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01 - 2.1 Jean Piaget and Cognitive Development

2.1 Jean Piaget and Cognitive Development

Contributions of the Psychosocial Sciences 2.1 Jean Piaget and Cognitive Development Jean Piaget (1896–1980) is considered one of the greatest thinkers of the 20th century. His contributions to the understanding of cognitive development had paradigmatic influence in developmental psychology and had major implications for interventions with children, both educational and clinical. Piaget was born in Neuchatel, Switzerland, where he studied at the university and received a doctorate in biology at the age of 22 (Fig. 2.1-1). Interested in psychology, he studied and carried out research at several centers, including the Sorbonne in Paris, and he worked with Eugen Bleuler at the Burghölzli Psychiatric Hospital. FIGURE 2.1-1 Jean Piaget (1896–1980). (Reprinted from the Jean Piaget Society, Temple University, Philadelphia, PA, with permission.)

Piaget created a broad theoretical system for the development of cognitive abilities; in this sense, his work was similar to that of Sigmund Freud, but Piaget emphasized the ways that children think and acquire knowledge. Widely renowned as a child (or developmental) psychologist, Piaget referred to himself primarily as a genetic epistemologist; he defined genetic epistemology as the study of the development of abstract thought on the basis of a biological or innate substrate. That self-designation reveals that Piaget's central project was more than the articulation of a developmental child psychology, as this term is generally understood; it was an account of the progressive development of human knowledge. COGNITIVE DEVELOPMENT STAGES According to Piaget, the following four major stages lead to the capacity for adult thought (Table 2.1-1): (1) sensorimotor, (2) preoperational thought, (3) concrete operations, and (4) formal operations. Each stage is a prerequisite for the following one, but the rate at which different children move through different stages varies with their native endowment and environmental circumstances. Table 2.1-1 Stages of Intellectual Development Postulated by Piaget Sensorimotor Stage (Birth to 2 Years) Piaget used the term sensorimotor to describe the first stage: Infants begin to learn through sensory observation, and they gain control of their motor functions through activity, exploration, and manipulation of the environment. Piaget divided this stage into six substages, listed in Table 2.1-2. Table 2.1-2 Piaget's Sensorimotor Period of Cognitive Development

From the outset, biology and experience blend to produce learned behavior. For example, infants are born with a sucking reflex, but a type of learning occurs when infants discover the location of the nipple and alter the shape of their mouths. A stimulus is received, and a response results, accompanied by a sense of awareness that is the first schema, or elementary concept. As infants become more mobile, one schema is built on another, and new and more complex schemata are developed. Infants' spatial, visual, and tactile worlds expand during this period; children interact actively with the environment and use previously learned behavior patterns. For example, having learned to use a rattle, infants shake a new toy as they did the rattle they had already learned to use. Infants also use the rattle in new ways. The critical achievement of this period is the development of object permanence or the schema of the permanent object. This phrase relates to a child's ability to understand that objects have an existence independent of the child's involvement with them. Infants learn to differentiate themselves from the world and are able to maintain a mental image of an object, even when it is not present and visible. When an object is dropped in front of infants, they look down to the ground to search for the object; that is, they behave for the first time as though the object has a reality outside themselves. At about 18 months, infants begin to develop mental symbols and to use words, a process known as symbolization. Infants are able to create a visual image of a ball or a mental symbol of the word ball to stand for, or signify, the real object. Such mental representations allow children to operate on new conceptual levels. The attainment of object permanence marks the transition from the sensorimotor stage to the

preoperational stage of development. Stage of Preoperational Thought (2 to 7 Years) During the stage of preoperational thought, children use symbols and language more extensively than in the sensorimotor stage. Thinking and reasoning are intuitive; children learn without the use of reasoning. They are unable to think logically or deductively, and their concepts are primitive; they can name objects but not classes of objects. Preoperational thought is midway between socialized adult thought and the completely autistic Freudian unconscious. Events are not linked by logic. Early in this stage, if children drop a glass that then breaks, they have no sense of cause and effect. They believe that the glass was ready to break, not that they broke the glass. Children in this stage also cannot grasp the sameness of an object in different circumstances: The same doll in a carriage, a crib, or a chair is perceived to be three different objects. During this time, things are represented in terms of their function. For example, a child defines a bike as "to ride" and a hole as "to dig." In this stage, children begin to use language and drawings in more elaborate ways. From one-word utterances, two-word phrases develop, made up of either a noun and a verb or a noun and an objective. A child may say, "Bobby eat," or "Bobby up." Children in the preoperational stage cannot deal with moral dilemmas, although they have a sense of what is good and bad. For example, when asked, "Who is more guilty, the person who breaks one dish on purpose or the person who breaks 10 dishes by accident?" a young child usually answers that the person who breaks 10 dishes by accident is more guilty because more dishes are broken. Children in this stage have a sense of immanent justice, the belief that punishment for bad deeds is inevitable. Children in this developmental stage are egocentric: They see themselves as the center of the universe; they have a limited point of view; and they are unable to take the role of another person. Children are unable to modify their behavior for someone else; for example, children are not being negativistic when they do not listen to a command to be quiet because their brother has to study. Instead, egocentric thinking prevents an understanding of their brother's point of view. During this stage, children also use a type of magical thinking, called phenomenalistic causality, in which

events that occur together are thought to cause one another (e.g., thunder causes lightning, and bad thoughts cause accidents). In addition, children use animistic thinking, which is the tendency to endow physical events and objects with lifelike psychological attributes, such as feelings and intentions. Semiotic Function. The semiotic function emerges during the preoperational period. With this new ability, children can represent something—such as an object, an event, or a conceptual scheme—with a signifier, which serves a representative function (e.g., language, mental image, symbolic gesture). That is, children use a symbol or sign to stand for something else. Drawing is a semiotic function initially done as a playful exercise but eventually signifying something else in the real world.

Stage of Concrete Operations (7 to 11 Years) The stage of concrete operations is so named because in this period children operate and act on the concrete, real, and perceivable world of objects and events. Egocentric thought is replaced by operational thought, which involves dealing with a wide array of information outside the child. Therefore, children can now see things from someone else's perspective. Children in this stage begin to use limited logical thought processes and can serialize, order, and group things into classes on the basis of common characteristics. Syllogistic reasoning, in which a logical conclusion is formed from two premises, appears during this stage; for example, all horses are mammals (premise); all mammals are warm blooded (premise); therefore, all horses are warm blooded (conclusion). Children are able to reason and to follow rules and regulations. They can regulate themselves, and they begin to develop a moral sense and a code of values. Children who become overly invested in rules may show obsessive-compulsive behavior; children who resist a code of values often seem willful and reactive. The most desirable developmental outcome in this stage is that a child attains a healthy respect for rules and understands that there are legitimate exceptions to rules. Conservation is the ability to recognize that, although the shape of objects may change, the objects still maintain or conserve other characteristics that enable them to be recognized as the same. For example, if a ball of clay is rolled into a long, thin sausage shape, children recognize that each form contains the same amount of clay. An inability to conserve (which is characteristic of the preoperational stage) is observed when a child declares that there is more clay in the sausage-shaped piece because it is longer. Reversibility is the capacity to understand the relation between things, to realize that one thing can turn into another and back again—for example, ice and water. The most important sign that children are still in the preoperational stage is that they have not achieved conservation or reversibility. The ability of children to understand concepts of quantity is one of Piaget's most important cognitive developmental theories. Measures of quantity include measures of substance, length, number, liquids, and area (Fig. 2.1-2).

FIGURE 2.1-2 Some simple tests for conservation, with approximate ages of attainment. When the sense of conservation is achieved, the child answers that B contains the same quantity as A. (Modified from Lefrancois GR. *Of Children: An Introduction to Child Development*. Wadsworth: Belmont, CA; 1973:305, with permission.) The 7- to 11-year-old child must organize and order occurrences in the real world. Dealing with the future and its possibilities occurs in the formal operational stage. **Stage of Formal Operations (11 through the End of Adolescence)** The stage of formal operations is so named because young persons' thinking operates in a formal, highly logical, systematic, and symbolic manner. This stage is characterized by the ability to think abstractly, to reason deductively, and to define concepts, and also by the emergence of skills for dealing with permutations and combinations; young persons can grasp the concept of probabilities. Adolescents

attempt to deal with all possible relations and hypotheses to explain data and events during this stage. Language use is

complex; it follows formal rules of logic and is grammatically correct. Abstract thinking is shown by adolescents' interest in a variety of issues—philosophy, religion, ethics, and politics.

Hypotheticodeductive Thinking. Hypotheticodeductive thinking, the highest organization of cognition, enables persons to make a hypothesis or proposition and to test it against reality. Deductive reasoning moves from the general to the particular and is a more complicated process than inductive reasoning, which moves from the particular to the general. Because young persons can reflect on their own and other persons' thinking, they are susceptible to self-conscious behavior. As adolescents attempt to master new cognitive tasks, they may return to egocentric thought, but on a higher level than in the past. For example, adolescents may think that they can accomplish everything or can change events by thought alone. Not all adolescents enter the stage of formal operations at the same time or to the same degree. Depending on individual capacity and intervening experience, some may not reach the stage of formal operational thought at all and may remain in the concrete operational mode throughout life.

PSYCHIATRIC APPLICATIONS Piaget's theories have many psychiatric implications. Hospitalized children who are in the sensorimotor stage have not achieved object permanence and, therefore, have separation anxiety. They do best if their mothers are allowed to stay with them overnight. Children at the preoperational stage, who are unable to deal with concepts and abstractions, benefit more from role-playing proposed medical procedures and situations than by having them verbally described in detail. For example, a child who is to receive intravenous therapy is helped by acting out the procedure with a toy intravenous set and dolls. Because children at the preoperational stage do not understand cause and effect, they may interpret physical illness as punishment for bad thoughts or deeds; and because they have not yet mastered the capacity to conserve and do not understand the concept of reversibility (which normally occurs during the concrete operational stage), they cannot understand that a broken bone mends or that blood lost in an accident is replaced. Adolescents' thinking, during the stage of formal operations, may appear overly abstract when it is, in fact, a normal developmental stage. Adolescent turmoil may not herald a psychotic process but may well result from a normal adolescent's coming to grips with newly acquired abilities to deal with the unlimited possibilities of the surrounding world. Adults under stress may regress cognitively as well as emotionally. Their thinking can become preoperational, egocentric, and sometimes animistic.

Implications for Psychotherapy

Piaget was not an applied psychologist and did not develop the implications of his cognitive model for psychotherapeutic intervention. Nevertheless, his work formed one of the foundations of the cognitive revolution in psychology. One aspect of this revolution was an increasing emphasis on the cognitive components of the therapeutic endeavor. In contrast to classical psychodynamic therapy, which focused primarily on drives and affects, and in contrast to behavior therapy, which focused on overt actions, cognitive approaches to therapy focused on thoughts, including automatic assumptions, beliefs, plans, and intentions. By including "theory theory" and "script theory" we can see additional applications to psychotherapy. Cognitive development theory has influenced psychotherapeutic approaches in multiple ways. Some therapists have taken developmental notions from Piaget's work and developed intervention techniques. Others have developed cognitive models of treatment independent of Piaget but with heavy reliance on the role of cognition. Others have included Piaget's concepts in a broader set of constructs to undergird

new developmental approaches to psychotherapy. First, some psychotherapists applied Piagetian notions directly to child interventions. Susan Harter, for example, discussed techniques for helping young children become aware of divergent or contradictory emotions and to integrate these complex emotions within a more abstract or higher class of emotions. One of Harter's techniques is to ask the young child to make a drawing that shows different and conflicting feelings in one person. This technique represents an application of the concrete operation of class inclusion to the realm of the emotions. Harter's work applied Piagetian findings to the common therapeutic problem of helping children to recognize, tolerate, and integrate mixed or ambivalent affects within stable object relations. As such, it drew on cognitive theory and psychodynamic theory. Similar techniques are important in work with children who have been exposed to trauma or to sexual abuse. It is an essential component of such work to assist them in labeling, differentiating, and accepting the full range of emotions stemming from these experiences. Second, other psychotherapists developed treatment models that, although not directly dependent on Piagetian psychology, emphasized core ideas quite similar to those Piaget discovered in his naturalistic observations of cognitive development. These models are even more closely aligned with recent developments in "theory theory." Aaron Beck, for example, developed an entire school of cognitive therapy that focuses on the role of cognitions in causing or maintaining psychopathology. Cognitive therapy has been shown to be an effective treatment for problems as diverse as depression, anxiety disorders, and substance abuse. A core idea in cognitive therapy is that the patient has developed certain core beliefs, aspects of the self-schema, and conditional probability beliefs as a result of developmental experiences, and these contribute to emotional or behavioral problems. For example, depressed persons may have the core belief "I am unlovable." Addicted persons may have the belief "Unless I drink I cannot feel happy." In cognitive therapy, the person can be assisted to identify the negative automatic thoughts and underlying

dysfunctional attitudes or beliefs that contribute to emotional distress or addictive behavior. The key therapeutic process after identification of the maladaptive thoughts is to help the patient view these thoughts more objectively, not take them in an unquestioning manner as veridical. Here, cognitive therapy emphasizes evidence, consistent both with Piagetian theory and "theory theory." The patient is assisted to seek out evidence to test negative thinking; active involvement, rather than passive listening, is required. What the cognitive therapist accomplishes through such techniques as Socratic questioning and asking if there are other ways to look at the same event is similar to what the talented teacher does in guiding children to more adequate, more intelligent understanding of operational tasks. The notion of equilibration is relevant in both instances. By helping the individual see that previous cognitive structures are in some ways inadequate, the therapist or teacher disturbs the old cognitive structure, and the patient or student experiences a disruption that leads to the search for more-adequate structures. The compensation for external disturbance is what Piaget termed equilibration. New structures can be constructed only through a process of accommodation, enabling the subject to assimilate a wider array of data, a new perspective, or more complex information. Because it requires thinking about thinking, cognitive therapy seems to require formal operational thinking, although this has not been empirically tested. At the least, it requires the ability to recognize and articulate affects, to recognize and label events that give rise to affects, and to translate into a thought the mediating process that occurs rapidly between the event and the affect. Cognitive-behavioral models of psychotherapy include cognitive techniques and more behavioral, interactive techniques, such as increasing pleasant activities and improving communication and problemsolving skills. It is possible that the less-

cognitive, more-behavioral techniques, although requiring a lower level of cognitive development, can also lead to garnering of evidence and modification of specific expectancies, attributions, and self-schemata. Because “script theory” or narrative approaches to cognition in psychotherapy are empirically based, generated by repetitive experiences rather than by reflective abstraction, and domain specific, they may have even more general application to psychotherapy than classic Piagetian theories or “theory theory.” For example, in dialectical behavior therapy, patients provide a “chain analysis” of events, feelings, thoughts, situational stimuli, and interpersonal factors that led up to a negative or selfdamaging behavior. This narrative provides guidance to the patient and the therapist about where and how to intervene to prevent subsequent similar behavior.

Developmentally Based Psychotherapy Developmentally based psychotherapy, developed by Stanley Greenspan, M.D., integrates cognitive, affective, drive, and relationship-based approaches with new understanding of the stages of human development. The clinician first determines the level of the patient’s ego or personality development and the presence or absence of

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deficits or constrictions. For example, can the person regulate activity and sensations, relate to others, read nonverbal affective symbols, represent experience, build bridges between representations, integrate emotional polarities, abstract feelings, and reflect on internal wishes and feelings? From a developmental point of view, the integral parts of the therapeutic process include learning how to regulate experience; to engage more fully and deeply in relationships; to perceive, comprehend, and respond to complex behaviors, and interactive patterns; and to be able to engage in the ever-changing opportunities, tasks, and challenges during the course of life (e.g., adulthood and aging) and, throughout, to observe and reflect on one's own and others' experiences. These processes are the foundation of the ego, and more broadly, the personality. Their presence constitutes emotional health and their absence, emotional disorder. The developmental approach describes how to harness these core processes and so assist the patients in mobilizing their own growth.

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2.2 Attachment Theory ATTACHMENT AND DEVELOPMENT Attachment can be defined as the emotional tone between children and their caregivers and is evidenced by an infant's seeking and clinging to the caregiving person, usually the mother. By their first month, infants usually have begun to show such behavior, which is designed to promote proximity to the desired person. Attachment theory originated in the work of John Bowlby, a British psychoanalyst (1907-1990) (Fig. 2.2-1). In his studies of infant attachment and separation, Bowlby

pointed out that attachment constituted a central motivational force and that mother- child attachment was an essential medium of human interaction that had important consequences for later development and personality functioning. Being monotropic, infants tend to attach to one person; but they can form attachments to several persons, such as the father or a surrogate. Attachment develops gradually; it results in an infant's wanting to be with a preferred person, who is perceived as stronger, wiser, and able to reduce anxiety or distress. Attachment thus gives infants feelings of security. The process is facilitated by interaction between mother and infant; the amount of time together is less important than the amount of activity between the two. FIGURE 2.2-1 John Bowlby (1907-1990). The term bonding is sometimes used synonymously with attachment, but the two are different phenomena. Bonding concerns the mother's feelings for her infant and differs from attachment. Mothers do not normally rely on their infants as a source of security, as is the case in attachment behavior. Much research reveals that the bonding of mother to infant occurs when there is skin-to-skin contact between the two or when other types of contact, such as voice and eye contact, are made. Some workers have concluded that a mother who has skin-to-skin contact with her baby immediately after birth shows a

stronger bonding pattern and may provide more attentive care than a mother who does not have this experience. Some researchers have even proposed a critical period immediately after birth, during which such skin-to-skin contact must occur if bonding is to take place. This concept is much disputed: Many mothers are clearly bonded to their infants and display excellent maternal care even though they did not have skin-to-skin contact immediately postpartum. Because human beings can develop representational models of their babies in utero and even before conception, this representational thinking may be as important to the bonding process as skin, voice, or eye contact. Ethological Studies Bowlby suggested a Darwinian evolutionary basis for attachment behavior; namely, such behavior ensures that adults protect their young. Ethological studies show that nonhuman primates and other animals exhibit attachment behavior patterns that are presumably instinctual and are governed by inborn tendencies. An example of an instinctual attachment system is imprinting, in which certain stimuli can elicit innate behavior patterns during the first few hours of an animal's behavioral development; thus, the animal offspring becomes attached to its mother at a critical period early in its development. A similar sensitive or critical period during which attachment occurs has been postulated for human infants. The presence of imprinting behavior in humans is highly controversial, but bonding and attachment behavior during the first year of life closely approximate the critical period; in humans, however, this period occurs over a span of years rather than hours. Harry Harlow. Harry Harlow's work with monkeys is relevant to attachment theory. Harlow demonstrated the emotional and behavioral effects of isolating monkeys from birth and keeping them from forming attachments. The isolates were withdrawn, unable to relate to peers, unable to mate, and incapable of caring for their offspring. PHASES OF ATTACHMENT In the first attachment phase, sometimes called the preattachment stage (birth to 8 or 12 weeks), babies orient to their mothers, follow them with their eyes over a 180-degree range, and turn toward and move rhythmically with their mother's voice. In the second phase, sometimes called attachment in the making (8 to 12 weeks to 6 months), infants become attached to one or more persons in the environment. In the third phase, sometimes called clear-cut attachment (6 through 24 months), infants cry and show other signs of distress when separated from the caretaker or mother; this phase can occur as early as 3 months in some infants. On being returned to the mother, the infant stops crying and clings, as if to gain further assurance of the mother's return. Sometimes, seeing the mother after a separation is sufficient for crying to stop. In

the fourth phase (25 months and beyond), the mother figure is seen as independent, and a more complex relationship between the mother and the child develops. Table 2.2-1 summarizes the development of normal attachment from birth through 3 years.

Table 2.2-1 Normal Attachment

Mary Ainsworth Mary Ainsworth (1913–1999) was a Canadian developmental psychologist from the University of Toronto. She described three main types of insecure attachment: insecure-avoidant, insecure-ambivalent, and insecure-disorganized. The insecure-avoidant child, having experienced brusque or aggressive parenting, tends to avoid close contact with people and lingers near caregivers rather than approaching them directly when faced with a threat. The insecure-ambivalent child finds exploratory play difficult, even in the absence of danger, and clings to his or her inconsistent parents. Insecure-disorganized children have parents who are emotionally absent with a parental history of abuse in their childhood. These children tend to behave in bizarre ways when threatened. According to Ainsworth, disorganization is a severe form of insecure attachment and a possible precursor of severe personality disorder and dissociative phenomena in adolescence and early adulthood. Mary Ainsworth expanded on Bowlby's observations and found that the interaction between the mother and her baby during the attachment period significantly influences the baby's current and future behavior. Patterns of attachments vary among babies; for example, some babies signal or cry less than others. Sensitive responsiveness to infant

signals, such as cuddling a crying baby, causes infants to cry less in later months, rather than reinforcing crying behavior. Close bodily contact with the mother when the baby signals for her is also associated with the growth of self-reliance, rather than a clinging dependence, as the baby grows older. Unresponsive mothers produce anxious babies; these mothers often have lower intelligence quotients (IQs) and are emotionally more immature and younger than responsive mothers. Ainsworth also confirmed that attachment serves to reduce anxiety. What she called the secure base effect enables children to move away from attachment figures and to explore the environment. Inanimate objects, such as a teddy bear and a blanket (called the transitional object by Donald Winnicott), also serve as a secure base, one that often accompanies them as they investigate the world. Strange Situation. Ainsworth developed strange situation, the research protocol for assessing the quality and security of an infant's attachment. In this procedure, the infant is exposed to escalating amounts of stress; for example, the infant and the parent enter an unfamiliar room, an unfamiliar adult then enters the room, and the parent leaves the room. The protocol has seven steps (Table 2.2-2). According to Ainsworth's studies, about 65 percent of infants are securely attached by the age of 24 months. Table 2.2-2 The Strange Situation ANXIETY Bowlby's theory of anxiety holds that a child's sense of distress during separation is perceived and experienced as anxiety and is the prototype of anxiety. Any stimuli that alarm children and cause fear (e.g., loud noises, falling, and cold blasts of air) mobilize signal indicators (e.g., crying) that cause the mother to respond in a caring way by

cuddling and reassuring the child. The mother's ability to relieve the infant's anxiety or fear is fundamental to the growth of attachment in the infant. When the mother is close to the child and the child experiences no fear, the child gains a sense of security, the opposite of anxiety. When the mother is unavailable to the infant because of physical absence (e.g., if the mother is in prison) or because of psychological impairment (e.g., severe depression), anxiety develops in the infant.

Expressed as tearfulness or irritability, separation anxiety is the response of a child who is isolated or separated from its mother or caretaker. It is most common at 10 to 18 months of age and disappears generally by the end of the third year. Somewhat earlier (at about 8 months) stranger anxiety, an anxiety response to someone other than the caregiver, appears. Signal Indicators Signal indicators are infants' signs of distress that prompt or elicit a behavioral response in the mother. The primary signal is crying. The three types of signal indicators are hunger (the most common), anger, and pain. Some mothers can distinguish between them, but most mothers generalize the hunger cry to represent distress from pain, frustration, or anger. Other signal indicators that reinforce attachment are smiling, cooing, and looking. The sound of an adult human voice can prompt these indicators. Losing Attachments Persons' reactions to the death of a parent or a spouse can be traced to the nature of their past and present attachment to the lost figure. An absence of demonstrable grief may be owing to real experiences of rejection and to the lack of closeness in the relationship. The person may even consciously offer an idealized picture of the deceased. Persons who show no grief usually try to present themselves as independent and as disinterested in closeness and attachment. Sometimes, however, the severing of attachments is traumatic. The death of a parent or a spouse can precipitate a depressive disorder, and even suicide, in some persons. The death of a spouse increases the chance that the surviving spouse will experience a physical or mental disorder during the next year. The onset of depression and other dysphoric states often involves having been rejected by a significant figure in a person's life.

DISORDERS OF ATTACHMENT Attachment disorders are characterized by biopsychosocial pathology that results from maternal deprivation, a lack of care by, and interaction with, the mother or caregiver. Failure-to-thrive syndromes, psychosocial dwarfism, separation anxiety disorder, avoidant personality disorder, depressive disorders, delinquency, academic problems, and borderline intelligence have been traced to negative attachment experiences. When maternal care is deficient because (1) a mother is mentally ill, (2) a child is

institutionalized for a long time, or (3) the primary object of attachment dies, children sustain emotional damage. Bowlby originally thought that the damage was permanent and invariable, but he revised his theories to take into account the time at which the separation occurred, the type and degree of separation, and the level of security that the child experienced before the separation. Bowlby described a predictable set and sequence of behavior patterns in children who are separated from their mothers for long periods (more than 3 months): protest, in which the child protests the separation by crying, calling out, and searching for the lost person; despair, in which the child appears to lose hope that the mother will return; and detachment, in which the child emotionally separates himself or herself from the mother. Bowlby believed that this sequence involves ambivalent feelings toward the mother; the child both wants her and is angry with her for her desertion. Children in the detachment stage respond in an indifferent manner when the mother returns; the mother has not been forgotten, but the child is angry at her for having gone away in the first place and fears that she will go away again. Some children have affectionless personalities characterized by emotional withdrawal, little or no feeling, and a limited ability to form affectionate relationships. Anaclitic Depression Anaclitic depression, also known as hospitalism, was first described by René Spitz in infants who had made normal attachments but were then suddenly separated from their mothers for varying times and placed in institutions or hospitals. The children became depressed, withdrawn, nonresponsive, and vulnerable to physical illness, but they recovered when their mothers returned or when surrogate mothering was available.

CHILD MALTREATMENT Abused children often maintain their attachments to abusive parents. Studies of

dogs have shown that severe punishment and maltreatment increase attachment behavior. When children are hungry, sick, or in pain, they too show clinging attachment behavior. Similarly, when children are rejected by their parents or are afraid of them, their attachment may increase; some children want to remain with an abusive parent. Nevertheless, when a choice must be made between a punishing and a nonpunishing figure, the nonpunishing person is the preferable choice, especially if the person is sensitive to the child's needs. PSYCHIATRIC APPLICATIONS The applications of attachment theory in psychotherapy are numerous. When a patient is able to attach to a therapist, a secure base effect is seen. The patient may then be able to take risks, mask anxiety, and practice new patterns of behavior that otherwise might not have been attempted. Patients whose impairments can be traced to never having made an attachment in early life may do so for the first time in therapy, with salutary

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effects. Patients whose pathology stems from exaggerated early attachments may attempt to replicate them in therapy. Therapists must enable such patients to recognize the ways their early experiences have interfered with their ability to achieve independence. For patients who are children and whose attachment difficulties may be more apparent than those of adults, therapists represent consistent and trusted figures who can engender a sense of warmth and self-esteem in children, often for the first time. Relationship Disorders A person's psychological health and sense of well-being depend significantly on the quality of his or her relationships and attachment to others, and a core issue in all close personal relationships is establishing and regulating that connection. In a typical attachment interaction, one person seeks more proximity and affection, and the other either reciprocates, rejects, or disqualifies the request. A pattern is shaped through repeated exchanges. Distinct attachment styles have been observed. Adults with an anxious-ambivalent attachment style tend to be obsessed with romantic partners, suffer from extreme jealousy, and have a high divorce rate. Persons with an avoidant attachment style are relatively uninvested in close relationships, although they often feel lonely. They seem afraid of intimacy and tend to withdraw when there is stress or conflict in the relationship. Break-up rates are high. Persons with a secure attachment style are highly invested in relationships and tend to behave without much possessiveness or fear of rejection. REFERENCES Freud S. The Standard Edition of the Complete Psychological Works of Sigmund Freud. 24 vols. London: Hogarth Press; 1953- Greenberg JR, Mitchell SA. Object Relations in Psychoanalytic Theory. Cambridge, MA: Harvard University Press; 1983. Laplanche J, Pontalis J-B. The Language of Psycho-analysis. New York: Norton; 1973. Mahler MS, Pine F, Bergman A. The Psychological Birth of the Human Infant. New York: Basic Books; 1975. Pallini S, Baiocco R, Schneider BH, Madigan S, Atkinson L. Early child-parent attachment and peer relations: A metaanalysis of recent research. J Fam Psychol. 2014;28:118. Stern D. The Interpersonal World of the Infant. New York: Basic Books; 1985. Meissner, W.W. Theories of Personality in Psychotherapy. In: Sadock BJ, Sadock VA, eds. Kaplan & Sadock's Comprehensive Textbook of Psychiatry. 9th ed. Vol. 1. Philadelphia: Lippincott Williams & Wilkins; 2009:788. 2.3 Learning Theory Learning is defined as a change in behavior resulting from repeated practice. The principles of learning are always operating and always influencing human activity. Learning principles are often deeply involved in the etiology and maintenance of psychiatric disorders because so much of human behavior (including overt behavior, thought patterns, and emotion) is acquired through learning. Learning processes also

strongly influence psychotherapy because human behavior changes. Thus, learning principles can influence the effectiveness of therapy. In fact, no method of therapy can be said to be immune to the effects of learning. Even the simple prescription of a medication can bring learning processes into play because the patient will have opportunities to learn about the drug's effects and side

effects, will need to learn to comply with the instructions and directions for taking it, and will need to learn to overcome any resistance to compliance. BASIC CONCEPTS AND CONSIDERATIONS A great deal of modern research on learning still focuses on Pavlovian (classical) and operant learning. Pavlovian conditioning, developed by Ivan Petrovich Pavlov (1849–1936), occurs when neutral stimuli are associated with a psychologically significant event. The main result is that the stimuli come to evoke a set of responses or emotions that may contribute to many clinical disorders, including (but not limited to) anxiety disorders and drug dependence. The events in Pavlov's experiment are often described using terms designed to make the experiment applicable to any situation. The food is the unconditional stimulus (US) because it unconditionally elicits salivation before the experiment begins. The bell is known as the conditional stimulus (CS) because it only elicits the salivary response conditional on the bell–food pairings. The new response to the bell is correspondingly called the conditional response (CR), and the natural response to the food itself is the unconditional response (UR). Modern laboratory studies of conditioning use a very wide range of CSs and USs and measure a wide range of conditioned responses. Operant conditioning, developed by B.F. Skinner (1904–1990), occurs when a behavior (instead of a stimulus) is associated with a psychologically significant event. In the laboratory, the most famous experimental arrangement is the one in which a rat presses a lever to earn food pellets. In this case, as opposed to Pavlov's, the behavior is said to be an operant because it operates on the environment. The food pellet is a reinforcer—an event that increases the strength of the behavior of which it is made a consequence. A major idea behind this method is that the rat's behavior is “voluntary” in the sense that the animal is not compelled to make the response (it can perform it whenever it “wants” to). In this sense, it is similar to the thousands of operant behaviors that humans choose to commit—freely—in any day. Of course, the even larger idea is that even though the rat's behavior appears as though it is voluntary, it is lawfully controlled by its consequences: If the experimenter were to stop delivering the food pellet, the rat would stop pressing the lever, and if the experimenter were to allow the lever press to produce larger pellets, or perhaps pellets at a higher probability or rate, then the rate of the behavior might increase. The point of operant conditioning experiments, then, is largely to understand the relation of behavior to its payoff. Pavlovian and operant conditioning differ in several ways. One of the most fundamental differences is that the responses observed in Pavlov's experiment are elicited and thus controlled by the presentation of an antecedent stimulus. In contrast,

the “response” observed in Skinner's experiment is not elicited or compelled by an antecedent stimulus in any obvious way—it is instead controlled by its consequences. This distinction between operants and respondents is important in clinical settings. If a young patient is referred to the clinic for acting out in the classroom, an initial goal of the clinician will be to determine whether the behavior is a respondent or an operant, and then the clinician will go about changing either its antecedents or its consequences, respectively, to reduce its probability of occurrence. Despite the academic separation of operant and respondent conditioning, they have an important common function: Both learning processes are designed by evolution to allow organisms to adapt to the environment. The idea is illustrated by considering the law of effect (Fig. 2.3-1), which says that whether an operant behavior increases or decreases in strength depends on the effect it has on the environment. When the action leads to a positive outcome, the action is strengthened; conversely, when the action leads to a negative outcome, we have punishment, and the action is weakened. In a similar manner, when an action decreases the probability of a positive event, behavior also declines. (Such a procedure is now widely known as time-out from reinforcement.) When an action

terminates or prevents the occurrence of a negative event, the behavior will strengthen. By thus enabling the organism to maximize its interaction with positive events and minimize its interaction with negative ones, operant conditioning allows the organism to optimize its interaction with the environment. Of course, events that were once positive in the human's earlier evolutionary history are so prevalent in modern society that they do not always seem adaptive today. Thus, reward learning also provides a framework for understanding the development of rather maladaptive behaviors like overeating (in which behavior is reinforced by food) and drug taking (in which behaviors are reinforced by the pharmacological effects of drugs)—cases in which reward principles lead to psychopathology. FIGURE 2.3-1 The law of effect in instrumental/operant learning. Actions either produce or prevent good or bad events, and the strength of the action changes accordingly (arrow). "Reinforcement" refers to a strengthening of behavior. Positive reinforcement occurs

when an action produces a positive event, whereas negative reinforcement occurs when an action prevents or eliminates a negative event. (Courtesy of Mark E. Bouton, PhD.) A parallel to Figure 2.3-1 exists in Pavlovian conditioning, in which one can likewise think of whether the CS is associated with positive or negative events (Fig. 2.3-2). Although such learning can lead to a wide constellation or system of behaviors, in a very general way, it also leads to behavioral tendencies of approach or withdrawal. Thus, when a CS signals a positive US, the CS will tend to evoke approach behaviors—called sign tracking. For example, an organism will approach a signal for food. Analogously, when a CS signals a negative US, it will evoke behaviors that tend to move the organism away from the CS. Conversely, CSs associated with a decrease in the probability of a good thing will elicit withdrawal behaviors, whereas CSs associated with the decrease in the probability of a bad thing can elicit approach. An example of the latter case might be a stimulus that signals safety or the decrease in probability of an aversive event, which evokes approach in a frightened organism. In the end, these very basic behavioral effects of both operant (see Fig. 2.3-1) and Pavlovian (see Fig. 2.3-2) learning serve to maximize the organism's contact with good things and minimize contact with bad things. FIGURE 2.3-2 Sign tracking in Pavlovian learning. Conditional stimuli (CSs) signal either an increase or a decrease in the probability of good or bad events, and the CS generally engages approach or withdrawal behaviors accordingly. (Courtesy of Mark E. Bouton, PhD.) Perhaps because they have such similar functions, Pavlovian learning and operant learning are both influenced by similar variables. For example, in either case, behavior is especially strong if the magnitude of the US or reinforcer is large, or if the US or reinforcer occurs relatively close to the CS or operant response in time. In either case, the learned behavior decreases if the US or reinforcer that was once paired with the CS or the response is eliminated from the situation. This phenomenon, called extinction, provides a means of eliminating unwanted behaviors that were learned through either

form of conditioning and has led to a number of very effective cognitive-behavioral therapies. PAVLOVIAN CONDITIONING Effects of Conditioning on Behavior Many lay people have the mistaken impression that Pavlovian learning is a rigid affair in which a fixed stimulus comes to elicit a fixed response. In fact, conditioning is considerably more complex and dynamic than that. For example, signals for food may evoke a large set of responses that function to prepare the organism to digest food: They can elicit the secretion of gastric acid, pancreatic enzymes, and insulin in addition to Pavlov's famous salivary response. The CS can also elicit approach behavior (as described earlier), an increase in body temperature, and a state of arousal and excitement. When a signal for food is presented to a satiated animal or human, he or she may eat more food. Some of these effects may

be motivational; for example, an additional effect of presenting a CS for food is that it can invigorate ongoing operant behaviors that have been reinforced with food. CSs thus have powerful behavioral potential. Signals for food evoke a whole behavior system that is functionally organized to find, procure, and consume food. Pavlovian conditioning is also involved in other aspects of eating. Through conditioning, humans and other animals may learn to like or dislike certain foods. In animals like rats, flavors associated with nutrients (sugars, starches, calories, proteins, or fats) come to be preferred. Flavors associated with sweet tastes are also preferred, whereas flavors associated with bitter tastes are avoided. At least as important, flavors associated with illness become disliked, as illustrated by the person who gets sick drinking an alcoholic beverage and consequently learns to hate the flavor. The fact that flavor CSs can be associated with such a range of biological consequences (USs) is important for omnivorous animals that need to learn about new foods. It also has some clinical implications. For example, chemotherapy can make cancer patients sick, and it can therefore cause the conditioning of an aversion to a food that was eaten recently (or to the clinic itself). Other evidence suggests that animals may learn to dislike food that is associated with becoming sick with cancer. On the flip side, conditioning can enable external cues to trigger food consumption and craving, a potential influence on overeating and obesity. Pavlovian conditioning also occurs when organisms ingest drugs. Whenever a drug is taken, in addition to reinforcing the behaviors that lead to its ingestion, the drug constitutes a US and may be associated with potential CSs that are present at the time (e.g., rooms, odors, injection paraphernalia,). CSs that are associated with drug USs can sometimes have an interesting property: They often elicit a conditioned response that seems opposite to the unconditional effect of the drug. For example, although morphine causes a rat to feel less pain, a CS associated with morphine elicits an opposite increase, not a decrease in pain sensitivity. Similarly, although alcohol can cause a drop in body temperature, a conditioned response to a CS associated with alcohol is typically an

increase in body temperature. In these cases, the conditioned response is said to be compensatory because it counteracts the drug effect. Compensatory responses are another example of how classical (Pavlovian) conditioning helps organisms prepare for a biologically significant US. Compensatory conditioned responses have implications for drug abuse. First, they can cause drug tolerance, in which repeated administration of a drug reduces its effectiveness. As a drug and a CS are repeatedly paired, the compensatory response to the CS becomes stronger and more effective at counteracting the effect of the drug. The drug therefore has less impact. One implication is that tolerance will be lost if the drug is taken without being signaled by the usual CS. Consistent with this idea, administering a drug in a new environment can cause a loss of drug tolerance and make drug overdose more likely. A second implication stems from the fact that compensatory responses may be unpleasant or aversive. A CS associated with an opiate may elicit several compensatory responses—it may cause the drug user to be more sensitive to pain, undergo a change in body temperature, and perhaps become hyperactive (the opposite of another unconditional opiate effect). The unpleasantness of these responses may motivate the user to take the drug again to get rid of them, an example of escape learning, or negative reinforcement, and a classic example of how Pavlovian and operant learning processes might readily interact. The idea is that the urge to take drugs may be strongest in the presence of CSs that have been associated with the drug. The hypothesis is consistent with self-reports of abusers, who, after a period of abstinence, are tempted to take the drug again when they are reexposed to drug-associated cues. Pavlovian learning may potentially be involved in anxiety disorders. CSs associated with frightening USs can elicit a whole

system of conditioned fear responses, broadly designed to help the organism cope. In animals, cues associated with frightening events (such as a brief foot shock) elicit changes in respiration, heart rate, and blood pressure, and even a (compensatory) decrease in sensitivity to pain. Brief CSs that occur close to the US in time can also elicit adaptively timed protective reflexes. For example, the rabbit blinks in response to a brief signal that predicts a mild electric shock near the eye. The same CS, when lengthened in duration and paired with the same US, elicits mainly fear responses, and fear elicited by a CS may potentiate the conditioned eyeblink response elicited by another CS or a startle response to a sudden noise. Once again, CSs do not merely elicit a simple reflex, but also evoke a complex and interactive set of responses. Classical fear conditioning can contribute to phobias (in which specific objects may be associated with a traumatic US), as well as other anxiety disorders, such as panic disorder and posttraumatic stress disorder (PTSD). In panic disorder, people who have unexpected panic attacks can become anxious about having another one. In this case, the panic attack (the US or UR) may condition anxiety to the external situation in which it occurs (e.g., a crowded bus) and also internal (“interoceptive”) CSs created by early symptoms of the attack (e.g., dizziness or a sudden pounding of the heart). These CSs may then evoke anxiety or panic responses. Panic disorder may begin because external cues associated with panic can arouse anxiety, which may then exacerbate the next unconditional panic attack and/or panic response elicited by an interoceptive CS. It is possible that the emotional reactions elicited by CSs may not require conscious awareness for their occurrence or development. Indeed, fear conditioning may be independent of conscious awareness. In addition to eliciting conditioned responses, CSs also motivate ongoing operant behavior. For example, presenting a CS that elicits anxiety can increase the vigor of operant behaviors that have been learned to avoid or escape the frightening US. Thus,

an individual with an anxiety disorder will be more likely to express avoidance in the presence of anxiety or fear cues. Similar effects may occur with CSs that predict other USs (such as drugs or food)—as already mentioned, a drug-associated CS may motivate the drug abuser to take more drugs. The motivating effects of CSs may stem from the fact that CSs may be associated with both the sensory and emotional properties of USs. For example, the survivor of a traumatic train derailment might associate stimuli that occur immediately before derailment (such as the blue flash that occurs when the train separates from its overhead power supply) with both the emotional and the sensory aspects of the crash. Consequently, when the survivor later encounters another flashing blue light (e.g., the lights on a police car), the CS might evoke both emotional responses (mediated by association with the trauma’s emotional qualities) and sensory associations (mediated by association with the trauma’s sensory qualities). Both might play a role in the nightmares and “re-experiencing” phenomena that are characteristic of PTSD. The Nature of the Learning Process Research beginning in the late 1960s began to uncover some important details about the learning process behind Pavlovian conditioning. Several findings proved especially important. It was shown, for example, that conditioning is not an inevitable consequence of pairing a CS with a US. Such pairings will not cause conditioning if there is a second CS present that already predicts the US. This finding (known as blocking) suggests that a CS must provide new information about the US if learning is to occur. The importance of the CS’s information value is also suggested by the fact that a CS will not be treated as a signal for the US if the US occurs equally often (or is equally probable) in the presence and the absence of the CS. Instead, the organism treats the CS as a signal for the US if the probability of the US is greater in the presence of the CS than in its absence. In addition, the organism will treat the CS as a signal for “no US” if

the probability of the US is less in the presence of the CS than in its absence. In the latter case, the signal is called a conditioned inhibitor because it will inhibit performance elicited by other CSs. The conditioned inhibition phenomenon is clinically relevant because inhibitory CSs may hold pathological CRs like fear or anxiety at bay. A loss of the inhibition would allow the anxiety response to emerge. There are also important variants of classical conditioning. In sensory preconditioning, two stimuli (A and B) are first paired, and then one of them (A) is later paired with the US. Stimulus A evokes conditioned responding, of course, but so does stimulus B—indirectly, through its association with A. One implication is that exposure to a potent US like a panic attack may influence reactions to stimuli that have never been paired with the US directly; the sudden anxiety to stimulus B might seem spontaneous and mysterious. A related finding is second-order conditioning. Here, A is paired with a US first and then subsequently paired with stimulus B. Once again, both A and B will evoke responding. Sensory preconditioning and second-order conditioning increase the range of stimuli that can control the conditioned response. A third variant worth mentioning occurs, as indicated previously, when the onset of a stimulus becomes associated with the rest of that stimulus, as when a sudden increase in heart rate caused by the onset of a panic attack comes to predict the rest of the

panic or feeling, or when the onset of a drug may predict the rest of the drug effect. Such intraevent associations may play a role in many of the body's regulatory functions, such that an initial change in some variable (e.g., blood pressure or blood glucose level) may come to signal a further increase in that variable and therefore initiate a conditioned compensatory response. Emotional responses can also be conditioned through observation. For example, a monkey that merely observes another monkey being frightened by a snake can learn to be afraid of the snake. The observer learns to associate the snake (CS) with its emotional reaction (US/UR) to the other monkey being afraid. Although monkeys readily learn to fear snakes, they are less likely to associate other salient cues (such as colorful flowers) with fear in the same way. This is an example of preparedness in classical conditioning—some stimuli are especially effective signals for some USs because evolution has made them that way. Another example is the fact that tastes are easily associated with illness but not shock, whereas auditory and visual cues are easily associated with shock but not illness. Preparedness may explain why human phobias tend to be for certain objects (snakes or spiders) and not others (knives or electric sockets) that may as often be paired with pain or trauma. Erasing Pavlovian Learning If Pavlovian learning plays a role in the etiology of behavioral and emotional disorders, a natural question concerns how to eliminate it or undo it. Pavlov studied extinction: Conditioned responding decreases if the CS is presented repeatedly without the US after conditioning. Extinction is the basis of many behavioral or cognitive-behavioral therapies designed to reduce pathological conditioned responding through repeated exposure to the CS (exposure therapy), and it is presumably a consequence of any form of therapy in the course of which the patient learns that previous harmful cues are no longer harmful. Another elimination procedure is counterconditioning, in which the CS is paired with a very different US/UR. Counterconditioning was the inspiration for systematic desensitization, a behavior therapy technique in which frightening CSs are deliberately associated with relaxation during therapy. Although extinction and counterconditioning reduce unwanted conditioned responses, they do not destroy the original learning, which remains in the brain, ready to return to behavior under the right circumstances. For example, conditioned responses that have been eliminated by extinction or counterconditioning can recover if time passes before the CS is presented again (spontaneous recovery). Conditioned responses can also return if the patient returns to the context of conditioning after extinction in

another context, or if the CS is encountered in a context that differs from the one in which extinction has occurred (all are examples of the renewal effect). The renewal effect is important because it illustrates the principle that extinction performance depends on the organism being in the context in which extinction was learned. If the CS is encountered in a different context, the extinguished behavior may relapse or return. Recovery and relapse can also occur if the current context is associated again with the US (“reinstatement”) or if the CS is paired with the US again (“rapid reacquisition”). One theoretical approach assumes that extinction and counterconditioning do not destroy the original learning but instead entail new learning that gives the CS a second meaning (e.g., “the CS is safe” in addition to “the CS is dangerous”). As with an ambiguous word,

which has more than one meaning, responding evoked by an extinguished or counterconditioned CS depends fundamentally on the current context. Research on context effects in both animal and human learning and memory suggests that a wide variety of stimuli can play the role of context (Table 2.3-1). Drugs, for example, can be very salient in this regard. When rats are given fear extinction while under the influence of a benzodiazepine tranquilizer or alcohol, fear is renewed when the CS is tested in the absence of the context provided by the drug. This is an example of state-dependent learning, in which the retention of information is best when tested in the same state in which it was originally learned. State-dependent fear extinction has obvious implications for combining therapy with drugs. It also has implications for the administration of drugs more generally. For example, if a person were to take a drug to reduce anxiety, the anxiety reduction would reinforce drug taking. State-dependent extinction might further preserve any anxiety that might otherwise be extinguished during natural exposure to the anxiety-eliciting cues. Thus, drug use could paradoxically preserve the original anxiety, creating a self-perpetuating cycle that could provide a possible explanation for the link between anxiety disorders and substance abuse. One point of this discussion is that drugs can play multiple roles in learning: They can be USs or reinforcers on one hand, and CSs or contexts on the other. The possible complex behavioral effects of drugs are worth bearing in mind. Table 2.3-1 Effective Contextual Stimuli Studied In Animal and Human Research Laboratories Another general message is that contemporary theory emphasizes the fact that extinction (and other processes, such as counterconditioning) entails new learning rather than a destruction of the old. Recent psychopharmacological research has built on this idea: If extinction and therapy constitute new learning, then drugs that might facilitate new learning might also facilitate the therapy process. For example, there has been considerable recent interest in D-cycloserine, a partial agonist of the N-methyl-D-aspartate (NMDA) glutamate receptor. The NMDA receptor is involved in long-term potentiation, a synaptic facilitation phenomenon that has been implicated in several examples of learning. Of interest, there is evidence that the administration of D-cycloserine can facilitate extinction learning in rats and possibly in humans undergoing exposure therapy for anxiety disorders. In the studies supporting this conclusion, the administration of the drug increased the amount of extinction that was apparent after a

small (and incomplete) number of extinction trials. Although such findings are promising, it is important to remember that the context dependence of extinction, and thus the possibility of relapse with a change of context, may easily remain. Consistent with this possibility, although D-cycloserine allows fear extinction to be learned in fewer trials, it does not appear to prevent or reduce the strength of the renewal effect. Such results further underscore the importance of behavioral research—and behavioral theory—in understanding the effects of drugs on therapy. Nonetheless, the search for drugs that might enhance the learning that occurs in therapy situations

will continue to be an important area of research. Another process that might theoretically modify or erase a memory is illustrated by a phenomenon called reconsolidation. Newly learned memories are temporarily labile and easy to disrupt before they are consolidated into a more stable form in the brain. The consolidation of memory requires the synthesis of new proteins and can be blocked by the administration of protein synthesis inhibitors (e.g., anisomycin). Animal research suggests that consolidated memories that have recently been reactivated might also return briefly to a similarly vulnerable state; their “reconsolidation” can likewise be blocked by protein synthesis inhibitors. For example, several studies have shown that the reactivation of a conditioned fear by one or two presentations of the CS after a brief fear conditioning experience can allow it to be disrupted by anisomycin. When the CS is tested later, there is little evidence of fear—as if reactivation and then drug administration diminished the strength of the original memory. However, like the effects of extinction, these fear-diminishing effects do not necessarily mean that the original learning has been destroyed or erased. There is some evidence that fear of the CS that has been diminished in this way can still return over time (i.e., spontaneously recover) or with reminder treatments. This sort of result suggests that the effect of the drug is somehow able to interfere with retrieval or access to the memory rather than to be an actual “reconsolidation.” Generally speaking, the elimination of a behavior after therapy should not be interpreted as erasure of the underlying knowledge. For the time being, it may be safest to assume that after any therapeutic treatment, a part of the original learning may remain in the brain, ready to produce relapse if retrieved. Instead of trying to find treatments that destroy the original memory, another therapeutic strategy might be to accept the possible retention of the original learning and build therapies that allow the organism to prevent or cope with its retrieval. One possibility is to conduct extinction exposure in the contexts in which relapse might be most problematic to the patient and to encourage retrieval strategies (such as the use of retrieval cues like reminder cards) that might help to remind the patient of the therapy experience.

OPERANT/INSTRUMENTAL LEARNING

The Relation Between Behavior and Payoff

Operant learning has many parallels with Pavlovian learning. As one example,

extinction also occurs in operant learning if the reinforcer is omitted following training. Although extinction is once again a useful technique for eliminating unwanted behaviors, just as we saw with Pavlovian learning, it does not destroy the original learning—spontaneous recovery, renewal, reinstatement, and rapid reacquisition effects still obtain. Although early accounts of instrumental learning, beginning with Edward Thorndike, emphasized the role of the reinforcer as “stamping in” the instrumental action, more-modern approaches tend to view the reinforcer as a sort of guide or motivator of behavior. A modern, “synthetic” view of operant conditioning (see later discussion) holds that the organism associates the action with the outcome in much the way that stimulus–outcome learning is believed to be involved in Pavlovian learning. Human behavior is influenced by a wide variety of reinforcers, including social ones. For example, simple attention from teachers or hospital staff members has been shown to reinforce disruptive or problematic behavior in students or patients. In either case, when the attention is withdrawn and redirected toward other activities, the problematic behaviors can decrease (i.e., undergo extinction). Human behavior is also influenced by verbal reinforcers, like praise, and, more generally, by conditioned reinforcers, such as money, that have no intrinsic value except for the value derived through association with more basic, “primary” rewards. Conditioned reinforcers have been used in schools and institutional settings in so-called token economies in which positive behaviors are reinforced with tokens that can be used to purchase valued items. In more natural settings, reinforcers are

always delivered in social relationships, in which their effects are dynamic and reciprocal. For example, the relationship between a parent and a child is full of interacting and reciprocating operant contingencies in which the delivery (and withholding) of reinforcers and punishers shapes the behavior of each. Like Pavlovian learning, operant learning is always operating and always influencing behavior. Research on operant conditioning in the laboratory has offered many insights into how action relates to its payoff. In the natural world, few actions are reinforced every time they are performed; instead, most actions are reinforced only intermittently. In a ratio reinforcement schedule, the reinforcer is directly related to the amount of work or responding that the organism emits. That is, there is some work requirement that determines when the next reinforcer will be presented. In a “fixed ratio schedule,” every xth action is reinforced; in a “variable ratio schedule,” there is an average ratio requirement, but the number of responses required for each successive reinforcer varies. Ratio schedules, especially variable ratio schedules, can generate high rates of behavior, as seen in the behavior directed at a casino slot machine. In an interval reinforcement schedule, the presentation of each reinforcer depends on the organism emitting the response after some period of time has also elapsed. In a “fixed interval schedule,” the first response after x seconds have elapsed is reinforced. In a “variable interval schedule,” there is an interval requirement for each reinforcer, but the length of that interval varies. A person checking e-mail throughout the day is being reinforced on a variable interval schedule—a new message is not present to reinforce each checking response, but the presence of a new message becomes available after variable time points throughout the day. Of interest, on interval schedules, the response rate can vary substantially without influencing the overall rate of reinforcement. (On ratio schedules, there is a more direct relationship between behavior rate and reinforcement rate.) In part because of this, interval schedules tend to generate slower response rates than ratio schedules. Classic research on operant behavior underscores the fact that the performance of any action always involves choice. That is, whenever the individual performs a particular behavior, he or she chooses to engage in that action over many other possible alternatives. When choice has been studied by allowing the organism to perform either of two different operant behaviors (paying off with their own separate schedules of reinforcement), the rate of operant behavior depends not only on the behavior’s rate of reinforcement, but also on the rate of reinforcement of all other behaviors in the

situation. Put most generally, the strength of Behavior 1 (e.g., the rate at which Behavior 1 is performed) is given by $B_1 = KR_1/(R_1 + R_0)$ where B_1 can be seen as the strength of Behavior 1, R_1 is the rate at which B_1 has been reinforced, and R_0 is the rate at which all alternative (or “other”) behaviors in the environment have been reinforced; K is a constant that corresponds to all behavior in the situation and may have a different value for different individuals. This principle, known as the quantitative law of effect, captures several ideas that are relevant to psychiatrists and clinical psychologists. It indicates that an action can be strengthened either by increasing its rate of reinforcement (R_1) or by decreasing the rate of reinforcement for alternative behaviors (R_0). Conversely, an action can be weakened either by reducing its rate of reinforcement (R_1) or by increasing the rate of reinforcement for alternative behaviors (R_0). The latter point has an especially important implication: In principle, one can slow the strengthening of new, undesirable behavior by providing an environment that is otherwise rich in reinforcement (high R_0). Thus, an adolescent who experiments with drugs or alcohol would be less likely to engage in this behavior at a high rate (high B_1) if his or her environment were otherwise rich with reinforcers (e.g., provided by extracurricular activities, outside interests, and so forth). Choice among actions is also

influenced by the size of their corresponding reinforcers and how soon the reinforcers will occur. For example, individuals sometimes have to choose between an action that yields a small but immediate reward (e.g., taking a hit of a drug) versus another that yields a larger but delayed reward (e.g., going to a class and earning credit toward a general educational development certificate). Individuals who choose the more immediate reward are often said to be “impulsive,” whereas those who choose the delayed reward are said to exercise “self-control.” Of interest, organisms often choose immediate small rewards over delayed larger ones, even though it may be maladaptive to do so in the long run. Such “impulsive” choices are especially difficult to resist when the reward is imminent. Choice is believed to be determined by the relative value of the two rewards, with that value being influenced by both the reinforcer’s size and its delay. The bigger the reinforcer, the better is the value, and the more immediate the reinforcer, the better too: When a reward is delayed, its value decreases or is “discounted” over time. When offered a choice, the organism will always choose the action that leads to the reward whose value is currently higher.

Theories of Reinforcement It is possible to use the foregoing principles of operant conditioning without knowing in advance what kind of event or stimulus will be reinforcing for the individual patient. None of the reinforcement rules say much about what sorts of events in an organism’s world will play the role of reinforcer. Skinner defined a reinforcer empirically, by considering the effect it had on an operant behavior. A reinforcer was defined as any event that could be shown to increase the strength of an operant if it was made a consequence of the operant. This empirical (some would say “atheoretical”) view can be valuable because it allows idiosyncratic reinforcers for idiosyncratic individuals. For instance, if a therapist works with a child who is injuring himself, the approach advises

the therapist merely to search for the consequences of the behavior and then manipulate them to bring the behavior under control. So if, for example, the child’s self-injurious behavior decreases when the parent stops scolding the child for doing it, then the scold is the reinforcer, which might seem counterintuitive to everyone (including the parent who thinks that the scold should function as a punisher). On the other hand, it would also be useful to know what kind of event will reinforce an individual before the therapist has to try everything. This void is filled by several approaches to reinforcement that allow predictions ahead of time. Perhaps the most useful is the Premack principle (named for researcher David Premack), which claims that, for any individual, reinforcers can be identified by giving the individual a preference test in which she or he is free to engage in any number of activities. The individual might spend the most time engaging in activity A, the secondmost time engaged in activity B, and the third-most time engaged in activity C. Behavior A can thus be said to be preferred to B and C, and B is preferred to C. The Premack principle asserts that access to a preferred action will reinforce any action that is less preferred. In the present example, if doing activity C allowed access to doing A or B, activity C will be reinforced—it will increase in strength or probability. Similarly, activity B will be reinforced by activity A (but not C). The principle accepts large individual differences. For example, in an early study, some children given a choice spent more time eating candy than playing pinball, whereas others spent more time playing pinball than eating candy. Candy eating reinforced pinball playing in the former group. In contrast, pinball playing reinforced candy eating in the latter group. There is nothing particularly special about food (eating) or any particular kind of activity as a possible reinforcer. Any behavior that is preferred to a second behavior will theoretically reinforce the second behavior. The principle has been refined over the years. It is now recognized that even a less-preferred behavior can reinforce a more-preferred behavior if the organism has been deprived of doing the low-preferred

behavior below its ordinary level. In the foregoing example, even the low-preference activity C could reinforce A or B if it were suppressed for a while below its baseline level of preference. However, the main implication is that in the long run, a person's reinforcers can be discovered by simply looking at how he or she allocates his or her activities when access to them is free and unconstrained. Motivational Factors Instrumental action is often said to be goal oriented. As Edward Tolman illustrated in many experiments conducted in the 1930s and 1940s, organisms may flexibly perform any of several actions to get to a goal; instrumental learning thus provides a variable means to a fixed end. Tolman's perspective on the effects of reinforcers has returned to favor. He argued that reinforcers are not necessary for learning, but instead are important for motivating instrumental behavior. The classic illustration of this point is the latent learning experiment. Rats received several trials in a complex maze in which they were removed from the maze without reward once they got to a particular goal

location. When arriving at the goal was suddenly rewarded, the rats suddenly began working through the maze with very few errors. Thus, they had learned about the maze without the benefit of the food reinforcer, but the reinforcer was nonetheless important for motivating them to get through the maze efficiently. The reinforcer was not necessary for learning, but it gave the organism a reason to translate its knowledge into action. Subsequent research has identified many motivating effects of reward. For example, organisms that have had experience receiving a small reward may show positive contrast when they are suddenly reinforced with a larger reward. That is, their instrumental behavior may become more vigorous than that in control subjects who have received the larger reward all along. Conversely, organisms show negative contrast when they are switched from a high reward to a lower reward—their behavior becomes weaker than control subjects who have received the same smaller reward all along. Negative contrast involves frustration and emotionality. Both types of contrast are consistent with the idea that the current effectiveness of a reinforcer depends on what the organism has learned to expect; an increase from expectation causes elation, whereas a decrease from expectation causes frustration. There is a sense in which receiving a reward that is smaller than expected might actually seem punishing. Negative contrast is an example of a paradoxical reward effect—a set of behavioral phenomena given the name because they show that reward can sometimes weaken behavior and that nonreward can sometimes strengthen it. The best known is the partial reinforcement extinction effect, in which actions that have been intermittently (or “partially”) reinforced persist longer when reinforcers are completely withdrawn than actions that have been continuously reinforced. The finding is considered paradoxical because an action that has been reinforced (say) half as often as another action may nonetheless be more persistent. One explanation is that the action that has been partially reinforced has been reinforced in the presence of some frustration—and is thus persistent in new adversity or sources of frustration. Other evidence suggests that effortfulness is a dimension of behavior that can be reinforced. That is, human and animal participants that have been reinforced for performing effortful responses learn a sort of “industriousness” that transfers to new behaviors. One implication is that new behaviors learned in therapy will be more persistent over time if high effort has been deliberately reinforced. The effectiveness of a reinforcer is also influenced by the organism's current motivational state. For example, food is more reinforcing for a hungry organism, and water is more reinforcing for a thirsty one. Such results are consistent with many theories of reinforcement (e.g., the Premack principle) because the presence of hunger or thirst would undoubtedly increase the organism's preference ranking for food or water. Recent research, however, indicates that the effects of motivational states on instrumental actions are not

this automatic. Specifically, if a motivational state is going to influence an instrumental action, the individual needs first to learn how the action's reinforcer will influence the motivational state. The process of learning about the effects the reinforcer has on the motivational state is called incentive learning. Incentive learning is best illustrated by an experimental example. In 1992, Bernard Balleine reported a study that taught trained rats that were not hungry to lever press to earn a novel food pellet. The animals were then food deprived and tested for their lever pressing under conditions in which the lever press no longer produced the pellet. The hunger state had no effect on lever-press rate; that is, hungry rats did not lever press

any more than rats that were not food deprived. On the other hand, if the rat had been given separate experience eating the pellets while it was food deprived, during the test it lever pressed at a high rate. Thus, hunger invigorated the instrumental action only if the animal had previously experienced the reinforcer in that state—which allowed it to learn that the specific substance influenced the state (incentive learning). The interpretation of this result, and others like it, will be developed further later in this section. The main idea is that individuals will perform an instrumental action when they know that it produces an outcome that is desirable in the current motivational state. The clinical implications are underexplored but could be significant. For example, persons who abuse drugs will need to learn that the drug makes them feel better in the withdrawal state before withdrawal will motivate drug seeking. Persons with anxiety might not be motivated to take a beneficial medication while anxious until they have actually had the opportunity to learn how the medication makes them feel when they are in the anxious state, and a person with depression may need to learn what natural reinforcers really make them feel better while they are depressed. According to theory, direct experience with a reinforcer's effect on depressed mood might be necessary before the person will be interested in performing actions that help to ameliorate the depressed state.

PAVLOVIAN AND OPERANT LEARNING TOGETHER

Avoidance Learning Theories of the motivating effects of reinforcers have usually emphasized that Pavlovian CSs in the background are also associated with the reinforcer, and that the expectancy of the reinforcer (or conditioned motivational state) the CSs arouse increases the vigor of the operant response. This is two-factor or two-process theory: Pavlovian learning occurs simultaneously and motivates behavior during operant learning. The interaction of Pavlovian and instrumental factors is especially important in understanding avoidance learning (see Fig. 2.3-1). In avoidance situations, organisms learn to perform actions that prevent the delivery or presentation of an aversive event. The explanation of avoidance learning is subtle because it is difficult to identify an obvious reinforcer. Although preventing the occurrence of the aversive event is obviously important, how can the nonoccurrence of that event reinforce? The answer is that cues in the environment (Pavlovian CSs) come to predict the occurrence of the aversive event, and consequently they arouse anxiety or fear. The avoidance response can therefore be reinforced if it escapes from or reduces that fear. Pavlovian and operant factors are thus both important: Pavlovian fear conditioning motivates and allows reinforcement of an instrumental action through its reduction. Escape from fear or anxiety is believed to play a significant role in many human behavior disorders, including the anxiety disorders. Thus, the obsessive-compulsive patient checks or washes his or her hands repeatedly to reduce anxiety, the agoraphobic stays home to escape fear of places associated with panic attacks, and the bulimic learns to vomit after a meal to reduce the learned anxiety evoked by eating the meal.

Although two-factor theory remains an important view of avoidance learning, excellent avoidance can be obtained in the laboratory without reinforcement: for example, if an animal is required to perform an action that resembles one of its natural and prepared fear responses—so-called species-specific defensive reactions (SSDRs). Rats will readily learn to freeze (remain motionless) or flee (run to another environment) to avoid shock, two behaviors that have evolved to escape or avoid predation. Freezing and fleeing are also respondents rather than operants; they are controlled by their antecedents (Pavlovian CSs that predict shock) rather than being reinforced by their consequences (escape from fear). Thus, when the rat can use an SSDR for avoidance, the only necessary learning is Pavlovian—the rat learns about environmental cues associated with danger, and these arouse fear and evoke natural defensive behaviors including withdrawal (negative sign tracking; Fig. 2.3-2). To learn to perform an action that is not similar to a natural SSDR requires more feedback or reinforcement through fear reduction. A good example is lever pressing, which is easy for the rat to learn when the reinforcer is a food pellet but difficult to learn when the same action avoids shock. More recent work with avoidance in humans suggests an important role for CS-aversive event and response-no aversive event expectancies. The larger point is that Pavlovian learning is important in avoidance learning; when the animal can avoid with an SSDR, it is the only learning necessary; when the required action is not an SSDR, Pavlovian learning permits the expectation of something bad. A cognitive perspective on aversive learning is also encouraged by studies of learned helplessness. In this phenomenon, organisms exposed to either controllable or uncontrollable aversive events differ in their reactivity to later aversive events. For example, the typical finding is that a subject exposed to inescapable shock in one phase of an experiment is less successful at learning to escape shock with an altogether new behavior in a second phase, whereas subjects exposed to escapable shock are normal. Both types of subject are exposed to the same shock, but its psychological dimension (its controllability) creates a difference, perhaps because subjects exposed to inescapable shock learn the independence of their actions and the outcome. Although this finding (and interpretation) was once seen as a model of depression, the current view is that the controllability of stressors mainly modulates their stressfulness and negative impact. At a theoretical level, the result also implies that organisms receiving instrumental contingencies in which their actions lead to outcomes might learn something about the controllability of those outcomes. One of the main conclusions of work on aversive learning is that there are both biological (i.e., evolutionary) and cognitive dimensions to instrumental learning. The possibility that much instrumental learning can be controlled by Pavlovian contingencies is also consistent with research in which animals have learned to respond to positive reinforcers. For example, pigeons have been widely used in operant learning experiments since the 1940s. In the typical experiment, the bird learns to peck at a plastic disk on a wall of the chamber (a response “key”) to earn food. Although pecking seems to be an operant response, it turns out that the pigeon’s peck can be entrained by merely illuminating the key for a few seconds before presenting the reinforcer on a number of trials. Although there is no requirement for the bird to peck the key, the bird will begin to peck at the illuminated key—a Pavlovian predictor of food—anyway. The pecking response is only weakly controlled by its consequences; if the experimenter arranges things so that pecks actually prevent the delivery of food (which is otherwise delivered on trials without pecks), the birds will continue to peck almost indefinitely on many trials. (Although the peck has a negative correlation with food, key illumination remains a weakly positive predictor of food.) Thus, this classic “operant” behavior is at least partly a Pavlovian one. Pavlovian contingencies cannot be ignored. When rats are punished with mild foot shock for pressing a lever that otherwise produces

food, they stop lever pressing at least partly (and perhaps predominantly) because they learn that the lever now predicts shock and they withdraw from it. A child might likewise learn to stay away from the parent who delivers punishment rather than refrain from performing the punished behavior. A great deal of behavior in operant learning settings may actually be controlled by Pavlovian learning and sign tracking rather than true operant learning. A Synthetic View of Instrumental Action The idea, then, is that behavior in any instrumental learning situation is controlled by several hypothetical associations, as illustrated in Figure 2.3-3. Much behavior in an instrumental learning arrangement can be controlled by a Pavlovian factor in which the organism associates background cues (CSs) with the reinforcer (S^* , denoting a biologically significant event). As discussed earlier, this type of learning can allow the CS to evoke a variety of behaviors and emotional reactions (and motivational states) that can additionally motivate instrumental action. FIGURE 2.3-3 Any instrumental/operant learning situation permits a number of types of learning, which are always occurring all the time. R, operant behavior or instrumental action; S, stimulus in the background; S^* , biologically significant event (e.g., reinforcer, US). (Courtesy of Mark E. Bouton, PhD.) In modern terms, the instrumental factor is represented by the organism learning a direct, and similar, association between the instrumental action (R) and the reinforcer (S^*). Evidence for this sort of learning comes from experiments on reinforcer devaluation (Fig. 2.3-4). In such experiments, the organism can first be trained to perform two instrumental actions (e.g., pressing a lever and pulling a chain), each paired with a

different reinforcer (e.g., food pellet versus a liquid sucrose solution). In a separate second phase, one of the reinforcers (e.g., pellet) is paired with illness, which creates the conditioning of a powerful taste aversion to the reinforcer. In a final test, the organism is returned to the instrumental situation and is allowed to perform either instrumental action. No reinforcers are presented during the test. The result is that the organism no longer performs the action that produced the reinforcer that is now aversive. To perform in this way, the organism must have (1) learned which action produced which reinforcer and (2) combined this knowledge with the knowledge that it no longer likes or values that reinforcer. The result cannot be explained by the simpler, more traditional view that reinforcers merely stamp in or strengthen instrumental actions. FIGURE 2.3-4 The reinforcer devaluation effect. Results of the test session. The result indicates the importance of the response–reinforcer association in operant learning. For the organism to perform in the way that it does during testing, it must learn which action leads to which reinforcer and then choose to perform the action that leads to the outcome it currently liked or valued. R1, R2, operant behaviors or instrumental actions. (Data from Colwill and Rescorla [1986]. From Bouton ME: Learning and Behavior: A Contemporary Synthesis. Sunderland, MA: Sinauer; 2007.) Organisms also need to learn how reinforcers influence a particular motivational state—the process called “incentive learning.” Incentive learning is crucially involved in instrumental learning as a process through which the animal learns the value of the reinforcer. Thus, in the reinforcer devaluation experiment shown in Figure 2.3-4, an important thing that occurs in the second phase is that the organism must actually contact the reinforcer and learn that it does not like it. As described earlier, incentive learning is probably always involved in making outcomes (and the associated actions

that produce them) more or less desirable. Other experiments have illustrated the other associations to the stimulus that are represented in Figure 2.3-3. In addition to being directly associated with the reinforcer, a stimulus can signal a relation between an action and an outcome. This is called occasion setting: Instead of eliciting a response directly, stimuli in operant situations

can set the occasion for the operant response. There is good evidence that they do so by signaling a specific response-reinforcer relationship. For example, in one experiment, rats learned to lever press and chain pull in the presence of a background noise and a background light. When the noise was present, lever pressing yielded a pellet reinforcer, and chain pulling yielded sucrose. In contrast, when the light was present, the relations were reversed: Lever pressing yielded sucrose, and chain pulling yielded pellet. There was evidence that the rats learned corresponding relationships. In a second phase, pellets were associated with illness, so the rat no longer valued the pellet. In a final test, rats were allowed to lever press or chain pull in extinction in the presence of noise or light present during separate tests. In the presence of the noise, the animals chain pulled rather than lever pressed. When the light was present, the animals lever pressed rather than chain pulled. Thus, the noise informed the rat that lever press yielded pellet, and the light informed the rat that the chain pull did. This is the occasion-setting function illustrated in Figure 2.3-3. It is worth noting that other stimuli besides lights and noises set the occasion for operant behavior. Modern research on learning in animals has underscored the importance of other stimuli, such as temporal and spatial cues, and of certain perception and memory processes. A particularly interesting example of research on the stimulus control of operant behavior is categorization. Pigeons can be shown images of cars, chairs, flowers, and cats on a computer screen positioned on the wall of a Skinner box. Pecking one of four keys in the presence of these images is reinforced in the presence of any picture containing a car, a chair, a flower, or a cat. Of interest, as the number of exemplars in each category increases, the pigeon makes more errors as it learns the discrimination. However, more exemplars create better learning in the sense that it is more ready to transfer to new test images—after many examples of each category, the pigeon is more accurate at categorizing (and responding accurately to) new stimuli. One implication is that training new behaviors in a variety of settings or ways will enhance generalization to new situations. The final association in Fig. 2.3-3 is simple habit learning, or a direct association between the stimulus and the response. Through this association, the background may elicit the instrumental action directly, without the intervening cognition of $R-S^*$ and the valuation of S^* . Although $S-R$ learning was once believed to dominate learning, the current view sees it as developing only after extensive and consistent instrumental training. In effect, actions that have been performed repeatedly (and repeatedly associated with the reinforcer) become automatic and routine. One source of evidence is the fact that the reinforcer devaluation effect—which implies a kind of cognitive mediation of operant behavior—no longer occurs after extensive instrumental training, as if the animal reflexively engages in the response without remembering the actual

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outcome it produces. It seems reasonable to expect that many pathological behaviors that come into the clinic might also be automatic and blind through repetition. Of interest, the evidence suggests that the eventual dominance of the S-R habit in behavior does not replace or destroy more cognitive mediation by learned S-S*, R-S*, and/or S- (R-S*) relations. Under some conditions, even a habitual response might be brought back under the control of the action-reinforcer association. The conversion of actions to habits and the relation of habit to cognition are active areas of research.

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2.4 Biology of Memory The topic of memory is fundamental to the discipline of psychiatry. Memory is the glue that binds our mental life, the scaffolding for our personal history. Personality is in part an accumulation of habits that have been acquired, many very early in life, which create dispositions and influence how we behave. In the same sense, the neuroses are often products of learning—anxieties, phobias, and maladaptive behaviors that result from particular experiences. Psychotherapy itself is a process by which new habits and skills are acquired through the accumulation of new experiences. In this sense, memory is at the theoretical heart of psychiatry's concern with personality, the consequences of early experience, and the possibility of growth and change. Memory is also of clinical interest because disorders of memory and complaints about memory are common in neurological and psychiatric illness. Memory impairment is also a side effect of certain treatments, such as electroconvulsive therapy. Accordingly, the effective clinician needs to understand something of the biology of memory, the varieties of memory dysfunction, and how memory can be evaluated.

FROM SYNAPSES TO MEMORY

Memory is a special case of the general biological phenomenon of neural plasticity. Neurons can show history-dependent activity by responding differently as a function of prior input, and this plasticity of nerve cells and synapses is the basis of memory. In the last decade of the 19th

century, researchers proposed that the persistence of memory could be accounted for by nerve cell growth. This idea has been restated many times, and current understanding of the synapse as the critical site of change is founded on extensive experimental studies in animals with simple nervous systems. Experience can lead to structural change at the synapse, including alterations in the strength of existing synapses and alterations in the number of synaptic contacts along specific pathways. Plasticity Neurobiological evidence supports two basic conclusions: First, short-lasting plasticity, which may last for seconds or minutes depending on specific synaptic events, including an increase in neurotransmitter release; and second, long-lasting memory depends on new protein synthesis, the physical growth of neural processes, and an increase in the number of synaptic connections. A major source of information about memory has come from extended study of the marine mollusk *Aplysia californica*. Individual neurons and connections between neurons have been identified, and the wiring diagram of some simple behaviors has been described. *Aplysia* is capable of associative learning (including classic conditioning and operant conditioning) and nonassociative learning (habituation and sensitization). Sensitization had been studied using the gill-withdrawal reflex, a defensive reaction in which tactile stimulation causes the gill and siphon to retract. When tactile stimulation is preceded by sensory stimulation to the head or tail, gill withdrawal is facilitated. The cellular changes underlying this sensitization begin when a sensory neuron activates a modulatory interneuron, which enhances the strength of synapses within the circuitry responsible for the reflex. This modulation depends on a second-messenger system in which intracellular molecules (including cyclic adenosine monophosphate [cAMP] and cAMP-dependent protein kinase) lead to enhanced transmitter release that lasts for minutes in the reflex pathway. Both short- and long-lasting plasticity within this circuitry are based on enhanced transmitter release. The long-lasting change uniquely requires the expression of genes and the synthesis of new proteins. Synaptic tagging mechanisms allow gene products that are delivered throughout a neuron to increase synaptic strength selectively at recently active synapses. In addition, the long-term change, but not the short-term change, is accompanied by the growth of neural processes of neurons within the reflex circuit. In vertebrates, memory cannot be studied as directly as in the simple nervous system of *Aplysia*. Nevertheless, it is known that behavioral manipulations can also result in measurable changes in the brain's architecture. For example, rats reared in enriched as opposed to ordinary environments show an increase in the number of synapses ending on individual neurons in the neocortex. These changes are accompanied by small increases in cortical thickness, in the diameter of neuronal cell bodies, and in the number and length of dendritic branches. Behavioral experience thus exerts powerful

effects on the wiring of the brain. Many of these same structural changes have been found in adult rats exposed to an enriched environment, as well as in adult rats given extensive maze training. In the case of maze training, vision was restricted to one eye, and the corpus callosum was transected to prevent information received by one hemisphere from reaching the other hemisphere. The result was that structural changes in neuronal shape and connectivity were observed only in the trained hemisphere. This rules out a number of nonspecific influences, including motor activity, indirect effects of hormones, and overall level of arousal. Long-term memory in vertebrates is believed to be based on morphological growth and change, including increases in synaptic strength along particular pathways. Long-Term Potentiation The phenomenon of long-term potentiation (LTP) is a candidate mechanism for mammalian long-term memory. LTP is observed when a postsynaptic neuron is persistently depolarized after a high-frequency burst of presynaptic neural firing. LTP has a number of properties that make it suitable as a physiological

substrate of memory. It is established quickly and then lasts for a long time. It is associative, in that it depends on the co-occurrence of presynaptic activity and postsynaptic depolarization. It occurs only at potentiated synapses, not all synapses terminating on the postsynaptic cell. Finally, LTP occurs prominently in the hippocampus, a structure that is important for memory. The induction of LTP is known to be mediated postsynaptically and to involve activation of the N-methyl-D-aspartate (NMDA) receptor, which permits the influx of calcium into the postsynaptic cell. LTP is maintained by an increase in the number of α -amino-3-hydroxy-5-methyl-4-isoxazolepropionate (AMPA; non-NMDA) receptors in the postsynaptic cell and also possibly by increased transmitter release. A promising method for elucidating molecular mechanisms of memory relies on introducing specific mutations into the genome. By deleting a single gene, one can produce mice with specific receptors or cell signaling molecules inactivated or altered. For example, in mice with a selective deletion of NMDA receptors in the CA1 field of the hippocampus, many aspects of CA1 physiology remain intact, but the CA1 neurons do not exhibit LTP, and memory impairment is observed in behavioral tasks. Genetic manipulations introduced reversibly in the adult are particularly advantageous, in that specific molecular changes can be induced in developmentally normal animals.

Associative Learning

The study of classical conditioning has provided many insights into the biology of memory. Classical conditioning has been especially well studied in rabbits, using a tone as the conditioned stimulus and an air puff to the eye (which automatically elicits a blink response) as the unconditioned stimulus. Repeated pairings of the tone and the air puff lead to a conditioned response, in that the tone alone elicits an eye blink. Reversible lesions of the deep nuclei of the cerebellum eliminate the conditioned response without affecting the unconditioned response. These lesions also prevent initial learning from occurring, and, when the lesion is reversed, rabbits learn normally. Thus, the cerebellum contains essential circuitry for the learned association. The relevant plasticity appears to be distributed between the cerebellar cortex and the deep nuclei.

An analogous pattern of cerebellar plasticity is believed to underlie motor learning in the vestibuloocular reflex and, perhaps, associative learning of motor responses in general. Based on the idea that learned motor responses depend on the coordinated control of changes in timing and strength of response, it has been suggested that synaptic changes in the cerebellar cortex are critical for learned timing, whereas synaptic changes in the deep nuclei are critical for forming an association between a conditioned stimulus and an unconditioned stimulus. Fear conditioning and fear-potentiated startle are types of learning that serve as useful models for anxiety disorders and related psychiatric conditions. For example, mice exhibit freezing behavior when returned to the same context in which aversive shock was delivered on an earlier occasion. This type of learning depends on the encoding of contextual features of the learning environment. Acquiring and expressing this type of learning requires neural circuits that include both the amygdala and the hippocampus. The amygdala may be important for associating negative affect with new stimuli. The hippocampus may be important for representing the context. With extinction training, when the context is no longer associated with an aversive stimulus, the conditioned fear response fades. Frontal cortex is believed to play a key role in extinction.

CORTICAL ORGANIZATION OF MEMORY

One fundamental question concerns the locus of memory storage in the brain. In the 1920s, Karl Lashley searched for the site of memory storage by studying the behavior of rats after removing different amounts of their cerebral cortex. He recorded the number of trials needed to relearn a maze problem that rats learned prior to surgery, and he found that the deficit was proportional to the amount of cortex removed. The deficit did not seem to depend on the particular location of

cortical damage. Lashley concluded that the memory resulting from maze learning was not localized in any one part of the brain but instead was distributed equivalently over the entire cortex. Subsequent research has led to reinterpretations of these results. Maze learning in rats depends on different types of information, including visual, tactile, spatial, and olfactory information. Neurons that process these various types of information are segregated into different areas of the rat cerebral cortex, and memory storage is segregated in a parallel manner. Thus, the correlation between maze-learning abilities and lesion size that Lashley observed is a result of progressive encroachment of larger lesions on specialized cortical areas serving the many components of information processing relevant for maze learning. The functional organization of the mammalian cerebral cortex has been revealed through neuropsychological analyses of deficits following brain damage and through physiological studies of intact brains. The cortical areas responsible for processing and storing visual information have been studied most extensively in nonhuman primates. Nearly one half of the primate neocortex is specialized for visual functions. The cortical pathways for visual information processing begin in primary visual cortex (V1) and proceed from there along parallel pathways or streams. One stream projects ventrally to inferotemporal cortex and is specialized for processing information concerning the identification of visual objects. Another stream projects dorsally to parietal cortex and is specialized for processing information about spatial location. Specific visual processing areas in the dorsal and ventral streams, together with areas in prefrontal cortex, register the

immediate experience of perceptual processing. The results of perceptual processing are first available as immediate memory. Immediate memory refers to the amount of information that can be held in mind (like a telephone number) so that it is available for immediate use. Immediate memory can be extended in time by rehearsing or otherwise manipulating the information, in which case what is stored is said to be in working memory. Regions of visual cortex in forward portions of the dorsal and ventral streams serve as the ultimate repositories of visual memories. Inferotemporal cortex, for example, lies at the end of the ventral stream, and inferotemporal lesions lead to selective impairments in both visual object perception and visual memory. Nonetheless, such lesions do not disrupt elementary visual functions, such as acuity. Electrophysiological studies in the monkey show that neurons in area TE, which is one part of inferotemporal cortex, register specific and complex features of visual stimuli, such as shape, and respond selectively to patterns and objects. Inferotemporal cortex can thus be thought of as both a higher-order visual processing system and a storehouse of the visual memories that result from that processing. In sum, memory is distributed and localized in the cerebral cortex. Memory is distributed in the sense that, as Lashley concluded, there is no cortical center dedicated solely to the storage of memories. Nonetheless, memory is localized in the sense that different aspects or dimensions of events are stored at specific cortical sites—namely, in the same regions that are specialized to analyze and process what is to be stored. MEMORY AND AMNESIA The principle that the functional specialization of cortical regions determines both the locus of information processing and the locus of information storage does not provide a complete account of the organization of memory in the brain. If it did, then brain injury would always include a difficulty in memory for a restricted type of information along with a loss of ability to process information of that same type. This kind of impairment occurs, for example, in the aphasias and the agnosias. However, there is another kind of impairment that can occur as well, called amnesia. The hallmark of amnesia is a loss of new learning ability that extends across all sensory modalities and stimulus domains. This anterograde amnesia can be explained by understanding the role of brain structures critical for

acquiring information about facts and events. Typically, anterograde amnesia occurs together with retrograde amnesia, a loss of knowledge that was acquired before the onset of amnesia. Retrograde deficits often have a temporal gradient, following a principle known as Ribot's law; deficits are most severe for information that was most recently learned. A patient with a presentation of amnesia exhibits severe memory deficits in the context of preservation of other cognitive functions, including language comprehension and production, reasoning, attention, immediate memory, personality, and social skills. The selectivity of the memory deficit in these cases implies that intellectual and perceptual functions of the brain are separated from the capacity to lay down in memory the records that ordinarily result from engaging in intellectual and perceptual work. Specialized Memory Function

Amnesia can result from damage to the medial portion of the temporal lobe or from damage to regions of the midline diencephalon. Studies of a severely amnesic patient known as HM stimulated intensive investigation of the role of the medial temporal lobe in memory. HM became amnesic in 1953, at 27 years of age, when he sustained a bilateral resection of the medial temporal lobe to relieve severe epilepsy. The removal included approximately one half of the hippocampus, the amygdala, and most of the neighboring entorhinal and perirhinal cortices (Fig. 2.4-1). After the surgery, HM's seizure condition was much improved, but he experienced profound forgetfulness. His intellectual functions were generally preserved. For example, HM exhibited normal immediate memory, and he could maintain his attention during conversations. After an interruption, however, HM could not remember what had recently occurred. HM's dense amnesia was permanent and debilitating. In HM's words, he felt as if he were just waking from a dream, because he had no recollection of what had just taken place. FIGURE 2.4-1 Structural magnetic resonance images of the brains of patients HM and EP through the level of the temporal lobe. Damaged tissue is indicated by bright signal in these T2weighted axial images. Both patients sustained extensive damage to medial temporal structures, as the result of surgery for epilepsy in HM, and as the result of viral encephalitis in EP. Scale bar: 2 cm. L, left side of the brain. (Reprinted from Corkin S, Amaral EG, González RG, Johnson KA, Hyman BT. H.M.'s medial temporal lobe lesion: Findings from magnetic resonance imaging. *J Neurosci.* 1997;17:3964; and Stefanacci L, Buffalo EA, Schmolck H, Squire LR. Profound amnesia after damage to the medial temporal lobe: A neuroanatomical and neuropsychological profile of patient E.P. *J Neurosci.* 2000;20:7024, with permission.)

In monkeys, many parallels to human amnesia have been demonstrated after surgical damage to anatomical components of the medial temporal lobe. Cumulative study of the resulting memory impairment eventually identified the medial temporal structures and connections that are crucial for memory. These include the hippocampus—which includes the dentate gyrus; hippocampal fields CA1, CA2, and CA3; and the subiculum— and the adjacent cortical regions, including the entorhinal, perirhinal, and parahippocampal cortices. Another important medial temporal lobe structure is the amygdala. The amygdala is involved in the regulation of much of emotional behavior. In particular, the storage of emotional events engages the amygdala. Modulatory effects of projections from the amygdala to the neocortex are responsible for producing enhanced memory for emotional or arousing events compared to neutral events. Detailed study of amnesic patients offers unique insights into the nature of memory and its organization in the brain. An extensive series of informative studies, for example, described the memory impairment of patient EP. EP was diagnosed with herpes simplex encephalitis at 72 years of age. Damage to the medial temporal lobe region (see Fig. 2.4-1) produced a persistent and profound amnesia. During testing sessions,

EP was cordial and talked freely about his life experiences, but he relied exclusively on stories from his childhood and early adulthood. He would repeat the same story many times. Strikingly, his performance on tests of recognition memory was no better than would result from guessing (Fig. 2.4-2A). Tests involving facts about his life and autobiographical experiences revealed poor memory for the time leading up to his illness but normal memory for his childhood (Fig. 2.4-2B). EP also has good spatial knowledge about the town in which he lived as a child, but he was unable to learn the layout of the neighborhood where he lived only after he became amnesic (Fig. 2.4-2C).

FIGURE 2.4-2 Formal test results for patient EP, showing severe anterograde and retrograde deficits, with intact remote memory. A. Scores were combined from 42 different tests of recognition memory for words given to patient EP and a group of five healthy control subjects. The testing format was either two-alternative forced choice or yes-no recognition. Brackets for EP indicate the standard error of the mean. Data points for the control group indicate each participant's mean score across all 42 recognition memory tests. EP's average performance (49.3 percent correct) was not different from chance and was approximately five standard deviations (SDs) below the average performance of control subjects (81.1 percent correct; SD, 6.3). B. Autobiographical remembering was quantified by using a structured interview known as the Autobiographical Memory Interview. Items assessed personal semantic knowledge (maximum score 21 for each time period). Performance for the recent time period reflects poor memory for information that could have been acquired only subsequent to the onset of his amnesia. For EP, performance for the early adult period reflects retrograde memory deficits. Performance for the childhood period reflects good remote memory. Similar results for semantic and episodic remembering were obtained from these time periods. (Data from Kopelman MD, Wilson BA, Baddeley AD. The autobiographical memory interview: A new assessment of autobiographical and personal semantic memory in amnesic

patients. *J Clin Exp Neuropsychol.* 1989;5:724; and Reed JM, Squire LR. Retrograde amnesia for facts and events: Findings from four new cases. *J Neurosci.* 1998;18:3943). C. Assessments of spatial memory demonstrated EP's good memory for spatial knowledge from his childhood, along with extremely poor new learning of spatial information. Performance was compared to that of five individuals (open circles) who attended EP's high school at the same time as he did, lived in the region over approximately the same time period, and, like EP (filled circles), moved away as young adults. Normal performance was found for navigating from home to different locations in the area (familiar navigation), between different locations in the area (novel navigation), and between these same locations when a main street was blocked (alternative routes). Subjects were also asked to point to particular locations while imagining themselves in a particular location (pointing to landmarks), or they were asked about locations in the neighborhoods in which they currently lived (new topographical learning). EP showed difficulty only in this last test, because he moved to his current residence after he became amnesic. (Data from Teng E, Squire LR. Memory for places learned long ago is intact after hippocampal damage. *Nature.* 1999;400:675.) (Adapted from Stefanacci L, Buffalo EA, Schmolck H, Squire LR. Profound amnesia after damage to the medial temporal lobe: A neuroanatomical and neuropsychological profile of patient E.P. *J Neurosci.* 2000;20:7024. Printed with permission.) Given the severity of the memory problems experienced by EP and other amnesic patients, it is noteworthy that these patients nonetheless perform normally on certain kinds of memory tests. The impairment selectively concerns memory for factual knowledge and autobiographical events, collectively termed declarative memory. Amnesia presents as a global deficit, in that it involves memory for information presented in any sensory

modality, but the deficit is limited, in that it covers only memory for facts and events. Hippocampal pathology in patients with amnesia can also be revealed using high-resolution magnetic resonance imaging (MRI). Such studies indicate that damage limited to the hippocampus results in clinically significant memory impairment. In addition to the hippocampus, other medial temporal lobe regions also make critical contributions to memory. Thus, a moderately severe memory impairment results from CA1 damage, whereas a more profound and disabling amnesia results from medial temporal lobe damage that includes the hippocampus and adjacent cortex. Memory impairment due to medial temporal lobe damage is also typical in patients with early Alzheimer's disease or amnesic mild cognitive impairment. As Alzheimer's disease progresses, the pathology affects many cortical regions and produces substantial cognitive deficits in addition to memory dysfunction. Amnesia can also result from damage to structures of the medial diencephalon. The critical regions damaged in diencephalic amnesia include the mammillary nuclei in the hypothalamus, the dorsomedial nucleus of the thalamus, the anterior nucleus, the internal medullary lamina, and the mammillothalamic tract. However, uncertainty remains regarding which specific lesions are required to produce diencephalic amnesia.

Alcoholic Korsakoff's syndrome is the most prevalent and best-studied example of diencephalic amnesia, and in these cases damage is found in brain regions that may be especially sensitive to prolonged bouts of thiamine deficiency and alcohol abuse. Patients with alcoholic Korsakoff's syndrome typically exhibit memory impairment due to a combination of diencephalic damage and frontal lobe pathology. Frontal damage alone produces characteristic cognitive deficits along with certain memory problems (e.g., in effortful retrieval and evaluation); in Korsakoff's syndrome the pattern of deficits thus extends beyond what is commonly found in other cases of amnesia (see Table 2.4-1). Table 2.4-1 Memory and Cognitive Deficits Associated with Frontal Damage The ability to remember factual and autobiographical events depends on the integrity of both the cortical regions responsible for representing the information in question and several brain regions that are responsible for memory formation. Thus, medial temporal and diencephalic brain areas work in concert with widespread areas of neocortex to form and to store declarative memories (Fig. 2.4-3).

FIGURE 2.4-3 Brain regions believed to be critical for the formation and storage of declarative memory. Medial diencephalon and medial temporal regions are critical for declarative memory storage. The entorhinal cortex is the major source of projections for the neocortex to the hippocampus, and nearly two thirds of the cortical input to the entorhinal cortex originates in the perirhinal and parahippocampal cortex. The entorhinal cortex also receives direct connections from the cingulate, insula, orbitofrontal, and superior temporal cortices. (Adapted from Paller KA, Neurocognitive foundations of human memory. In: Medin DL, ed.: *The Psychology of Learning and Motivation*. Vol. 40. San Diego, CA: Academic Press; 2008:121; and Gluck MA, Mercado E, Myers CE.: *Learning and Memory: From Brain to Behavior*. New York: Worth; 2008:109, Fig. 3.16.)

Retrograde Amnesia Memory loss in amnesia typically affects recent memories more than remote memories (Fig. 2.4-4). Temporally graded amnesia has been demonstrated retrospectively in studies of amnesic patients and prospectively in studies of monkeys, rats, mice, and rabbits. These findings have important implications for understanding the nature of the memory storage process. Memories are dynamic, not static. As time passes after learning, some memories are forgotten, whereas others become stronger due to a process of consolidation that depends on cortical, medial temporal, and diencephalic structures.

FIGURE 2.4-4 A. Temporally limited retrograde amnesia for free recall of 251 news events. Scores were aligned relative to the onset of amnesia in patients (N = 6) and to a corresponding time point in age-matched and education-matched healthy individuals (N = 12). The time period after the onset of amnesia is labeled AA (anterograde amnesia) to designate that this time point assessed memory for events that occurred after the onset of amnesia. Standard errors ranged from 2 to 10 percent. Brain damage in the patient group was limited primarily to the hippocampal region. B. Temporally limited retrograde amnesia in rats with lesions of the hippocampus and subiculum. Rats learned to prefer an odorous food as the result of an encounter with another rat with that odor on its breath. Percent preference for the familiar food was observed for three training surgery intervals. At 1 day after learning, the control group performed significantly better than the rats with lesions ($P < .05$). At 30 days, the two groups performed similarly, and both groups performed well above chance. Error bars show standard errors of the mean. (Adapted from Manns JR, Hopkins RO, Squire LR. Semantic memory and the human hippocampus. *Neuron*. 2003;38:127; and Clark RE, Broadbent NJ, Zola SM,

Squire LR. Anterograde amnesia and temporally graded retrograde amnesia for a nonspatial memory task after lesions of hippocampus and subiculum. *J Neurosci*. 2002;22:4663, with permission.) The study of retrograde amnesia has been important for understanding how memory changes over time. The dynamic nature of memory storage can be conceptualized as follows. An event is experienced and encoded by virtue of a collection of cortical regions that are involved in representing a combination of different event features. At the same time, the hippocampus and adjacent cortex receive pertinent high-level information from all sensory modalities. Later, when the original event is recalled, the same set of cortical regions is activated. If a subset of the cortical regions is activated, the hippocampus and related structures can facilitate recall by facilitating the activation of the remaining cortical regions (i.e., pattern completion). When the original event is retrieved and newly associated with other information, hippocampal-cortical networks can be modified. In this way, a gradual consolidation process occurs that changes the nature of memory storage (see Fig. 2.4-3). The neocortical components representing some events can become so effectively linked together that ultimately a memory can be retrieved without any contribution from the medial temporal lobe. As a result, amnesic patients can exhibit normal retrieval of remote facts and events, as well as autobiographical memories. Distributed neocortical regions are the permanent repositories of these enduring memories. In contrast to what is observed after damage restricted to the hippocampus, extensive retrograde impairments for facts and events from the distant past can also occur. Damage to the frontal lobes, for example, can lead to difficulty in organizing memory retrieval. Accurate retrieval often begins with an activation of lifetime periods and proceeds to an identification of general classes of events and then more specific events, but this process becomes difficult following frontal damage. Damage to other cortical regions can also impair memory storage. Networks in anterolateral temporal cortex, for example, are critical for retrieving stored information because these areas are important for long-term storage itself. Patients with focal retrograde amnesia exhibit substantial retrograde memory impairments together with only moderately impaired new learning ability. Some capacity for new learning remains, presumably because medial temporal lobe structures are able to communicate with other areas of cortex that remain undamaged.

MULTIPLE TYPES OF MEMORY Memory is not a single faculty of the mind but consists of various subtypes. Amnesia affects only one kind of memory, declarative memory. Declarative memory is what is ordinarily meant by the term memory in everyday language. Declarative memory supports the conscious recollection of facts and events.

The classic impairment in amnesia thus concerns memory for routes, lists, faces, melodies, objects, and other verbal and nonverbal material, regardless of the sensory modality in which the material is presented. Amnesic patients can display a broad impairment in these components of declarative memory while a number of other memory abilities are preserved. The heterogeneous set

of preserved abilities is collectively termed nondeclarative memory. Nondeclarative memory includes skill learning, habit learning, simple forms of conditioning, and a phenomenon called priming. For these kinds of learning and memory, amnesic patients can perform normally. In controlled laboratory settings, the acquisition of a variety of perceptual, perceptual-motor, and cognitive skills can be tested in isolation, and amnesic patients are found to acquire these skills at rates equivalent to the rates at which healthy individuals acquire the skills. For example, amnesic patients can learn to read mirror-reversed text normally, they exhibit the normal facilitation in reading speed with successive readings of normal prose, and they improve as rapidly as healthy individuals at speeded reading of repeating nonwords. In addition, amnesic patients can, after seeing strings of letters generated by a finite-state rule system, classify novel strings of letters as rule based or not rule based. Classification performance is normal despite the fact that amnesic patients are impaired at remembering the events of training or the specific items they have studied. Priming refers to a facilitation of the ability to detect or to identify a particular stimulus based on a specific recent experience. Many tests have been used to measure priming in amnesia and show that it is intact. For example, words might be presented in a study phase and then again, after a delay, in a test phase when a priming measure such as reading speed is obtained. Patients are instructed to read words as quickly as possible in such a test, and they are not informed that memory is being assessed. In one priming test, patients named pictures of previously presented objects reliably faster than they named pictures of new objects, even after a delay of 1 week. This facilitation occurred at normal levels, despite the fact that the patients were markedly impaired at recognizing which pictures had been presented previously. Particularly striking examples of preserved priming come from studies of patient EP (Fig. 2.4-5), who exhibited intact priming for words but performed at chance levels when asked to recognize which words had been presented for study. This form of memory, termed perceptual priming, is thus a distinct class of memory that is independent of the medial temporal lobe regions typically damaged in amnesia.

FIGURE 2.4-5 Preserved priming in patient EP relative to seven control subjects. A. Stem-completion priming on six separate tests. Priming reflected a tendency for subjects to complete three-letter stems with previously encountered words when they were instructed to produce the first word to come to mind (e.g., MOT___ completed to form MOTEL). Priming scores were calculated as percentage correct for studied words minus percentage correct for baseline words (guessing). B. Perceptual-identification priming on 12 separate tests. Subjects attempted to read 48 words that were visually degraded. Priming scores were calculated as percentage correct identification of previously studied words minus percentage correct identification of nonstudied words. Brackets indicate standard error of the mean. (Data from Hamann SB, Squire LR. Intact perceptual memory in the absence of conscious memory. *Behav Neurosci.* 1997;111:850.) (Reprinted from Stefanacci L, Buffalo EA, Schmolck H, Squire LR. *Profound amnesia after damage*

to the medial temporal lobe: A neuroanatomical and neuropsychological profile of patient E.P. *J Neurosci.* 2000;20:7024, with permission.) Another form of priming reflects improved access to meaning rather than percepts. For example, subjects study a list of words, including tent and belt,

and then are asked to free associate to other words. Thus, they are given words such as canvas and strap and asked to produce the first word that comes to mind. The result is that subjects are more likely to produce tent in response to canvas and to produce belt in response to strap than if the words tent and belt had not been presented recently. This effect, called conceptual priming, is also preserved in amnesic patients, even though they fail to recognize the same words on a conventional memory test (Fig. 2.4-6). FIGURE 2.4-6 Preserved conceptual priming in amnesia. In the free association test, subjects studied a set of words (e.g., lemon) and 5 minutes later viewed cue words that included associates of the studied words (e.g., orange). Subjects were asked to produce the first word that came to mind in response to each cue word. Results are shown separately for the control group (CON; n = 12), amnesic patients with large medial temporal lobe lesions (MTL; n = 2), and amnesic patients with lesions believed to be limited to the hippocampal region (H; n = 3). The left panel shows conceptual priming scores computed as the percentage of studied words produced in the free association test minus a baseline measure of the likelihood of producing those words by chance. All of the groups performed similarly in the conceptual priming test. The right panel shows results from a yes-no recognition memory test using comparable words. Both patient groups were impaired relative to the control group. The dashed line indicates chance performance. The data points for the MTL and H groups show the scores of individual patients averaged across four separate tests. Brackets show standard errors of the mean for the control group. (Reprinted from Levy DA, Stark CEL, Squire LR. Intact conceptual priming in the absence of declarative memory. *Psychol Sci.* 2004;15:680, with permission.)

Not all types of priming are preserved in amnesia. Some priming tests have been designed to examine the formation of new associations. When priming tests are based not on preexisting knowledge but on the acquisition of new associative knowledge, priming tends to be impaired. In other words, priming in certain complex situations can require the same type of linkage among multiple cortical regions that is critical for declarative memory. Memory Systems Table 2.4-2 depicts one scheme for conceptualizing multiple types of memory. Declarative memory depends on medial temporal and midline diencephalic structures along with large portions of the neocortex. This system provides for the rapid learning of facts (semantic memory) and events (episodic memory). Nondeclarative memory depends on several different brain systems. Habits depend on the neocortex and the neostriatum, and the cerebellum is important for the conditioning of skeletal musculature, the amygdala for emotional learning, and the neocortex for priming. Table 2.4-2 Types of Memory Declarative memory and nondeclarative memory differ in important ways. Declarative memory is phylogenetically more recent than nondeclarative memory. In addition, declarative memories are available to conscious recollection. The flexibility of declarative memory permits the retrieved information to be available to multiple response systems. Nondeclarative memory is inaccessible to awareness and is expressed only by engaging specific processing systems. Nondeclarative memories are stored as changes within these processing systems—changes that are encapsulated such that the stored information has limited accessibility to other processing systems. Semantic memory, which concerns general knowledge of the world, has often been categorized as a separate form of memory. Facts that are committed to memory typically become independent of the original episodes in which the facts were learned. Amnesic patients can sometimes acquire information that would ordinarily be learned as facts, but the patients learn it by relying on a different brain system than the system that supports declarative memory. Consider a test requiring the concurrent learning of eight object pairs. Healthy individuals can rapidly learn which the correct object in each pair is, whereas severely amnesic patients like EP

learn only gradually over many weeks, and at the

start of each session they cannot describe the task, the instructions, or the objects. In patients who do not have severe amnesia, factual information is typically acquired as consciously accessible declarative knowledge. In these cases, the brain structures that remain intact within the medial temporal lobe presumably support learning. In contrast, when factual information is acquired as nondeclarative knowledge, as in the case of EP's learning of pairs of objects, learning likely occurs directly as a habit, perhaps supported by the neostriatum. Humans thus appear to have a robust capacity for habit learning that operates outside of awareness and independent of the medial temporal lobe structures that are damaged in amnesia.

Frontal Contributions to Memory Although amnesia does not occur after limited frontal damage, the frontal lobes are fundamentally important for declarative memory. Patients with frontal lesions have poor memory for the context in which information was acquired, they have difficulty in unaided recall, and they may even have some mild difficulty on tests of item recognition. More generally, patients with frontal lesions have difficulty implementing memory retrieval strategies and evaluating and monitoring their memory performance.

NEUROIMAGING AND MEMORY The understanding of memory derived from studies of amnesia has been extended through studies using various methods for monitoring brain activity in healthy individuals. For example, activation of posterior prefrontal regions with positron emission tomography (PET) and functional MRI have shown that these regions are involved in strategic processing during retrieval, as well as in working memory. Anterior frontal regions near the frontal poles have been linked with functions such as evaluating the products of retrieval. Frontal connections with posterior neocortical regions support the organization of retrieval and the manipulation of information in working memory. Consistent with the evidence from patients with frontal lesions, frontal-posterior networks can be viewed as instrumental in the retrieval of declarative memories and in the online processing of new information. Neuroimaging has also identified contributions to memory made by parietal cortex. Multiple parietal regions (including inferior and superior parietal lobules, precuneus, posterior cingulate, and retrosplenial cortex) are activated in conjunction with remembering recent experiences. Although many functions have been hypothesized to explain this parietal activity, a single consensus position has not yet been reached, and it may be the case that several different functions are relevant. Neuroimaging studies have also illuminated priming phenomena and how they differ from declarative memory. Perceptual priming appears to reflect changes in early stages of the cortical pathways that are engaged during perceptual processing. For example, in the case of stem-completion priming, in which subjects study a list of words (e.g., MOTEL) and then are tested with a list of stems (e.g., MOT___) and with instructions to complete each stem with the first word to come to mind, neuroimaging and divided visual-field studies have implicated visual processing systems in extrastriate cortex, especially in the right hemisphere. In contrast, conscious recollection of remembered

words engages brain areas at later stages of processing. Neural mechanisms supporting priming and declarative memory retrieval have also been distinguished in brain electrical activity recorded from the scalp (Fig. 2.4-7). In sum, priming differs from declarative memory in that it is signaled by brain activity that occurs earlier and that originates in different brain regions.

FIGURE 2.4-7 Brain potentials associated with perceptual priming versus declarative memory retrieval. Paller et al. (2003) studied 16 volunteers, who took a memory test involving three sorts of faces: new faces, faces they had seen recently and remembered well, and faces they had seen but did not remember

because the faces had been presented too briefly to process effectively. In a companion experiment with a priming test, speeded responses were found, indicative of priming. Frontal recordings of brain waves elicited by the primed faces included negative potentials from 200 to 400 ms after face presentation that differed from the brain waves elicited by new faces. These differences were particularly robust for trials with the fastest responses (data shown were from trials with responses faster than the median reaction time). Remembered faces uniquely elicited positive brain waves that began about 400 ms after face presentation. Brain potential correlates of face recollection occurred later than those for perceptual priming and were larger over posterior brain regions. (Adapted from Paller KA, Hutson CA, Miller BB, Boehm SG. Neural manifestations of memory with and without awareness. *Neuron*. 2003;38:507, with permission.) Hippocampal activity associated with the formation and retrieval of declarative memories has also been investigated with neuroimaging. In keeping with the neuropsychological evidence, the hippocampus appears to be involved in the recollection of recent events (Fig. 2.4-8). Retrieval-related hippocampal activity has

been observed in memory tests with many different types of stimuli. The hippocampus is also active during the initial storage of information. Whereas left inferior prefrontal cortex is engaged as a result of attempts to encode a word, hippocampal activity at encoding is more closely associated with whether encoding leads to a stable memory that can later be retrieved (Fig. 2.4-9). These findings confirm and extend the idea that medial temporal and frontal regions are important for memory storage and that they make different contributions. FIGURE 2.4-8 Activity in the left and right hippocampal regions measured with functional magnetic resonance imaging (fMRI) during declarative memory retrieval. Data were collected from 11 participants who saw words at study and test and from 11 different participants who saw pictures of namable objects at study and test. Recognition memory accuracy was 80.2 percent correct for words and 89.9 percent correct for objects. Areas of significant fMRI signal change (targets vs. foils) are shown in sagittal sections as color overlays on averaged structural images. The green box indicates the area in which reliable data were available for all subjects. With words, retrieval-related activity was observed in the hippocampus on the left side (A) but not on the right side (B). With namable objects, retrieval-related activity was observed in the hippocampus on both the left side (C) and the right side (D). (Reprinted from Stark CE, Squire LR. Functional magnetic resonance imaging (fMRI) activity in the hippocampal region during recognition memory. *J Neurosci*. 2000;20:7776, with permission.)

FIGURE 2.4-9 Functional activations of prefrontal and medial temporal regions that were predictive of later memory performance. Single words were presented visually, each followed by an instruction to remember (R cue) or to forget (F cue). Trials were sorted based on the remember or forget instruction and on subsequent recognition performance. Activity in the left inferior prefrontal cortex and left hippocampus was predictive of subsequent recognition but for different reasons. Left inferior prefrontal activation (A) was associated with the encoding attempt, in that responses were largest for trials with a cue to remember, whether or not the word was actually recognized later. The time course of activity in this region (B) was computed based on responses that were time locked to word onset (time 0). Left inferior prefrontal activity increased for words that were later remembered, but there was a stronger association with encoding attempt, because responses were larger for words followed by an R cue that were later forgotten than for words followed by an F cue that were later remembered. In contrast, left parahippocampal and posterior hippocampal activation (C) was associated with encoding success. As shown by the time course of activity in this

region (D), responses were largest for words that were subsequently remembered, whether the cue was to remember or to forget. (Reprinted from Reber PJ, Siwiec RM, Gitelman DR, Parrish TB, Mesulam MM, Paller KA. Neural correlates of successful encoding identified using functional magnetic resonance imaging. *J Neurosci.* 2002;22:9541, with permission.)

SLEEP AND MEMORY

The speculation that memories are processed during sleep has a long history. Freud noted that dreams can reveal fragments of recent experiences in the form of day residues. Although many questions about how and why memories may be processed during sleep remain unresolved, recent experiments have provided new empirical support to bolster the idea that memory processing during sleep serves an adaptive function. It is now clear that memory performance can be facilitated when sleep occurs after initial learning, and that sleep-related facilitation can be observed for many different types of memory. Memory storage appears to be specifically aided by processing during deep sleep within a few hours after learning, especially in stages 3 and 4 (slow-wave sleep). Some results indicate that slow-wave sleep facilitates the storage of declarative memories but not nondeclarative memories. Direct evidence for this proposal has been obtained using stimulation with olfactory stimuli (Fig. 2.4-10), stimulation with direct current electrical input at the approximate frequency of electroencephalographic slow waves, and other methods. Furthermore, neuronal recordings in animals have revealed a phenomenon of hippocampal replay, in which activity patterns expressed during the day are later observed during sleep. In summary, declarative memories acquired during waking can be processed again during sleep, and this processing can influence the likelihood of subsequent memory retrieval when the individual is awake. The facilitation of declarative memory is typically manifest as a reduction in the amount of forgetting that occurs, not as an improvement in memory.

FIGURE 2.4-10 Evidence for memory processing during sleep. Subjects first learned object-location associations when a rose odor was present. Following learning, subjects slept wearing a device for delivering odors to the nose, and the rose odor was administered during the first two slow-wave sleep periods of the night (in 30-second periods to prevent habituation). Memory facilitation was observed when object-location associations were tested the following morning in the absence of odor stimulation. Facilitated memory was not found when stimulation occurred during slow-wave sleep but not during learning, when stimulation occurred during learning and then during rapid-eyemovement (REM) sleep, or when subjects were kept awake. Moreover, odor stimulation during slow-wave sleep was found to produce anterior and posterior hippocampal activation (lower panels). (Reprinted from Rasch B, Büchel C, Gais S, Born J. Odor cues during slow-wave sleep prompt declarative memory consolidation. *Science.* 2007;315:1426, with permission.)

ASSESSMENT OF MEMORY FUNCTIONS A variety of quantitative methods are available to assess memory functions in neurological and psychiatric patients. Quantitative methods are useful for evaluating and following patients longitudinally, as well as for carrying out a one-time

examination to determine the status of memory function. It is desirable to obtain information about the severity of memory dysfunction, as well as to determine whether memory is selectively affected or whether memory problems are occurring, as they often do, against a background of additional intellectual deficits. Although some widely available tests, such as the Wechsler Memory Scale, provide useful measures of memory, most single tests assess memory rather narrowly. Even general-purpose neuropsychological batteries provide for only limited testing of memory functions. A complete assessment of memory usually involves a number of specialized tests that sample

intellectual functions, new learning capacity, remote memory, and memory self-report. The assessment of general intellectual functions is central to any neuropsychological examination. In the case of memory testing, information about intellectual functions provides information about a patient's general test-taking ability and a way to assess the selectivity of memory impairment. Useful tests include the Wechsler Adult Intelligence Scale; a test of object naming, such as the Boston Naming Test; a rating scale to assess the possibility of global dementia; a test of word fluency; and specialized tests of frontal lobe function. New Learning Capacity Memory tests are sensitive to impaired new learning ability when they adhere to either of two important principles. First, tests are sensitive to memory impairment when more information is presented than can be held in immediate memory. For example, one might ask patients to memorize a list of ten faces, words, sentences, or digits, given that ten items is more than can be held in mind. The paired-associate learning task is an especially sensitive test of this kind. In the paired-associate task, the examiner asks the patient to learn a list of unrelated pairs of words (for example, queen-garden, office-river) and then to respond to the first word in each pair by recalling the second word. Second, tests are sensitive to memory impairment when a delay, filled with distraction, is interposed between the learning phase and the test phase. In that case, examiners typically ask patients to learn a small amount of information and then distract them for several minutes by conversation to prevent rehearsal. Recollection is then assessed for the previously presented material. Memory can be tested by unaided recall of previously studied material (free recall), by presenting a cue for the material to be remembered (cued recall), or by testing recognition memory. In multiple-choice tests of recognition memory, the patient tries to select previously studied items from a group of studied and unstudied items. In yes-no recognition tests, patients see studied and unstudied items one at a time and are asked to say "yes" if the item was presented previously and "no" if it was not. These methods for assessing recently learned material vary in terms of their sensitivity for detecting memory impairment, with free recall being most sensitive, cued recall intermediate, and recognition least sensitive. The specialization of function of the two cerebral hemispheres in humans means that left and right unilateral damage is associated with different kinds of memory problems.

Accordingly, different kinds of memory tests must be used when unilateral damage is a possibility. In general, damage to medial temporal or diencephalic structures in the left cerebral hemisphere causes difficulty in remembering verbal material, such as word lists and stories. Damage to medial temporal or diencephalic structures in the right cerebral hemisphere impairs memory for faces, spatial layouts, and other nonverbal material that is typically encoded without verbal labels. Left medial temporal damage can lead to impaired memory for spoken and written text. Right medial temporal damage can lead to impaired learning of spatial arrays, whether the layouts are examined by vision or by touch. A useful way to test for nonverbal memory is to ask a patient to copy a complex geometric figure and then, after a delay of several minutes, without forewarning, ask the patient to reproduce it. Remote Memory Evaluations of retrograde memory loss should attempt to determine the severity of any memory loss and the time period that it covers. Most quantitative tests of remote memory are composed of material in the public domain that can be corroborated. For example, tests have been used that concern news events, photographs of famous persons, or former one-season television programs. An advantage of these methods is that one can sample large numbers of events and can often target particular time periods. A disadvantage is that these tests are not so useful for detecting memory loss for information learned during the weeks or months immediately before the onset of amnesia. Most remote

memory tests sample time periods rather coarsely and cannot detect a retrograde memory impairment that covers only a few months. In contrast, autobiographical memory tests can potentially provide fine-grained information about a patient's retrograde memory. In the word-probe task, first used by Francis Galton in 1879, patients are asked to recollect specific episodes from their past in response to single word cues (e.g., bird and ticket) and to date the episodes. The number of episodes recalled tends to be systematically related to the time period from which the episode is taken. Most memories normally come from recent time periods (the last 1 to 2 months), whereas patients with amnesia often exhibit temporally graded retrograde amnesia, drawing few episodic memories from the recent past but producing as many remote autobiographical memories as do normal subjects (see Fig. 2.4-4). Memory Self-Reports Patients can often supply descriptions of their memory problems that are extremely useful for understanding the nature of their impairment. Tests of the ability to judge one's memory abilities are called tests of metamemory. Self-rating scales are available that yield quantitative and qualitative information about memory impairment. As a result, it is possible to distinguish memory complaints associated with depression from memory complaints associated with amnesia. Depressed patients tend to rate their memory as poor in a rather undifferentiated way, endorsing equally all of the items on a self-rating form. By contrast, amnesic patients tend to endorse some items more than

others; that is, there is a pattern to their memory complaints. Amnesic patients do not report difficulty in remembering very remote events or in following what is being said to them, but they do report having difficulty remembering an event a few minutes after it happens. Indeed, self-reports can match rather closely the description of memory dysfunction that emerges from objective tests. Specifically, new-learning capacity is affected, immediate memory is intact, and very remote memory is intact. Some amnesic patients, however, tend to markedly underestimate their memory impairment. In patients with Korsakoff's syndrome, for example, their poor metamemory stems from frontal lobe dysfunction. In any case, querying patients in some detail about their sense of impairment and administering self-rating scales are valuable and informative adjuncts to more formal memory testing. Psychogenic Amnesia Patients sometimes exhibit memory impairment that differs markedly from the typical patterns of memory loss that follow brain damage. For example, some cases of amnesia present with a sudden onset of retrograde amnesia, a loss of personal identity, and minimal anterograde amnesia. These patients may even be unable to recall their name. Given the psychological forces that prompt the onset of amnesia in these cases, they are commonly termed psychogenic amnesia, or sometimes hysterical amnesia, functional amnesia, or dissociative amnesia. Differentiating psychogenic amnesia from a memory disorder that results from frank neurological injury or disease is often straightforward. Psychogenic amnesias typically do not affect new-learning capacity. Patients enter the hospital able to record a continuing procession of daily events. By contrast, new-learning problems tend to be at the core of neurological amnesia. The main positive symptom in psychogenic amnesia is extensive and severe retrograde amnesia. Patients may be unable to recollect pertinent information from childhood or from some part of their past. Formal neuropsychological testing has shown that the pattern of memory deficits varies widely from patient to patient. This variability may reflect a patient's commonsense concepts of memory, even when symptoms are not the result of conscious attempts to simulate amnesia. Some patients may perform poorly only when asked to remember past autobiographical events. Other patients also may fail at remembering past news events. Some patients perform well when memory tests appear to assess general knowledge, such as remembering the names of celebrities or cities. Learning new material is usually intact, perhaps

because such tests appear to concern the present moment, not traveling into the past. Occasionally, patients with psychogenic amnesia exhibit broad memory deficits such that they cannot perform previously familiar skills or identify common objects or common vocabulary words. By contrast, patients with neurological amnesia never forget their name, and remote memory for the events of childhood and adolescence is typically normal, unless there is damage to the lateral temporal or frontal lobes. Patients with psychogenic amnesia sometimes have evidence of head trauma or brain injury, but nevertheless the pattern of deficits cannot be taken as a straightforward result of neurological insult. The clinician's challenge is not to distinguish psychogenic amnesia from neurological amnesia, but to distinguish psychogenic amnesia from malingering. Indeed, the diagnosis of psychogenic amnesia can be difficult to substantiate and may be met with skepticism by hospital staff. Some features that argue in favor of a genuine psychogenic disorder include: (1) memory test scores that are not as low as possible, and never worse than chance levels; (2) memory access that is improved by hypnosis or amobarbital (Amytal)

interview; and (3) a significant premorbid psychiatric history. In some cases, psychogenic amnesia has been observed to clear after a period of days, but in many cases it has persisted as a potentially permanent feature of the personality. IMPLICATIONS Memory Distortion Current understanding of the biology of memory has significant implications for several fundamental issues in psychiatry. Given the selective and constructive nature of autobiographical remembering and the imperfect nature of memory retrieval more generally, it is surprising that memory is so often accurate. How much can we trust our memories? Subjective feelings of confidence are apparently not perfect indicators of retrieval accuracy. Moreover, memory distortion can clearly lead to unfortunate consequences, such as when mistaken eyewitness testimony harms an innocent individual. In fact it is possible to remember with confidence events that never happened. For example, it is possible to confuse an event that was only imagined or dreamed about with an event that actually occurred. One factor that contributes to memory distortion is that similar brain regions are important both for visual imagery and for the long-term storage of visual memories (Fig. 2.4-11). Another factor that contributes to memory distortion is that memory functions best in remembering the gist of an event, not the particulars from which the gist is derived. In a noted demonstration, people listen to a list of words: Candy, sour, sugar, tooth, heart, taste, dessert, salt, snack, syrup, eat, and flavor. Subsequently, when asked to write down the words they heard, 40 percent of them wrote down the word sweet, even though this word did not appear in the list. Thus, many people in this demonstration failed to discriminate between the words that had been presented and a word that was strongly associated to all the words but had not itself been presented. The word sweet can be thought of as a gist word, a word that represents the other words and that captures the meaning of the whole list. Presumably, the words in the study list evoked a thought of the word sweet, either at the time of learning or during the memory test, and people then tended to confuse merely thinking of the word with actually hearing it.

FIGURE 2.4-11 Neural substrates of false memories. A. Functional magnetic resonance imaging data were acquired in a learning phase, when subjects read names of objects and visualized the referents. One half of the names were followed 2 seconds later by a picture of the object. B. In a surprise memory test given outside of the scanner, subjects listened to object names and decided whether they had seen a picture of the corresponding object. On some trials, subjects claimed to have seen a picture of an object that they had only imagined. C. Results showed that the left inferior prefrontal cortex and the left anterior hippocampus were more active during learning in

response to pictures later remembered compared to pictures later forgotten. D. Several different brain areas showed a greater response to words in the learning phase that were later falsely remembered as pictures compared to words not misremembered. Activations that predicted false remembering were found in a brain network important for the generation of visual imagery in response to object names (precuneus, inferior parietal cortex, and anterior cingulate, shown in the left, middle, and right images, respectively). (Reprinted from Gonsalves B, Reber PJ, Gitelman DR, Parrish TB, Mesulam MM, Paller KA. Neural evidence that vivid imagining can lead to false remembering. *Psychol Sci.* 2004;15:655, with permission.) The reconstructive nature of recollection means that the interpretation of eyewitness testimony is not straightforward. Whole episodes are not available in the neocortex, but rather must be pieced together based on fragmentary components and in the context of potentially misleading influences present at the time of retrieval. Studies in adults and in children have documented that illusory memories can be created. Children are particularly susceptible to these effects, especially when subjected to leading questions and false suggestions. In view of these features of memory, when a memory for childhood abuse is remembered after many years, it is prudent to ask whether the memory is accurate. Genuine examples of memory recovery have been documented, whereby an individual produces a veridical memory for a past traumatic event after not recalling the event for

extended time periods. Numerous examples of apparent memory recovery have also been subsequently discovered to be instances of false memory. Unfortunately, there is no perfect method, in the absence of independent corroboration, for determining whether a recollective experience is based on a real event. Infantile Amnesia The biology of memory has also provided insights relevant to the phenomenon of infantile amnesia—the apparent absence of conscious memory for experiences from approximately the first 3 years of life. Traditional views of infantile amnesia have emphasized repression (psychoanalytic theory) and retrieval failure (developmental psychology). A common assumption has been that adults retain memories of early events but cannot bring them into consciousness. However, it now appears that the capacity for declarative memory does not become fully available until approximately the third year of life, whereas nondeclarative memory emerges early in infancy (e.g., classical conditioning and skill learning). Thus, infantile amnesia results not from the adult's failure to retrieve early memories, but from the child's failure to store them adequately in the first place. Nevertheless, studies in young infants show that a rudimentary capacity for declarative memory is present even at a few months of age. As a child develops, memories can be retained across increasingly long intervals, and what is represented becomes correspondingly richer and more full of detail. Medial temporal and diencephalic regions seem to be sufficiently developed during these early months and years. What limits the capacity for declarative memory appears to be the gradual development and differentiation of the neocortex. As the neocortex develops, the memories represented there become more complex, language abilities allow for more elaborate verbal descriptions of events, and a developing sense of self supports autobiographical knowledge. As new strategies emerge for organizing incoming information, declarative memories become more persistent, more richly encoded, and better interconnected with other information. It is not the case that fully formed childhood memories are stored but cannot be retrieved. The perspective consistent with current understanding of the biology of memory is that declarative memories formed very early in life are fragmentary, simple, and tied to the specific context of an infant's understanding of the world. They are unlike typical declarative memories in adults, which are imbued with meaning and a complex understanding of events. Memories and the Unconscious The existence of multiple

memory systems also has implications for issues central to psychoanalytic theory, including the construct of the unconscious. How one believes that past experience influences current behavior depends on what view one takes of the nature of memory. By the traditional view, memory is a unitary faculty, and representations in memory vary mainly in strength and accessibility. Material that is unconscious is below some threshold of accessibility but could potentially be made available to consciousness.

The modern, biological view begins with the distinction between a kind of memory that can be brought to mind—declarative memory—and other kinds of memory that are, by their nature, unconscious. Stored nondeclarative memories are expressed through performance without affording any conscious memory content. Our personalities are shaped by nondeclarative memories in the form of numerous habits and conditioned responses. In this view, one's behavior is indeed affected by events from early life, but the effects of early experience persist in a nondeclarative form without necessarily including an explicit, conscious record of the events. Learned behavior can be expressed through altered dispositions, preferences, conditioned responses, habits, and skills, but exhibiting such behavior need not be accompanied by awareness that behavior is being influenced by past experience, nor is there a necessity that any particular past experience has been recorded as a complete episode. That is, an influence from early experience does not require a memory of any specific episode. One can be afraid of dogs without remembering being knocked down by a dog as a child. In this case, the fear of dogs is not experienced as a memory. It is experienced as a part of personality. Furthermore, a strong fear of dogs carries with it no implication that the brain retains a specific record of any early experience that subsequently resulted in a fear of dogs. Behavioral change can occur by one's acquiring new habits that supersede old ones or by becoming sufficiently aware of a habit that one can to some extent isolate it, countermand it, or limit the stimuli that elicit it. However, one need not become aware of any early formative event in the same sense that one knows the content of a declarative memory. The unconscious does not become conscious. Various forms of nondeclarative memory simply influence behavior without having the additional capacity for these influences to become accessible to conscious awareness.

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05 - 2.5 Normality and Mental Health

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2.5 Normality and Mental Health There has been an implicit assumption that mental health could be defined as the antonym of mental illness. In other words, mental health was the absence of psychopathology and synonymous with normal. Achieving mental health through the alleviation of gross pathologic signs and symptoms of illness is also the definition of the mental health model strongly advocated by third-party payers. Indeed, viewing mental health as simply the absence of mental illness is at the heart of much of the debate concerning mental health policies. The great epidemiological studies of the last halfcentury also focused on who was mentally ill, and not who was well.

DEFINING MENTAL HEALTH Several steps are necessary in defining positive mental health. The first step is to note that “average” is not healthy; it always includes mixing in with the healthy the prevalent amount of psychopathology in the population. For example, in the general population, being of “average” weight or eyesight is unhealthy, and if all sources of biopsychosocial pathology were excluded from the population, the average IQ would be significantly greater than 100. The second step in discussing mental health is to appreciate the caveat that what is healthy sometimes depends on geography, culture, and the historical moment. Sickle cell trait is unhealthy in New York City, but in the tropics, where malaria is endemic, the sickling of red blood cells may be lifesaving. The third step is to make clear whether one is discussing trait or state. Who is physically healthier—an Olympic miler disabled by a simple but temporary (state) sprained ankle or a type 1 diabetic (trait) with a temporarily normal blood sugar? In cross-cultural studies such differences become especially important. Superficially, an Indian mystic in a state of trance may resemble a person with catatonic schizophrenia, but the mystic does not resemble someone in the schizophrenic condition over time. The fourth and most important step is to appreciate the twofold danger of “contamination by values.” On one hand, cultural anthropology teaches us how fallacious any definition of mental health can be. Competitiveness and scrupulous neatness may be healthy in one culture and regarded as personality disorders in another. Furthermore, if mental health is “good,” what is it good for? The self or the society? For “fitting in” or for creativity? For happiness or survival? And who should be the judge?

MODELS OF MENTAL HEALTH This chapter contrasts six different empirical approaches to mental health. First, mental health can be conceptualized as above normal and a mental state that is objectively desirable, as in Sigmund Freud’s definition of mental health which is the capacity

to work and to love. Second, from the viewpoint of healthy adult development, mental

health can be conceptualized as maturity. Third, mental health can be conceptualized in terms of positive psychology—as epitomized by the presence of multiple human strengths. Fourth, mental health can be conceptualized as emotional intelligence and successful object relations. Fifth, mental health can be conceptualized as subjective well-being—a mental state that is subjectively experienced as happy, contented, and desired. Sixth, mental health can be conceptualized as resilience, as the capacity for successful adaptation and homeostasis.

Model A: Mental Health as Above Normal This first perspective differs from the traditional medical approach to health and illness. No manifest psychopathology equals mental health. In this medical model, if one were to put all individuals on a continuum, normality would encompass the major portion of adults, and abnormality would be the small remainder. This definition of health correlates with the traditional role model of the doctor who attempts to free his patient from grossly observable signs of illness. In other words, in this context health refers to a reasonable, rather than an optimal, state of functioning. Yet, as already pointed out, mental health is not normal; it is above average. Some believe that true mental health is the exception, not the rule. Moreover, until recently some believed that mental health was imaginary.

Model B: Mental Health as Maturity Unlike other organs of the body that are designed to stay the same, the brain is designed to be plastic. Therefore, just as optimal brain development requires almost a lifetime, so does the assessment of positive mental health. A 10-year-old's lungs and kidneys are more likely to reflect optimal function than are those of a 60-year-old, but that is not true of a 10-year-old's central nervous systems. To some extent, then, adult mental health reflects a continuing process of maturational unfolding. Statistically, physically healthy 70-year-olds are mentally healthier than they were at age 30 years; for example, Laura Carstensen found through prospective studies that individuals are less depressed and show greater emotional modulation at age 70 years than they did at age 30 years. However, if prospective studies of adult development reveal that the immature brain functions less well than the mature brain, does that mean that adolescents are mentally healthier than toddlers? Are the middle-aged mentally healthier than adolescents? The answer is both yes and no, but the question illustrates that in order to understand mental health we must first understand what we mean by maturity. To confirm the hypothesis that maturity and positive mental health are almost synonymous, it is necessary to study the behavior and emotional states of persons over a lifetime. Although such longitudinal studies have come to fruition only recently, all of them illustrate the association of maturity with increasing mental health. After age 50 years, of course, the association between mental health and maturity is contingent on a healthy central nervous system. The ravages of illnesses like brain trauma, major depression, arteriosclerosis, Alzheimer's, and alcoholism must all be avoided.

The association of mental health to maturity is probably mediated not only by progressive brain myelination into the sixth decade but also by the evolution of emotional and social intelligence through experience. Erik Erikson conceptualized that such development produced a “widening social radius.” In such a view, life after age 50 years was no longer to be a staircase leading downward, as in the Pennsylvania Dutch cartoons of life-span development, but a path leading outward. In Erikson's model the adult social radius expanded over time through the mastery of certain tasks such as “Identity versus Identity Diffusion,” “Intimacy versus Isolation,” “Generativity versus Stagnation,” and “Integrity versus Despair.” Identity. In such a model the social radius of each adult developmental task fits inside the next. First, adolescents must achieve an Identity that

allows them to become separate from their parents, for mental health and adult development cannot evolve through a false self. The task of Identity requires mastering the last task of childhood: sustained separation from social, residential, economic, and ideological dependence on family of origin. Identity is not just a product of egocentricity, of running away from home, or of marrying to get out of a dysfunctional family. There is a world of difference between the instrumental act of running away from home and the developmental task of knowing where one's family values end and one's own values begin. Such separation derives as much from the identification and internalization of important adolescent friends and nonfamily mentors as it does from simple biological maturation. For example, our accents become relatively fixed by age 16 years and reflect those of our adolescent peer group rather than the accents of our parents.

Intimacy. Then, young adults should develop Intimacy, which permits them to become reciprocally, and not selfishly, involved with a partner. However, living with just one other person in an interdependent, reciprocal, committed, and contented fashion for years and years may seem neither desirable nor possible to a young adult. Once achieved, however, the capacity for intimacy may seem as effortless and desirable as riding a bicycle. Sometimes the relationship is with a person of the same gender; sometimes it is completely asexual; and sometimes, as in religious orders, the interdependence is with a community. Superficially, mastery of intimacy may take very different guises in different cultures and epochs, but "mating-for-life" and "marriage-type love" are developmental tasks built into the developmental repertoires of many warm-blooded species, including ours.

Career Consolidation. Career Consolidation is a task that is usually mastered together with or that follows the mastery of intimacy. Mastery of this task permits adults to find a career as valuable as they once found play. On a desert island one can have a hobby but not a career, for careers involve being of value to other people. There are four crucial developmental criteria that transform a "job" or hobby into a "career:" Contentment, compensation, competence, and commitment. Obviously, such a career can be "wife and mother"—or, in more recent times, "husband and father." To the

outsider the process of Career Consolidation often appears "selfish," but without such "selfishness" one becomes "selfless" and has no "self" to give away in the next stage of generativity. Persons with schizophrenia and individuals with severe personality disorder often manifest a lifelong inability to achieve either intimacy or sustained, gratifying employment.

Generativity. Generativity involves the demonstration of a clear capacity to care for and guide the next generation. Research reveals that sometime between age 35 and 55 years our need for achievement declines and our need for community and affiliation increases. Depending on the opportunities that the society makes available, generativity can mean serving as a consultant, guide, mentor, or coach to young adults in the larger society. Like leadership, generativity means to be in a caring relationship in which one gives up much of the control that parents retain over young children. Good mentors learn "to hold loosely" and to share responsibility. Generativity reflects the capacity to give the self—finally completed through mastery of the first three tasks of adult development—away. Its mastery is strongly correlated with successful adaptation to old age. This is because in old age there are inevitable losses, and these may overwhelm us if we have not continued to grow beyond our immediate family.

Integrity. Finally, in old age it is common to feel that some life exists after death and that one is part of something greater than one's self. Thus, the last life task in Erikson's words is Integrity, the task of achieving some sense of peace and unity with respect both to one's life and to the whole world. Erikson described integrity as "an experience which conveys some world order and spiritual sense. No matter how dearly paid for, it is the acceptance of one's one

and only life cycle as something that had to be and that, by necessity, permitted of no substitutions.” It must be kept in mind that mastery of one life task is not necessarily healthier than mastery of another, for adult development is neither a foot race nor a moral imperative. Rather, these sequential tasks are offered as a road map to help clinicians make sense of where they are and where their patients might be located. One can be a mature 20-year-old, that is, healthy. One can be an immature 50-year-old, which may be unhealthy. Nevertheless, acquiring a social radius that extends beyond the person by definition allows more flexibility and thus is usually healthier than self-preoccupation. Generativity by age 40 to 50 years offers a powerful predictor of a contented old age. Model C: Mental Health as Positive or “Spiritual” Emotions This model defines both mental and spiritual health as the amalgam of the positive emotions that bind us to other human beings. Love, hope, joy, forgiveness, compassion, faith, awe, and gratitude comprise the important positive and “moral” emotions included in this model. Of great importance, these selected positive emotions all involve human connection. None of the emotions listed is just about the self. These positive emotions appear to be a common denominator of all major faiths. Omitted from the list

are five other positive emotions—excitement, interest, contentment (happiness), humor, and a sense of mastery, for a person can feel these latter five emotions alone on a desert island. Negative emotions originating in the hypothalamus such as fear and anger are elaborated in the human amygdala (larger in humans than in other mammals). Of tremendous importance to individual survival, the negative emotions are all about “me.” In contrast, positive emotions, apparently generated in the limbic system and unique to mammals, have the potential to free the self from the self. People feel both the emotions of vengeance and of forgiveness deeply, but the long-term results of these two emotions are very different. Negative emotions are crucial for survival in present time. The positive emotions are more expansive and help us to broaden and build. In future time, they widen one’s tolerance for strangers, expand one’s moral compass, and enhance one’s creativity. Whereas negative emotions narrow attention and miss the forest for the trees, positive emotions, especially joy, make thought patterns more flexible, creative, integrative, and efficient. The effect of positive emotion on the autonomic (visceral) nervous system has much in common with the relaxation response to meditation. In contrast to the metabolic and cardiac arousal that the fight-or-flight response of negative emotion induces in our sympathetic autonomic nervous system, positive emotion via our parasympathetic nervous system reduces basal metabolism, blood pressure, heart rate, respiratory rate, and muscle tension. Functional magnetic resonance imaging (fMRI) studies of Kundalini yoga practitioners demonstrate that meditation increases the activity of the hippocampus and the right lateral amygdala, which in turn leads to parasympathetic stimulation and the sensation of deep peacefulness. Positive emotions have a biological basis, which means that they have evolved through natural selection. The prosocial emotions probably reflect adaptations that permitted the survival of relatively defenseless *Homo sapiens* and their extremely defenseless children in the African savannah 1 to 2 million years ago. Evidence for Positive Emotions. It has taken recent developments in neuroscience and ethology to make positive emotions a subject fit for scientific study. For example, infantile autism, a not uncommon genetic disorder of emotional attachment, was not discovered until 1943 by a Johns Hopkins child psychiatrist, Leo Kanner—in his son. Until then it was not possible for medicine to articulate a positive emotion as basic, but as cognitively subtle, as attachment. Today, the congenital lack of empathy and difficulties of attachment in childhood autism can be recognized by any competent pediatrician. To locate positive emotion in the mammalian limbic system has been

a slow, arduous process. In 1955, James Olds, an innovative neuropsychologist, observed that 35 of 41 electrode placements within the limbic system of rats, but only 2 of 35 placements outside of the limbic system, proved sufficiently rewarding to lead to self-stimulation. Also in the 1950s, neurobiologist Paul MacLean pointed out that the limbic structures govern our mammalian capacity not only to remember (cognition), but also to play

(joy), to cry out at separation (faith/trust), and to take care of our own (love). Except for rudimentary memory, reptiles express none of these qualities. Studies using fMRI demonstrated that when individuals subjectively experience existential states of fear, sadness, or pleasure, blood flow increases in limbic areas and decreases in many higher brain areas. Various studies have located human pleasurable experiences (tasting chocolate, winning money, admiring pretty faces, enjoying music, and experiencing orgasmic ecstasy) in limbic areas—especially in the orbitofrontal region, anterior cingulate, and insula. These diverse structures are closely integrated and organized to help us to seek and to recognize all that falls under the rubric of mammalian love and human spirituality. The anterior cingulate gyrus links valence and memory to create attachment. Along with the hippocampus, the anterior cingulate is the brain region most responsible for making the past meaningful. In terms of mediating attachment, the anterior cingulate receives one of the richest dopaminergic innervations of any cortical area. Thus, the cingulate gyrus provides motivational salience not only for lovers, but also for drug addicts. The anterior cingulate is crucial in directing who we should approach and who we should avoid. Maternal touch, body warmth, and odor via the limbic system and especially via the anterior cingulate regulate a rat pup's behavior, neurochemistry, endocrine release, and circadian rhythm. Brain imaging studies reveal that the anterior cingulate gyrus is aroused neither by facial recognition of friends per se nor by sexual arousal per se. Rather, anterior cingulate fMRI images light up when a lover gazes at a picture of a partner's face or when a new mother hears her infant's cry. Perhaps no area of the brain is more ambiguous in its evolutionary heritage or more crucial to mental health than our prefrontal cortex. The prefrontal cortex is in charge of estimating rewards and punishments and plays a critical role in adapting and regulating our emotional response to new situations. Thus, the prefrontal lobes are deeply involved in emotional, "moral," and "spiritual" lives. From an evolutionary standpoint the human frontal lobes are not different from those of chimpanzees in terms of number of neurons. Rather, it is the frontal lobe white matter (the connectivity between neurons through myelinated fibers) that accounts for larger frontal lobes of humans. This connectivity to the limbic system underscores its "executive" function, which includes the ability to delay gratification, comprehend symbolic language, and, most important, to establish temporal sequencing. By being able to connect memory of the past to "memory of the future," the frontal lobes establish for Homo sapiens predictable cause and effect. Surgical or traumatic ablation of the ventromedial prefrontal cortex can turn a conscientious, responsible adult into a moral imbecile without any other evidence of intellectual impairment. The insula is another part of the limbic system that is only beginning to be understood. The insula is a medial cortical gyrus located between the amygdala and the frontal lobe. The brain has no sensation; humans feel emotion only in their bodies. The insula helps to bring these visceral feelings into consciousness: The pain in one's heart of grief, the warmth in one's heart of love, and the tightness in one's gut from fear all make their way into consciousness through the insula. Both the limbic anterior cingulate and insula appear to be active in the positive emotions of humor, trust, and empathy. The higher apes are set apart from other mammals by a unique neural component called the spindle cell. Humans have 20 times more spindle cells than either chimps or gorillas (adult chimpanzees average about 7,000 spindle cells; human newborns

have four times more; and human adults have almost 200,000 spindle cells). Monkeys and other mammals, with

the possible exception of whales and elephants, are totally lacking in these special cells. These large, cigar-shaped spindle or “von Economo” neurons appear to be central to the governance of social emotions and moral judgment. Spindle cells may have helped the Great Apes and humans integrate their mammalian limbic systems with their expanding neocortices. Spindle cells are concentrated in the anterior cingulate cortex, the prefrontal cortex, and the insula. More recently, scientists have discovered a special group of “mirror neurons” that reside in the insula and anterior cingulate. These neurons are more highly developed in humans than in primates and appear to mediate empathy—the experience of “feeling” the emotions of another. Although the practical applications of this newest model of mental health are still many years away, these findings provide further evidence that the brain and mind are one. In several studies the prosocial biological activity of the anterior cingulate cortex and insula was highest in individuals with the highest levels of social awareness (based on objectively scored tests). In other words, there are not only biological individual differences for negative mental health, but also for positive mental health.

Model D: Mental Health as Socioemotional Intelligence High socioemotional intelligence reflects above-average mental health in the same way that a high intelligence quotient (IQ) reflects above-average intellectual aptitude. Such emotional intelligence lies at the heart of positive mental health. In the *Nicomachean Ethics*, Aristotle defined socioemotional intelligence as follows: “Anyone can become angry—that is easy. But to be angry with the right person, to the right degree, at the right time, for the right purpose, and in the right way—that is not easy.” All emotions exist to assist basic survival. Although the exact number of primary emotions is arguable, seven emotions are currently distinguished according to characteristic facial expressions connoting anger, fear, excitement, interest, surprise, disgust, and sadness. The capacity to identify these different emotions in ourselves and in others plays an important role in mental health. The benefits of being able to read feelings from nonverbal cues have been demonstrated in almost a score of countries. These benefits included being better emotionally adjusted, more popular, and more responsive to others. Empathic children, without being more intelligent, do better in school and are more popular than their peers. The Head Start Program, a program of the United States Department of Health and Human Services that provides education and other services for low-income children and their families, found that early school success was achieved not by intelligence but by knowing what kind of behavior is expected, knowing how to rein in the impulse to misbehave, being able to wait, and knowing how to get along with other children. At the same time the child must be able to communicate his or her needs and turn to teachers for help. Ethologically, emotions are critical to mammalian communication. Because such communications are not always consciously recognized, the more skillful individuals are in identifying their emotions, the more skilled the individual will be in communicating with others and in empathically recognizing their emotions. Put differently, the more one is skilled in empathy, the more one will be valued by others, and thus the greater

will be social supports, self-esteem, and intimate relationships. Social and emotional intelligence can be defined by the following criteria: Accurate conscious perception and monitoring of one’s emotions. Modification of emotions so that their expression is appropriate. This involves the capacity to self-soothe personal anxiety and to shake off hopelessness and gloom. Accurate recognition of and response to emotions in others. Skill in negotiating close relationships with

others. Capacity for focusing emotions (motivation) toward a desired goal. This involves delayed gratification and adaptively displacing and channeling impulse. Some behavioral scientists divide emotions into positive and negative, as if negative emotions were unhealthy (this point of view was emphasized in Model C). This tendency is an oversimplification. As with pus, fever, and cough, so the negative emotions of sadness, fear, and anger are also important to healthy self-preservation. On one hand, positive emotions like joy, love, interest, and excitement are associated with subjective contentment; on the other hand, although negative emotions interfere with contentment, their expression can be equally healthy. Advances in Studying Emotional Intelligence. Over the last 15 years, three important empirical steps have been taken in our understanding of the relationship of socioemotional intelligence to positive mental health. The first step is that both fMRI studies and neurophysiological experimentation have led to advances in our understanding of the integration of prefrontal cortex with the limbic system, especially with the amygdala and its connections. As noted in the previous model, these research advances have brought us closer to understanding emotions as neurophysiological phenomena rather than as Platonic abstractions. The prefrontal cortex is the region of the brain responsible for working memory, and the frontal lobes, through their connections to the amygdala, hippocampus, and other limbic structures, encode emotional learning in a manner quite distinct from both conventional conditioning and declarative memory. The second step has been the slow but steady progress in conceptualizing and measuring "emotional intelligence." Over the last decade measures of emotional intelligence have evolved rapidly. The third advance is the use of videotape to chart emotional interaction. Videos of sustained family interactions reveal that the most important aspect of healthy infant development, of adolescent development, and of marital harmony is how partners or parents respond to emotion in others. To ignore, to punish, and to be intimidated or contemptuous of how another feels spells disaster. Children of emotionally attuned parents are better at handling their own emotions and are more effective at soothing themselves when upset. Such children even manifest lower levels of stress hormones and other physiological indicators of emotional arousal. There are now many exercises in handling relationships that help couples, business

executives, and diplomats to become more skilled at conflict resolution and negotiation. In the last decade, there has also been an increasing effort to teach schoolchildren core emotional and social competencies, sometimes called "emotional literacy." The relevance of these advances in psychology to psychiatry include teaching emotion recognition and differentiation in eating disorders and teaching anger modulation and finding creative solutions to social predicaments for behavior disorders. Model E: Mental Health as Subjective Well-Being Positive mental health does not just involve being a joy to others; one must also experience subjective well-being. Long before humankind considered definitions of mental health, they pondered criteria for subjective happiness. For example, objective social support accomplishes little if subjectively the individual cannot feel loved. Thus, capacity for subjective well-being becomes an important model of mental health. Subjective well-being is never categorical. Healthy blood pressure is the objective absence of hypotension and hypertension, but happiness is less neutral. Subjective wellbeing is not just the absence of misery, but the presence of positive contentment. Nevertheless, if happiness is an inescapable dimension of mental health, happiness is often regarded with ambivalence. If through the centuries philosophers have sometimes regarded happiness as the highest good, psychologists and psychiatrists have tended to ignore it. Subjective happiness can have maladaptive as well as adaptive facets. The search for happiness can appear selfish, narcissistic, superficial, and banal. Pleasures can come easily and be soon gone. Happiness is often based on illusion or on dissociative

states. Illusory happiness is seen in the character structure associated with bipolar and dissociative disorders. Maladaptive happiness can bring temporary bliss but has no sticking power. In the Study of Adult Development, scaled measures of "happiness" had little predictive power and, often, insignificant association with other subjective and objective measures of contentment. It is because of such ambiguity of meaning that, throughout this section, the term subjective well-being will be substituted for happiness. Empirical Evidence. The mental health issues involved in subjective well-being are complicated and clouded by historical relativism, value judgment, and illusion. Europeans have always been skeptical of the American concern with happiness. Only in the last decade have investigators pointed out that a primary function of positive emotional states and optimism is that they facilitate self-care. Subjective well-being makes available personal resources that can be directed toward innovation and creativity in thought and action. Thus, subjective well-being, like optimism, becomes an antidote to learned helplessness. Again, controlling for income, education, weight, smoking, drinking, and disease, happy people are only half as likely to die at an early age or become disabled as unhappy people. A distinction can be made between pleasure and gratification. Pleasure is in the moment, is closely allied with happiness, and involves the satisfaction of impulse and of

biological needs. Pleasure is highly susceptible to habituation and satiety. If pleasure involves satisfaction of the senses and emotions, gratification involves joy, purpose, and the satisfaction of "being the best you can be" and of meeting aesthetic and spiritual needs. Subjective (unhappy) distress can be healthy. As ethologically minded investigators have long pointed out, subjective negative affects (e.g., fear, anger, and sadness) can be healthy reminders to seek environmental safety and not to wallow in subjective wellbeing. If positive emotions facilitate optimism and contentment, fear is the first protection against external threat; sadness protests against loss and summons help, and anger signals trespass. Clarifying Subjective Well-Being. Since the 1970s investigators have made a serious effort to attend to definitional and causal parameters of subjective well-being and thereby address important questions. One such question is: Is subjective well-being more a function of environmental good fortune or a function of an inborn, genetically based temperament? Put differently, does subjective well-being reflect trait or state? If subjective well-being reflects a safe environment and the absence of stress, it should fluctuate over time, and those individuals who are happy in one domain or time in their lives might not be happy in another. A second question, but one related to the first, is what is cause and what is effect. Are happy people more likely to achieve enjoyable jobs and good marriages, or does conjugal stability and career contentment lead to subjective well-being? Or are such positive associations the result of still a third factor? For example, the absence of a genetic tendency for alcoholism, for major depression, for trait neuroticism, and even for the presence of a chronic wish to give socially desirable answers (impression management) might facilitate both subjective well-being and reports of good marriage and career contentment. As with physiological homeostasis, evolution has prepared humans to make subjective adjustments to environmental conditions. Thus, one can adapt to good and bad events so that one does not remain in a state of either elation or despair. However, humans have a harder time adjusting to their genes. Studies of adopted-away twins have demonstrated that half of the variance in subjective well-being is due to heritability. The subjective well-being of monozygotic twins raised apart is more similar than the subjective well-being of heterozygous twins raised together. Among the heritable factors making a significant contribution to high subjective well-being are low trait neuroticism, high trait extraversion, absence of alcoholism, and absence of major depression. In contrast to tested intelligence, when heritable

variables are controlled, subjective well-being is not affected by environmental factors like income, parental social class, age, and education. If subjective well-being were due largely to the meeting of basic needs, then there should be a relatively low correlation between subjective well-being in work and subjective well-being in recreational settings or between subjective well-being in social versus subjective well-being in solitary settings. Because women experience more objective clinical depression than men, the fact that gender is not a determining factor in subjective well-being is interesting. One explanation is that women appear to report both positive and negative affects more vividly than men. In one study, gender accounted for only 1 percent of the variance in happiness but 13 percent of the variance in the intensity of reported emotional experiences.

Other Sources of Well-Being. In some instances environment can be important to subjective well-being. Young widows remain subjectively depressed for years. Even though their poverty has been endured for centuries, respondents in very poor nations, like India and Nigeria, report lower subjective well-being than do other, more prosperous nations. The loss of a child never stops aching. Although achieving concrete goals like money and fame does not lead to a sustained increase in subjective wellbeing, social comparison, like watching one's next-door neighbor become richer than you, exerts a negative effect on subjective well-being. The maintenance of self-efficacy, agency, and autonomy make additional environmental contributions to subjective well-being. For example, elders will use discretionary income to live independently even though this means living alone rather than with relatives. Subjective well-being is usually higher in democracies than in dictatorships. Assuming responsibility for favorable or unfavorable outcomes (internalization) is another major factor leading to subjective well-being. Placing the blame elsewhere (externalization) significantly reduces subjective well-being. In other words, the mental mechanisms of paranoia and projection make people feel worse rather than better. Refined methods of measurement of subjective states of mind have included the Positive and Negative Affect Scale (PANAS), which assesses both positive and negative affect, each with ten affect items. The Satisfaction with Life Scale represents the most recent evolution of a general life satisfaction scale. Most recently the widely validated Short Form 36 (SF-36) has allowed clinicians to assess the subjective cost/benefits of clinical interventions. Because short-lived environmental variables can distort subjective well-being, consensus is emerging that naturalistic experience-sampling methods are the most valid way to assess subjective well-being. With such sampling methods, research subjects are contacted by beeper at random times during the day for days or weeks and at each interval are asked to assess their subjective well-being. This method provides a more stable report of subjective well-being. Finally, to tease verbal self-report from actual subjective experience, physiological measures of stress (e.g., measuring galvanic skin response and salivary cortisol and filming facial expression by concealed cameras) have also proven useful.

Model F: Mental Health as Resilience There are three broad classes of coping mechanisms that humans use to overcome stressful situations. First, there is the way in which an individual elicits help from appropriate others: Namely consciously seeking social support. Second, there are conscious cognitive strategies that individuals intentionally use to master stress. Third, there are adaptive involuntary coping mechanisms (often called "defense mechanisms") that distort our perception of internal and external reality in order to reduce subjective distress, anxiety, and depression.

Involuntary Coping Mechanisms. Involuntary coping mechanisms reduce

conflict and cognitive dissonance during sudden changes in internal and external reality. If such changes in reality are not "distorted" and "denied," they can result in disabling anxiety or

depression, or both. Such homeostatic mental “defenses” shield us from sudden changes in the four lodestars of conflict: impulse (affect and emotion), reality, people (relationships), and social learning (conscience). First, such involuntary mental mechanisms can restore psychological homeostasis by ignoring or deflecting sudden increases in the lodestar of impulse—affect and emotion. Psychoanalysts call this lodestar “id,” religious fundamentalists call it “sin,” cognitive psychologists call it “hot cognition,” and neuroanatomists point to the hypothalamic and limbic regions of brain. Second, such involuntary mental mechanisms can provide a mental time-out to adjust to sudden changes in reality and self-image, which cannot be immediately integrated. Individuals who initially responded to the television images of the sudden destruction of New York City’s World Trade Center as if it were a movie provide a vivid example of the denial of an external reality that was changing too fast for voluntary adaptation. Sudden good news—the instant transition from student to physician or winning the lottery—can evoke involuntary mental mechanisms as often as can an unexpected accident or a diagnosis of leukemia. Third, involuntary mental mechanisms can mitigate sudden unresolvable conflict with important people, living or dead. People become a lodestar of conflict when one cannot live with them and yet cannot live without them. Death is such an example; another is an unexpected proposal of marriage. Internal representations of important people may continue to cause conflict for decades after they are dead yet continue to evoke involuntary mental response. Finally, the fourth source of conflict or anxious depression is social learning or conscience. Psychoanalysts call it “super ego,” anthropologists call it “taboos,” behaviorists call it “conditioning,” and neuroanatomists point to the associative cortex and the amygdala. This lodestar is not just the result of admonitions from our parents that we absorb before age 5 years, but it is formed by our whole identification, with culture, and sometimes by irreversible learning resulting from overwhelming trauma.

Healthy Involuntary Mental Mechanisms. Longitudinal studies from both Berkeley’s Institute of Human Development and Harvard’s Study of Adult Development have illustrated the importance of the mature defenses to mental health.

HUMOR. Humor makes life easier. With humor one sees all, feels much, but does not act. Humor permits the discharge of emotion without individual discomfort and without unpleasant effects upon others. Mature humor allows individuals to look directly at what is painful, whereas dissociation and slapstick distract the individual to look somewhere else. Yet, like the other mature defenses, humor requires the same delicacy as building a house of cards—timing is everything.

ALTRUISM. When used to master conflict, altruism involves an individual getting pleasure from giving to others what the individual would have liked to receive. For example, using reaction formation, a former alcohol abuser works to ban the sale of

alcohol in his town and annoys his social drinking friends. Using altruism, the same former alcoholic serves as an Alcoholics Anonymous sponsor to a new member— achieving a transformative process that may be lifesaving to both giver and receiver. Obviously, many acts of altruism involve free will, but others involuntarily soothe unmet needs.

SUBLIMATION. The sign of a successful sublimation is neither careful cost accounting nor shrewd compromise, but rather psychic alchemy. By analogy, sublimation permits the oyster to transform an irritating grain of sand into a pearl. In writing his Ninth Symphony, the deaf, angry, and lonely Beethoven transformed his pain into triumph by putting Schiller’s “Ode to Joy” to music.

SUPPRESSION. Suppression is a defense that modulates emotional conflict or internal/external stressors through stoicism. Suppression minimizes and postpones but does not ignore gratification. Empirically, this is the defense most highly associated with other facets of mental health. Used effectively, suppression is analogous to a welltrimmed sail; every restriction is precisely calculated to exploit, not hide, the winds of

passion. Evidence that suppression is not simply a conscious “cognitive strategy” is provided by the fact that jails would empty if delinquents could learn to just say “No.” ANTICIPATION. If suppression reflects the capacity to keep current impulse in mind and control it, anticipation is the capacity to keep affective response to an unbearable future event in mind in manageable doses. The defense of anticipation reflects the capacity to perceive future danger affectively as well as cognitively and by this means to master conflict in small steps. Examples are the fact that moderate amounts of anxiety before surgery promote postsurgical adaptation and that anticipatory mourning facilitates the adaptation of parents of children with leukemia. Psychiatry needs to understand how best to facilitate the transmutation of lessadaptive defenses into more-adaptive defenses. One suggestion has been first to increase social supports and interpersonal safety and second to facilitate the intactness of the central nervous system (e.g. rest, nutrition, and sobriety). The newer forms of integrative psychotherapies using videotape can also catalyze such change by allowing patients to actually see their involuntary coping style. REFERENCES Blom RM, Hagesteinde Bruijn C, de Graaf R, ten Have M, Denys DA. Obsessions in normality and psychopathology. *Depress Anxiety*. 2011; 28(10):870. Macaskill A. Differentiating dispositional self-forgiveness from other-forgiveness: Associations with mental health and life satisfaction. *J Soc Clin Psychol*. 2012;31:28. Sajobi TT, Lix LM, Clara I, Walker J, Graff LA, Rawsthorne P, Miller N, Rogala L, Carr R, Bernstein CN. Measures of relative importance for health-related quality of life. *Qual Life Res*. 2012;21:1. Tol WA, Patel V, Tomlinson M, Baingana F, Galappatti A, Silove D, Sondorp E, van Ommeren M, Wessells MG, Panter-Brick C. Relevance or excellence? Setting research priorities for mental health and psychosocial support in humanitarian settings. *Harv Rev Psychiatry*. 2012;20:25.

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