requirement, psychological researchers also subscribe to the Ethical Principles of Psychologists and Code of Conduct (American Psychological Association, 2002) or follow it as a matter of state legislation. As a code of conduct, these principles focus the attention of researchers on fundamental values and issues, because they and similar codes (e.g., Canadian Psychological Association, 2000) have developed from common social and cultural roots (see Adair, 2001; Hadjistavropoulos et al., 2002). Codes of research ethics make these shared values explicit.

Codes of human research ethics echo our widely accepted values about everyday interpersonal relations. In their everyday lives, most people believe that (1) it is wrong to hurt others needlessly; (2) it is good to help others; (3) it is usually wrong to make others do things contrary to their wishes and best interests; (4) it is usually wrong to lie to others; (5) we should respect others' privacy; (6) under most circumstances we should not break our promises to keep others' secrets; and (7) we should afford special protection to those who are relatively powerless or especially vulnerable to harm.

How are these interpersonal values translated to research relationships between researchers and participants? Codes of research ethics tell us that (1) we should minimize harm to participants, whether physical or mental; (2) we should maximize the benefits of research to participants in particular and society in general; (3) participants should be fully informed about the nature of the research in which they are invited to participate, including risks and benefits, and their informed consent to participate must be voluntary; (4) deception in research is generally unacceptable, although it may be tolerated under limited circumstances; (5) we should not intrude into the private lives of participants without their permission; (6) with certain exceptions, we should promise confidentiality-we should guarantee participants that information they provide will be kept anonymous or confidential unless they agree to make it public; and (7) vulnerable populations (e.g., children, prisoners, seriously ill patients, persons with compromised cognitive abilities) should be treated with special care. A university's IRB will have very strict guidelines about how these values must be translated into research procedures. For example, because children are members of a vulnerable population, a parent or guardian must also consent to participation in research.

-[ CASE STUDY ] In the late 1930s, a young psychologist at the University of Iowa, Wendell Johnson, was beginning to develop a new explanation for the speech problem known as stuttering. In contrast to the prevailing theory, which held it to be a result of brain physiology, Johnson felt that stuttering originated when children were overcorrected for minor lapses of correct speech.

**informed consent** A person's agreement to participate in an experiment after he or she has received information about the nature of the research and any possible risks and benefits.

confidentiality Privacy of participants and nondisclosure of their participation in a research project.

To test this theory, Johnson and his graduate student devised a study in which children residing at a nearby orphanage were divided into different groups and given different types of feedback regarding their speech. Six children, judged to not be stutterers, were assigned to a group in which each hesitancy in speaking was pointed out to them by the experimenter over a four- to five-month period. The objective was to see if speech fluency could be adversely affected by this type of feedback (Reynolds, 2003).

Decades later, this study contrasts sharply with the research ethics we use today. The children and their caretakers (the teachers at the orphanage) were given false information to conceal the purpose of the study, and it's unclear how much the administrators knew about the intent of the project. Notice that the hypothesis envisioned that the treatment would produce speech impairments. Yet Johnson and his student apparently did not develop a preplanned debriefing or a prearranged means to ameliorate the possible harm that might ensue (Schwartz, 2006).

When contacted sixty years later and informed of the details, the people who had been subjected to this treatment reacted with dismay and outrage (Dyer, 2001). Some reported an adult life of shyness, speech deficits, and social difficulties and, when they heard the news, attributed these problems to the consequences of the study. They sued. In August, 2007, the state of Iowa agreed to pay \$925,000 to three of the surviving subjects and the estates of three others for the distress the study had caused them.

It's clearly difficult to compare an ethical decision made seventy years ago to one we would make today. However, it's helpful to consider why the former participants of this study felt so betrayed. Basically, their complaints were related to many of the principles we've just discussed: They were subjected to procedures that they, at least, felt were harmful (Principle 1); they had not given informed consent (Principle 3); they were deceived (Principle 4); and they felt that their status as wards of the state had made them vulnerable (Principle 7) (Luna, 2007). Their distress underlines the need for a code of ethics that addresses these possible results of research.

Johnson's colleagues considered him a kindly, altruistic man who would not knowingly subject children to a harmful procedure (Yairi, 2006). The lesson we can take from this episode is that such good intentions are not enough. Difficulties sometimes arise when researchers try to translate everyday values to research. Research procedures that represent good science are sometimes in conflict with respect for participants' dignity. The psychologist Philip Zimbardo attempted to study the way prison guards treated inmates under their supervision. He asked participants to play the role of either a guard or a prisoner. Although this project had considerable scientific merit and important implications for real situations (such as the incidents of abuse at Abu Ghraib prison in Iraq), Zimbardo decided to stop the project in its early stage after he realized that the role of a "prisoner" resulted in increased risk to a participant's self-esteem and dignity. The interesting problem that researchers set for themselves is how to resolve these conflicts—to accomplish the best possible research while simultaneously ensuring that participants are treated properly. Sometimes researchers speak as though the values of scientific inquiry themselves are contrary to the value of respecting people. This is not the case. Effective research procedures, not the values of scientific inquiry, are sometimes in conflict with good treatment of participants. The goal is to identify and use research procedures that are both as ethical and as scientifically valid as possible.

You may have noticed that the list of research ethics values derived from interpersonal values includes exceptions to the general rules (as is the case for the interpersonal values themselves). For example, sometimes telling participants the full truth about the nature of the research will invalidate the research results (see Principle 4). In this type of situation, the researcher may decide that concealing the hypothesis from participants, or actively deceiving them about the nature of the hypothesis, would be good science.

Yet there is a conflict with the interpersonal value of not telling lies. The result of ethical decision making and ethics review by IRBs is sometimes to identify an acceptable balance. The researcher may be permitted to use concealment or minor deception, but only if there is no foreseeable harm to participants and if the researcher can re-establish trust with participants by immediately disclosing the truth to them on completion of the experiment, a process called **debriefing**.

#### **Research with Animals**

Although most psychologists study the behavior of humans, some study the behavior of other animals. Any time another species of animal is used for research purposes, the research itself should be humane and worthwhile. Humane treatment is a matter of procedure. We know how to maintain laboratory animals in good health and in comfortable, sanitary conditions. For experiments that involve surgery, we know how to administer anesthetics and analgesics so that animals do not suffer. Most industrially developed societies have very strict regulations about the care of animals and require approval of the procedures that will be used in animal experiments. American psychologists who use animals in their research adhere to ethical guidelines developed by the American Psychological Association (2007) and regulations of various federal agencies such as the National Institutes of Health and the U.S. Department of Agriculture. Under these guidelines projects involving animals, including teaching and research projects but excepting some purely observational studies, are reviewed by a committee that must include a veterinarian and a member of the public community not affiliated with the institution where the research is carried out (Public Health Service, 2002). These committee members

**debriefing** Full disclosure to research participants of the nature and purpose of a research project after its completion.