chapter 3

THE BRAIN AND COGNITIVE DEVELOPMENT

chapter **outline**

1 The Brain

Learning Goal 1 Describe the developmental changes in the brain during adolescence

The Neuroconstructivist View
Neurons
Brain Structure, Cognition, and Emotion
Experience and Plasticity

2 The Cognitive Developmental View

Learning Goal 2 Discuss the cognitive developmental view of adolescence

Piaget's Theory
Vygotsky's Theory

3 The Information-Processing View

Learning Goal 3 Characterize the information-processing view of adolescence

Cognitive Resources
Attention and Memory
Executive Function

4 The Psychometric/ Intelligence View

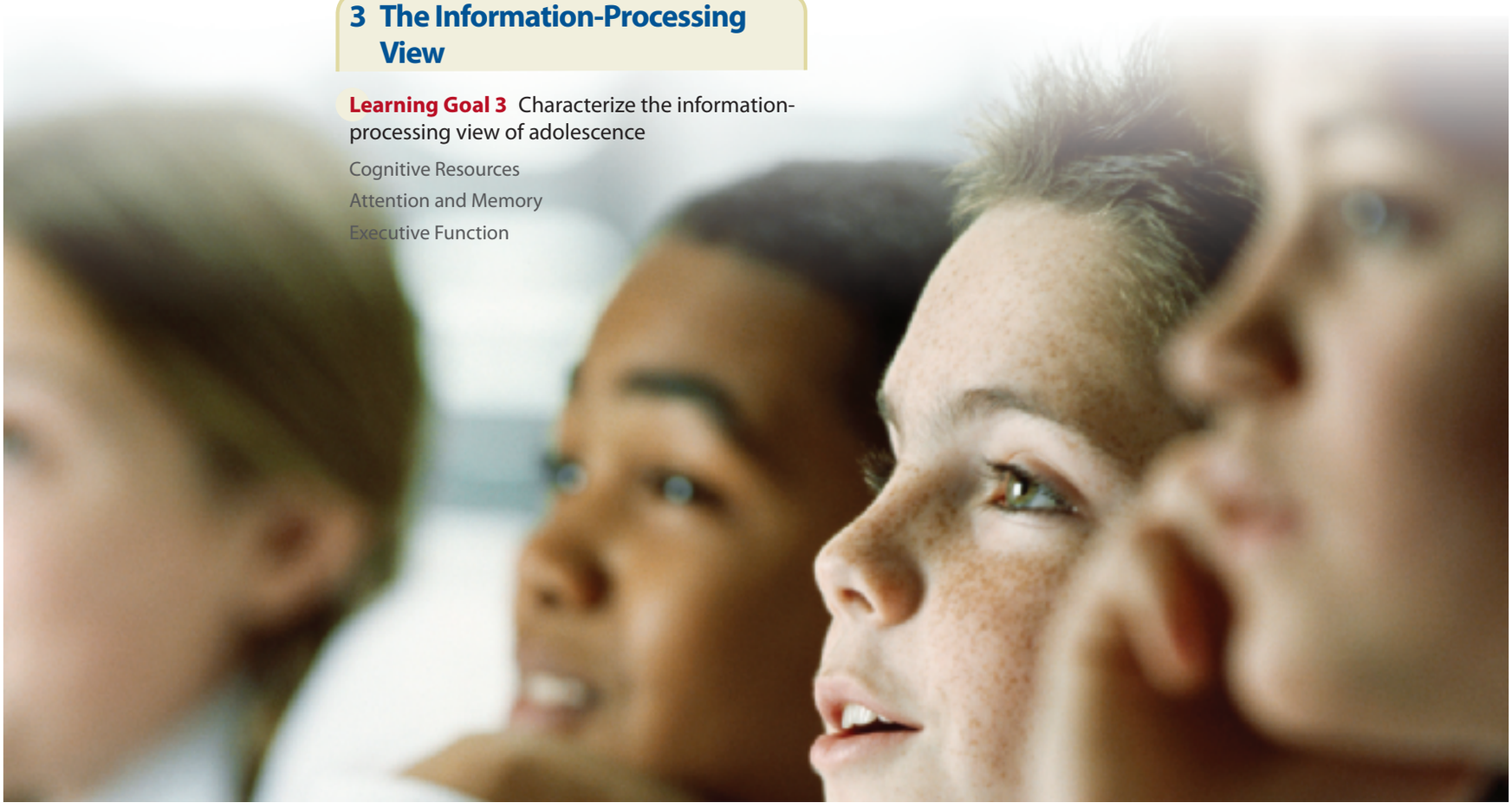
Learning Goal 4 Summarize the psychometric/ intelligence view of adolescence

Intelligence Tests
Multiple Intelligences
Heredity and Environment

5 Social Cognition

Learning Goal 5 Explain how social cognition is involved in adolescent development

Adolescent Egocentrism
Social Cognition in the Remainder of the Text



One of my most vivid memories of my oldest daughter, Tracy, involves something that happened when she was 12 years of age. I had accompanied her and her younger sister, Jennifer (10 at the time), to a tennis tournament. As we walked into a restaurant to have lunch, Tracy bolted for the restroom. Jennifer and I looked at each other, wondering what was wrong. Five minutes later Tracy emerged, looking calmer. I asked her what had happened. Her response: "This one hair was out of place and every person in here was looking at me!"

Consider another adolescent—Margaret. During a conversation with her girlfriend, 16-year-old Margaret said, "Did you hear about Catherine? She's pregnant. Do you think I would ever let that happen to me? Never."

Also think about 13-year-old Adam as he describes himself: "No one understands me, especially my parents. They have no idea of what I am feeling. They have never experienced the pain I'm going through."

Comments like Tracy's, Margaret's, and Adam's reflect the emergence of egocentric thought during adolescence. When we think about thinking, we usually consider it in terms of school subjects like math and English, or solutions to intellectual problems. But people's thoughts about social circumstances also are important. Later in the chapter we will further explore adolescents' social thoughts.

preview

When we think about adolescence, we often focus on the biological changes of puberty or socioemotional changes, such as the motivation for independence, relations with parents and peers, and problems such as drug abuse and delinquency. Further, when developmentalists have studied cognitive processes, their main focus has been on infants and young children, not on adolescents. However, you will see in this chapter that adolescents also display some impressive cognitive changes and that increasingly researchers are finding that these changes are linked to the development of the brain. Indeed, to begin this chapter, you will read about the explosion of interest in the changing adolescent brain and then study three different views of cognitive development: cognitive developmental, information processing, and psychometric. At the chapter's close you will study social cognition, including the emergence of adolescent egocentrism.

The Brain

LG1 Describe the developmental changes in the brain during adolescence

- The Neuroconstructivist View
- Neurons
- Brain Structure, Cognition, and Emotion
- Experience and Plasticity

The thoughts of youth are long, long thoughts.

—Henry Wadsworth Longfellow
American Poet, 19th Century

Until recently, little research had been conducted on developmental changes in the brain during adolescence. Although research in this area is still in its infancy, an increasing number of studies are under way (Reyna & others, 2012). Scientists now note that the adolescent's brain differs from the child's brain and that the brain continues to develop during adolescence (Blakemore & Mills, 2014; Casey, Jones, & Somerville, 2011).

The dogma of the unchanging brain has been discarded and researchers are mainly focused on context-induced plasticity of the brain over time (Zelazo, 2013). The development of the brain mainly changes in a bottom-up, top-down sequence with sensory, appetitive (eating, drinking), sexual, sensation-seeking, and risk-taking brain linkages maturing first and higher-level brain linkages such as self-control, planning, and reasoning maturing later (Zelazo, 2013). This extensive plasticity is further explored in the next section, which describes the neuroconstructivist view of brain development.

THE NEUROCONSTRUCTIVIST VIEW

Not long ago, scientists thought that our genes exclusively determine how our brains are "wired" and that the cells in the brain responsible for processing information just develop on their own with little or no input from environmental experiences. In that view, whatever brain your genes have provided to you, you are essentially stuck with it. This view, however, turned out to be wrong. Instead, it is clear that the brain has plasticity and its development depends on context (Diamond, 2013; Nelson, 2012; Westerman, Thomas, & Karmiloff-Smith, 2011; Peltzer-Karpf, 2012).

The brain depends on experiences to determine how connections are made (Markant & Thomas, 2013; Zelazo, 2013). Before birth, it appears that genes mainly direct basic wiring patterns in the formation of the brain. Neurons grow and travel to distant places awaiting further instructions (Nelson, 2012). After birth, the inflowing stream of sights, sounds, smells, touches, language, and eye contact help shape the brain's neural connections. Throughout the human life span, experiences continue to influence the functioning of the brain (Nudo & McNeal, 2013; Sharma, Classen, & Cohen, 2013).

In the increasingly popular **neuroconstructivist view,** (a) biological processes (genes, for example) and environmental experiences (enriched or impoverished, for example) influence the brain's development; (b) the brain has plasticity and is context dependent; and (c) development of the brain is linked closely with cognitive development. These factors constrain or advance the construction of cognitive skills (Westermann, Thomas, & Karmiloff-Smith, 2011). The neuroconstructivist view emphasizes the importance of interactions between experiences and gene expression in the brain's development, much as the epigenetic view proposes (see Chapter 2).

NEURONS

Neurons, or nerve cells, are the nervous system's basic units. A neuron has three basic parts: the cell body, dendrites, and axon (see Figure 3.1). The dendrite is the receiving part of the neuron, and the axon carries information away from the cell body to other cells. Through a process called **myelination,** the axon portion of a neuron becomes covered and insulated with a layer of fat cells (called the myelin sheath), increasing the speed and efficiency of information processing in the nervous system (Buttermore, Thaxton, & Bhat, 2013). Myelination continues during adolescence and emerging adulthood (Giedd, 2012).

In the language of neuroscience, the term *white matter* is used to describe the whitish color of myelinated axons, and the term *gray matter* refers primarily to dendrites and the cell body of the neuron (see Figure 3.2). A significant developmental change in adolescence is the increase in white matter and the decrease in gray matter in the prefrontal cortex (Giedd, 2012; Ladouceur & others, 2012; Markant, & Thomas, 2013; Yap & others, 2013). Most accounts emphasize that the increase in white matter across adolescence is due to increased myelination, although a recent analysis proposed that the white matter increase also might be due to an increase in the diameter of axons (Paus, 2010).

In addition to the encasement of axons through myelination, another important aspect of the brain's development is the dramatic increase in connections between neurons, a process that is called synaptogenesis (Emes & Grant, 2013). **Synapses** are gaps between neurons, where connections between the axon and dendrites take place. Synaptogenesis begins in infancy and continues through adolescence.

Researchers have discovered that nearly twice as many synaptic connections are made than will ever be used (Huttenlocher & Dabholkar, 1997). The connections that are used are strengthened and survive, while the unused ones are replaced by other pathways or disappear altogether (Campbell & others, 2012). That is, in the language of neuroscience, these connections will be

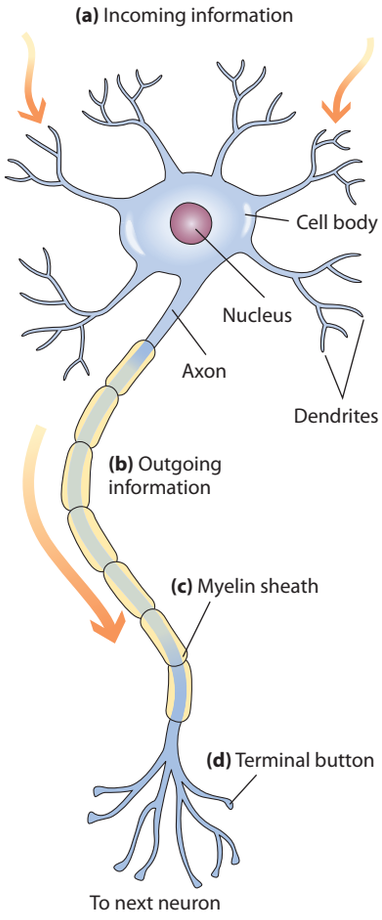


FIGURE **3.1**

THE NEURON. (a) The dendrites of the cell body receive information from other neurons, muscles, or glands. (b) An axon transmits information away from the cell body. (c) A myelin sheath covers most axons and speeds information transmission. (d) As the axon ends, it branches out into terminal buttons.

neuroconstructivist view Developmental perspective in which biological processes and environmental conditions influence the brain's development; the brain has plasticity and is context dependent; and cognitive development is closely linked with brain development.

neurons Nerve cells, which are the nervous system's basic units.

myelination The process by which the axon portion of the neuron becomes covered and insulated with a layer of fat cells, which increases the speed and efficiency of information processing in the nervous system.

synapses Gaps between neurons, where connections between the axon and dendrites occur.

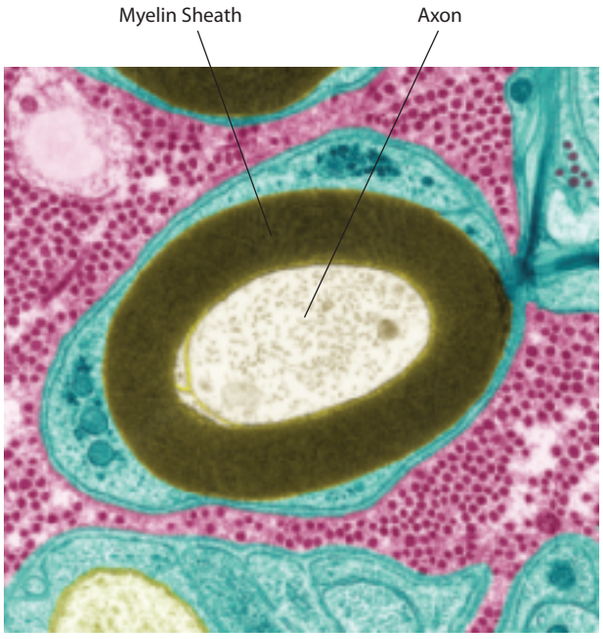


FIGURE **3.2**

A MYELINATED NERVE FIBER. The myelin sheath, shown in brown, encases the axon (white). This image was produced by an electron microscope that magnified the nerve fiber 12,000 times. *What role does myelination play in the brain's development?*

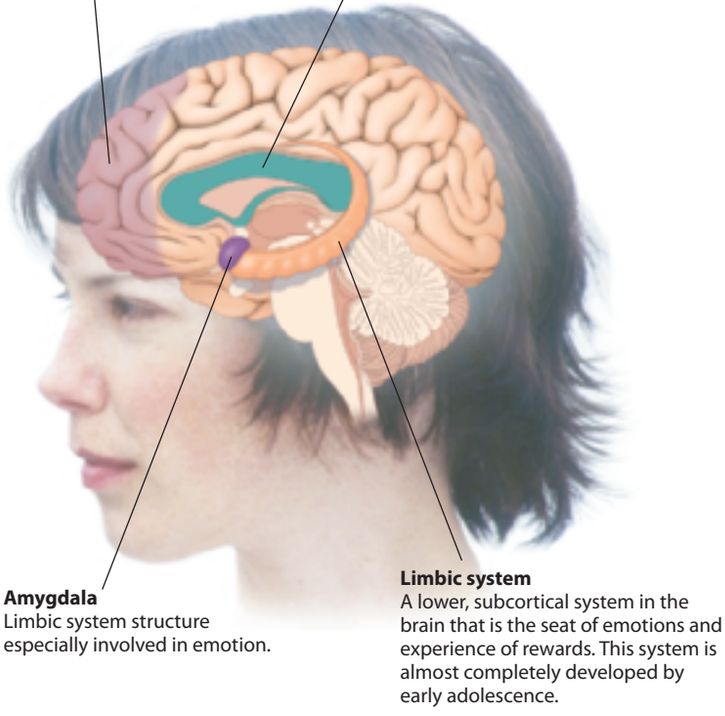


FIGURE **3.3**

THE PREFRONTAL CORTEX, LIMBIC SYSTEM, AMYGDALA, AND CORPUS CALLOSUM

"pruned." What results from this pruning is that by the end of adolescence individuals have "fewer, more selective, more effective neuronal connections than they did as children" (Kuhn, 2009, p. 153). And this pruning indicates that the activities adolescents choose to engage in and not to engage in influence which neural connections will be strengthened and which will disappear.

With the onset of puberty, the levels of *neurotransmitters*—chemicals that carry information across the synaptic gap between one neuron and the next—change (McEwen, 2013). For example, an increase in the neurotransmitter dopamine occurs in both the prefrontal cortex and the limbic system during adolescence (Ernst & Spear, 2009). Increases in dopamine have been linked to increased risk taking and the use of addictive drugs (Wahlstrom & others, 2010). Researchers have found that dopamine plays an important role in reward seeking (Doremus-Fitzwater, Varlinskaya, & Spear, 2010).

BRAIN STRUCTURE, COGNITION, AND EMOTION

Neurons do not simply float in the brain. Connected in precise ways, they form the various structures in the brain. The brain is hierarchically organized and mainly develops from the bottom up, with sensory areas reaching full maturity before the higher-level association areas of the prefrontal cortex.

Using functional magnetic resonance imaging (fMRI) to scan the brain, scientists have recently discovered that adolescents' brains undergo significant structural changes (Blakemore & Mills, 2014; Blakemore & Robbins, 2012; Byrnes, 2012; Forbes & Dahl, 2012; Giedd & others, 2012; Pokhrel & others, 2013). An fMRI creates a magnetic field around a person's body and bombards the brain with radio waves. The result is a computerized image of the brain's tissues and biochemical activities.

Among the most important structural changes in the brain during adolescence are those involving the corpus callosum, the prefrontal cortex, the limbic system, and the amygdala. The **corpus callosum,** a large bundle of axon fibers that connects the brain's left and right hemispheres, thickens in adolescence, and this thickening improves adolescents' ability to process information (Giedd, 2008). Advances in the development of the **prefrontal cortex**—the highest level of the frontal lobes that is involved in reasoning, decision making, and self-control—continue through the emerging adult years, approximately 18 to 25 years of age (Blakemore & Mills, 2014). However, at a lower, subcortical level, the **limbic system,** which is the seat of emotions and where rewards are experienced, matures much earlier than the prefrontal cortex and is almost completely developed by early adolescence (Blakemore & Mills, 2014). The limbic system structure that is especially involved in emotion is the **amygdala.** Figure 3.3 shows the locations of the corpus callosum, prefrontal cortex, the limbic system, and the amygdala.

In late adolescence and emerging adulthood, the increase in myelination allows greater connectivity and integration of brain regions (Giedd & others, 2012). For example, the important connections between the prefrontal cortex and limbic system strengthen in late adolescence and emerging adulthood (Steinberg, 2012, 2013). This strengthening is especially important for emotional control.

Leading researcher Charles Nelson (2003) points out that although adolescents are capable of very strong emotions, their prefrontal cortex hasn't adequately developed to the point at which they can control these passions. It is as if the prefrontal cortex doesn't yet have the brakes to slow down the limbic system's emotional intensity and reward focus. Another researcher describes adolescence as a period that combines

"early activation of strong 'turbo-charged' feelings with a relatively un-skilled set of 'driving skills' or cognitive abilities to modulate strong emotions and motivations" (Dahl, 2004, p. 18).

Recall from the earlier discussion of neurotransmitters that dopamine production increases in early adolescence, which produces increased reward seeking and risk taking. Dopamine activity is greater in the limbic system pathways in early adolescence than at any other point in development (Steinberg, 2012). In recent research conducted by Laurence Steinberg and his colleagues (Albert & Steinberg, 2011a, b; Steinberg, 2010, 2011, 2012, 2013; Steinberg & others, 2008, 2009), preference for immediate rewards (assessed in such contexts as a gambling task and a video driving game) increased from 14 to 16 years of age and then declined. Also, in Steinberg's (2010, 2011, 2012, 2013) research, adolescents' belief that the benefits of risk taking override its potential negative outcomes peaks at about 14 to 16 years of age. By contrast, impulse control increases in a linear fashion from preadolescence to emerging adulthood.

The increase in risk taking in adolescence is usually thought to result in negative outcomes. However, there are some aspects of risk taking that benefit adolescents. Being open to new experiences and challenges, even risky ones, can help adolescents to stretch themselves to learn about aspects of the world they would not have encountered if they had shied away from such exploration (Allen & Allen, 2009). Later in the chapter, we will revisit the issue of risk taking in the context of adolescents' sense of invulnerability and recent research that distinguishes between different types of vulnerability (Lapsley & Hill, 2010; Lapsley & Stey, 2012).

A topic of some controversy involves which comes first—biological changes in the brain or experiences that stimulate these changes (Lerner, Boyd, & Du, 2008). Consider a study in which the prefrontal cortex thickened and more brain connections formed when adolescents resisted peer pressure (Paus & others, 2007). A recent study also found that adolescents from Mexican backgrounds with greater family obligation values showed decreased activation in the brain's regions (ventral striatum) involving reward sensitivity, which was linked to less real-life risk-taking behavior, and increased activation in the brain's regions (prefrontal cortex) involving cognitive control, which was associated with better decision-making skills (Telzer & others, 2013).

Scientists have yet to determine whether the brain changes come first or whether the brain changes are caused by experiences with peers, parents, and others. Once again, we encounter the nature-nurture issue that is so prominent in examining development through the life span. Nonetheless, there is adequate evidence that environmental experiences make important contributions to the brain's development (Zelazo, 2013).

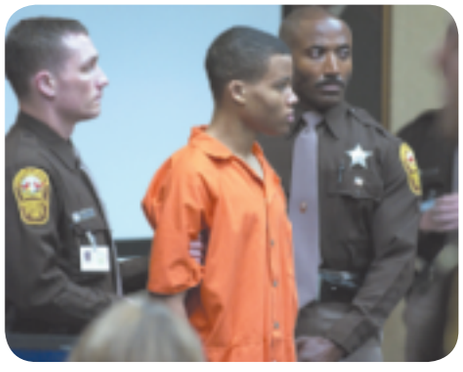
According to leading expert Jay Giedd (2007, pp. 1–2D), "Biology doesn't make teens rebellious or have purple hair or take drugs. It does not mean you are going to do drugs, but it gives you more of a chance to do that."

Does our increased understanding of changes in the adolescent brain have implications for the legal system? For example, can the recent brain research we have just discussed be used to argue that because the adolescent's brain, especially the higher-level prefrontal cortex, is still developing, adolescents are less mature than adults and therefore should not receive the death penalty for acts of violence? Leading expert Elizabeth Sowell (2004) points out that scientists can't do brain scans on adolescents to determine whether they should be tried as adults. In 2005, giving the death penalty to adolescents (under the age of 18) was prohibited by the U.S. Supreme Court, but the topic continues to be debated (Steinberg, 2012).

developmental **connection**

Brain Development

Developmental social neuroscience is a recently developed field that focuses on connections between development, socioemotional factors, and neuroscience. Chapter 1, p. 15



Malvo was 17 years old when he and John Muhammad, an adult, went on a sniper spree in 2002, terrorizing the Washington, D.C., area and killing 10 people. A 2005 U.S. Supreme Court ruling stated that individuals who are 18 years of age and under, like Malvo, cannot be given the death penalty. *Do scientific findings about the adolescent's brain have implications for legal decisions such as the death penalty?*

EXPERIENCE AND PLASTICITY

Scientists are especially interested in the extent to which environmental experiences influence the brain's development. They also want to know how much plasticity the brain retains as individuals progress through childhood, adolescence, and adulthood (Diamond, 2013; Giedd, 2012; Nudo & McNeal, 2013). A recent analysis indicated that early adolescence is a time of considerable plasticity in the brain (Gogtay & Thompson, 2010). Let's examine three questions involving the roles of experience and plasticity in the development of the brain in adolescence:

- *Can new brain cells be generated in adolescence?* Until close to the end of the twentieth century, scientists argued that the brain generated no new cells (neurons) after the early childhood years. However, researchers have recently discovered that people can generate

corpus callosum A large bundle of axon fibers that connect the brain's left and right hemispheres.

prefrontal cortex The highest level of the brain's frontal lobes that is involved in reasoning, decision making, and self-control.

limbic system A lower, subcortical system in the brain that is the seat of emotions and experience of rewards.

amygdala A portion of the brain's limbic system that is the seat of emotions such as anger.

What do we know about brain development that could lead to changes in adolescents' education?

new brain cells throughout their lives (Berry & others, 2012). Currently, researchers have documented neurogenesis in only two brain regions, the hippocampus, which is involved in memory, and the olfactory bulb, which functions in smell (Xu & others, 2012). It also is not known what functions these new brain cells perform, and at this point researchers have documented that they last only several weeks. Researchers currently are studying factors that might inhibit and promote neurogenesis, including various drugs, stress, exercise, and cognitive fitness (Dranovsky & Leonardo, 2012; Shors & others, 2012). And they are exploring how the grafting of neural stem cells to various regions of the brain, such as the hippocampus, might increase neurogenesis (Decimo & others, 2012).

- *Can the adolescent's brain recover from injury?* In childhood and adolescence, the brain has a remarkable ability to repair itself (Nelson, 2012). In Chapter 1, you read about Michael Rehbein, whose left hemisphere was removed because of brain seizures. The plasticity of the human brain was apparent as his right hemisphere reorganized itself to take over functions that normally take place in the left hemisphere, such as speech. The brain retains considerable plasticity in adolescence, and the earlier a brain injury occurs, the higher the likelihood of a successful recovery (Yen & Wong, 2007).
- *What do we know about applying information about brain development to adolescents' education?* Unfortunately, too often statements about the implications of brain science for secondary education are speculative and far removed from what neuroscientists know about the brain (Blakemore, 2010; Bradshaw & others, 2012; Fischer & Immordino-Yang, 2008). We don't have to look any further than the hype about "left-brained" individuals being more logical and "right-brained" individuals being more creative to see that links between neuroscience and brain education are incorrectly made.

Another commonly promoted link between neuroscience and brain education is the assertion that most of the key changes in the brain occur prior to adolescence (Fischer & Immordino-Yang, 2008). However, recent research on the plasticity of the adolescent's brain and the continuing development of the prefrontal cortex through adolescence support the view that education can benefit adolescents considerably (Blakemore & Mills, 2014; Giedd, 2012). In this regard, higher-level cognitive functioning, especially in managing one's thoughts, engaging in goal-directed behavior and controlling emotions, as discussed later in this chapter, are especially important potential areas of change in adolescence (Bradshaw & others, 2012).

In closing this section on the development of the brain in adolescence a caution is in order. Much of the research on neuroscience and the development of the brain in adolescence is correlational in nature, and thus causal statements need to be scrutinized.

Review *Connect* Reflect

LG1 Describe the developmental changes in the brain during adolescence

Review

- What characterizes the neuroconstructivist view?
- What are neurons? How do the brain's neurons change in adolescence?
- What changes involving brain structure, cognition, and emotion occur in adolescence?
- How much plasticity does the brain have in adolescence?

Connect

- Relate the structural changes in the brain that occur during adolescence to the psychological dimensions of puberty discussed in Chapter 2.

Reflect *Your Own Personal Journey of Life*

- Evaluate your lifestyle in terms of factors such as your exercise, eating habits, whether you get adequate sleep, and how much you challenge yourself to learn and achieve. Considering what you have learned about the brain's plasticity, what are some implications for your lifestyle's influence on the development of your brain in adolescence and emerging adulthood?

The Cognitive Developmental View

LG2 Discuss the cognitive developmental view of adolescence

Piaget's Theory

Vygotsky's Theory

The process of brain development that we have just discussed provides a biological foundation for the cognitive changes that characterize adolescence. Reflect for a moment about your thinking skills as a young adolescent. Were your thinking skills as good then as they are now? Could you solve difficult abstract problems and reason logically about complex topics? Or did those skills improve during your high school years? Can you describe any ways in which your thinking skills are better now than they were in high school?

In Chapter 1, we briefly examined Jean Piaget's theory of cognitive development. Piaget was intrigued by the changes in thinking that take place during childhood and adolescence. In this section, we further explore his ideas about adolescent cognition, as well as the increasingly popular sociocultural cognitive theory of Lev Vygotsky.

Jean Piaget, the main architect of the field of cognitive development, at age 27.

PIAGET'S THEORY

We begin our coverage of Piaget's theory by describing the main processes he viewed as responsible for cognitive changes throughout the life span. Then we examine each of his cognitive stages, giving special attention to concrete operational and formal operational thought.

Cognitive Processes Piaget's theory is the best-known, most widely discussed theory of adolescent cognitive development. According to his theory, adolescents are motivated to understand their world because doing so is biologically adaptive. Adolescents actively construct their own cognitive worlds; information doesn't just pour into their minds from the environment. To make sense of the world, adolescents organize their experiences, separating important ideas from less important ones and connecting one idea to another. They also adapt their thinking to include new ideas because the additional information furthers their understanding.

In actively constructing their world, adolescents use schemas. A **schema** is a mental concept or framework that is useful in organizing and interpreting information. Piaget was especially interested in how children and adolescents use schemas to organize and make sense out of their current experiences.

Piaget (1952) found that children and adolescents use and adapt their schemas through two processes: assimilation and accommodation. **Assimilation** is the incorporation of new information into existing knowledge. In assimilation, the schema does not change. **Accommodation** is the adjustment of a schema to new information. In accommodation, the schema changes.

Suppose, for example, that a 13-year-old girl wants to learn how to use a new smartphone her parents have given her for her birthday. Although she has never had the opportunity to use one, from her experience and observation she realizes that she needs to press a button to turn on the phone. This behavior fit into an existing conceptual framework (assimilation). Once the phone is activated, she presses an icon on the screen but it doesn't take her to the screen she wants. She also wants to add an application but can't figure out how to do that. Soon she realizes that she needs help in learning how to use the smartphone—either by studying the instructions further or getting help from a friend who has experience using this type of phone. This adjustment in her approach shows her awareness of the need to alter her conceptual framework (accommodation).

Equilibration, another process Piaget identified, is a shift in thought from one state to another. At times adolescents experience cognitive conflict or a sense of disequilibrium in their attempt to understand the world. Eventually they resolve the conflict and reach a balance, or equilibrium, of thought. Piaget maintained that individuals move back and forth between states of cognitive equilibrium and disequilibrium.

We are born capable of learning.

—Jean-Jacques Rousseau
Swiss-Born French Philosopher, 18th Century

schema A mental concept or framework that is useful in organizing and interpreting information.

assimilation The incorporation of new information into existing knowledge.

accommodation An adjustment of a schema to new information.

equilibration A mechanism in Piaget's theory that explains how individuals shift from one state of thought to the next. The shift occurs as individuals experience cognitive conflict or a disequilibrium in trying to understand the world. Eventually, the individual resolves the conflict and reaches a balance, or equilibrium, of thought.

Sensorimotor Stage

Infants gain knowledge of the world from the physical actions they perform on it. Infants coordinate sensory experiences with these physical actions. An infant progresses from reflexive, instinctual action at birth to the beginning of symbolic thought toward the end of the stage.

Birth to 2 Years of Age

Preoperational Stage

The child begins to use mental representations to understand the world. Symbolic thinking, reflected in the use of words and images, is used in this mental representation, which goes beyond the connection of sensory information with physical action. However, there are some constraints on the child's thinking at this stage, such as egocentrism and centration.

2 to 7 Years of Age

Concrete Operational Stage

The child can now reason logically about concrete events, understands the concept of conservation, organizes objects into hierarchical classes (classification), and places objects in ordered series (seriation).

7 to 11 Years of Age

Formal Operational Stage

The adolescent reasons in more abstract, idealistic, and logical (hypothetical-deductive) ways.

11 Years of Age Through Adulthood

FIGURE **3.4**

PIAGET'S FOUR STAGES OF COGNITIVE DEVELOPMENT

Stages of Cognitive Development Piaget theorized that individuals develop through four cognitive stages: sensorimotor, preoperational, concrete operational, and formal operational (see Figure 3.4). Each of these age-related stages consists of distinct ways of thinking. This *different* way of understanding the world is what makes one stage more advanced than another; simply knowing more information does not make an adolescent's thinking more advanced. Thus, in Piaget's theory, a person's cognition is *qualitatively* different in one stage compared with another.

Sensorimotor and Preoperational Thought The **sensorimotor stage,** which lasts from birth to about 2 years of age, is the first Piagetian stage. In this stage, infants construct an understanding of the world by coordinating sensory experiences (such as seeing and hearing) with physical, motoric actions—hence the term *sensorimotor.*

The **preoperational stage,** which lasts approximately from 2 to 7 years of age, is the second Piagetian stage. In this stage, children begin to represent the world with words, images, and drawings. Symbolic thought goes beyond simple connections of information and action.

Concrete Operational Thought The **concrete operational stage,** which lasts approximately from 7 to 11 years of age, is the third Piagetian stage. Logical reasoning replaces intuitive thought as long as the reasoning can be applied to specific or concrete examples. According to Piaget, concrete operational thought involves operations—mental actions that allow individuals to do mentally what earlier they did physically.

Piaget used the term *conservation* to refer to an individual's ability to recognize that the length, number, mass, quantity, area, weight, and volume of objects and substances does not change through transformations that alter their appearance. Concrete operational thinkers have conservation skills; preoperational thinkers don't.

sensorimotor stage Piaget's first stage of development, lasting from birth to about 2 years of age. In this stage, infants construct an understanding of the world by coordinating sensory experiences with physical, motoric actions.

preoperational stage Piaget's second stage, which lasts approximately from 2 to 7 years of age. In this stage, children begin to represent their world with words, images, and drawings.

concrete operational stage Piaget's third stage, which lasts approximately from 7 to 11 years of age. In this stage, children can perform operations. Logical reasoning replaces intuitive thought as long as the reasoning can be applied to specific or concrete examples.

Another characteristic of concrete operational thought is *classification*, or class inclusion reasoning. Children who engage in classification can systematically organize objects into hierarchies of classes and subclasses.

Although concrete operational thought is more advanced than preoperational thought, it has limitations. Logical reasoning replaces intuitive thought as long as the principles can be applied to specific, *concrete* examples. For example, the concrete operational child cannot imagine the steps necessary to complete an algebraic equation, an abstract statement with no connection to the concrete world.

"Ben is in his first year of high school, and he's questioning all the right things."

Formal Operational Thought The **formal operational stage** is Piaget's fourth and final stage of cognitive development. Piaget argued that this stage emerges at 11 to 15 years of age. Adolescents' developing power of thought opens up new cognitive and social horizons. What are the characteristics of formal operational thought? Most significantly, formal operational thought is more abstract than concrete operational thought. Adolescents are no longer limited to actual, concrete experiences as anchors for thought. They can conjure up make-believe situations—events that are purely hypothetical possibilities or strictly abstract propositions—and try to reason logically about them.

The abstract quality of the adolescent's thought at the formal operational level is evident in the adolescent's verbal problem-solving ability. Whereas the concrete operational thinker would need to see the concrete elements A, B, and C to be able to make the logical inference that if A = B and B = C, then A = C, the formal operational thinker can solve this problem merely through verbal representation.

Another indication of the abstract quality of adolescents' thought is their increased tendency to think about thought itself. As one adolescent commented, "I began thinking about why I was thinking what I was. Then I began thinking about why I was thinking about why I was thinking about what I was." If this statement sounds abstract, it is, and it characterizes the adolescent's enhanced focus on thought and its abstract qualities. Later in this chapter, we return to the topic of thinking about thinking, which is called *metacognition*.

Might adolescents' ability to reason hypothetically and to evaluate what is ideal versus what is real lead them to engage in demonstrations, such as this protest related to better ethnic relations? What other causes might be attractive to adolescents' newfound cognitive abilities of hypothetical-deductive reasoning and idealistic thinking?

Besides being abstract, formal operational thought is full of idealism and possibilities. Whereas children frequently think in concrete ways about what is real and limited, adolescents begin to engage in extended speculation about ideal characteristics—qualities they desire in themselves and others. Such thoughts often lead adolescents to compare themselves and others in regard to such ideal standards. And, during adolescence, the thoughts of individuals are often fantasy flights into future possibilities. It is not unusual for adolescents to become impatient with these newfound ideal standards and perplexed over which of many ideals to adopt.

At the same time that adolescents think more abstractly and idealistically, they also think more logically. Adolescents begin to reason more as a scientist does, devising ways to solve problems and test solutions systematically. Piaget gave this type of problem solving an imposing name, **hypothetical-deductive reasoning**—that is, the ability to develop hypotheses, or best guesses, about how to solve problems, such as algebraic equations. Having developed a hypothesis, the formal operational thinker then systematically deduces, or concludes, the best path to follow in solving the problem. In contrast, children are more likely to solve problems by trial and error.

Piaget maintained that formal operational thought is the best description of how adolescents think. Formal operational thought is not a homogeneous stage of development, however. Not all adolescents are full-fledged formal operational thinkers. Instead, some developmentalists argue that the stage of formal operational thought consists of two subperiods (Broughton, 1983):

- *Early formal operational thought*. Adolescents' newfound ability to think in hypothetical ways produces unconstrained thoughts with unlimited possibilities. In this early period, flights of fantasy may submerge reality and the world is perceived subjectively and idealistically. Assimilation is the dominant process in this subperiod.

formal operational stage Piaget's fourth and final stage of cognitive development, which he argued emerges at 11 to 15 years of age. It is characterized by abstract, idealistic, and logical thought.

hypothetical-deductive reasoning Piaget's term for adolescents' ability, in the formal operational stage, to develop hypotheses, or best guesses, about ways to solve problems; they then systematically deduce, or conclude, the best path to follow in solving the problem.

- *Late formal operational thought*. As adolescents test their reasoning against experience, intellectual balance is restored. Through accommodation, adolescents begin to adjust to the upheaval they have experienced. Late formal thought may appear in the middle adolescent years.

In this two-subperiod view, assimilation characterizes early formal operational thought; accommodation characterizes late formal operational thought (Lapsley, 1990).

In his early writings, Piaget (1952) indicated that both the onset and consolidation of formal operational thought are completed during early adolescence, from about 11 to 15 years of age. Later, Piaget (1972) revised his view and concluded that formal operational thought is not completely achieved until later in adolescence, between approximately 15 and 20 years of age.

Still, his theory does not adequately account for the individual differences that characterize the cognitive development of adolescents, which have been documented in a number of investigations (Kuhn, 2009). Some young adolescents are formal operational thinkers; others are not. For instance, a review of investigations about formal operational thought revealed that only about one of every three eighth-grade students is a formal operational thinker (Strahan, 1983). Some investigators have found that formal operational thought increased with age in adolescence; others have not found this result. In fact, many college students and adults do not think in formal operational ways. Investigators have found that from 17 to 67 percent of college students think on the formal operational level (Elkind, 1961; Tomlinson-Keasey, 1972).

At the same time that many young adolescents are just beginning to think in a formal operational manner, others are at the point of consolidating their concrete operational thought, using it more consistently than they did in childhood. By late adolescence, many youth are beginning to consolidate their formal operational thought, using it more consistently. And there often is variation across the content areas of formal operational thought, just as there is in concrete operational thought in childhood. A 14-year-old adolescent might reason at the formal operational level when analyzing algebraic equations but not when solving verbal problems or when reasoning about interpersonal relations.

Evaluating Piaget's Theory What were Piaget's main contributions? Has his theory withstood the test of time? In this section, we examine both Piaget's contributions and the criticisms of his work.

Contributions Piaget has been a giant in the field of developmental psychology. We owe to him the present field of cognitive development as well as a long list of masterful concepts of enduring power and fascination, including assimilation, accommodation, conservation, and hypothetical-deductive reasoning, among others. We also owe to Piaget the current vision of children as active, constructive thinkers (Miller, 2011).

Piaget was a genius when it came to observing children. His careful observations documented inventive new ways to discover how children act on and adapt to their world. Piaget showed us some important things to look for in cognitive development, such as the shift from preoperational to concrete operational thinking. He also pointed out that children need to make their experiences fit their schemas, or cognitive frameworks, yet they can simultaneously adapt their schemas based on information gained through experience. He also revealed that cognitive change is likely to occur if the context is structured to allow gradual movement to the next higher level. We owe to Piaget the current belief that a concept does not emerge suddenly, full blown, but develops instead through a series of partial accomplishments that lead to an increasingly comprehensive understanding.

Criticisms Piaget's theory has not gone unchallenged (Miller, 2011). Questions are raised about the timing and nature of his stage view of cognitive development, whether he failed to adequately study in detail key cognitive processes, and the effects of culture on cognitive development. Let's consider each of these criticisms in turn.

In terms of timing and stages, some cognitive abilities have been found to emerge earlier than Piaget had thought (Diamond, 2013; Johnson, 2013). For example, conservation of number (which Piaget said emerged at approximately 7 years of age in the concrete operational stage) has been demonstrated as early as age 3 (which instead is early in his preoperational stage). Other cognitive abilities often emerge later than Piaget indicated (Byrnes, 2012). Many

adolescents still think in concrete operational ways or are just beginning to master formal operations. Even as adults, many individuals are not formal operational thinkers. The evidence does not support Piaget's view that prior to age 11 children don't engage in abstract thinking and that from 11 years onward they do (Kuhn, 2009). Thus, adolescents' cognitive development is not as stage-like as Piaget envisioned (Siegler, 2012, 2013).

One group of cognitive developmentalists, the **neo-Piagetians,** conclude that Piaget's theory does not adequately focus on attention, memory, and cognitive strategies that adolescents use to process information, and that Piaget's explanations of cognitive changes are too general. They especially maintain that a more accurate vision of children's and adolescents' thinking requires more knowledge of the strategies they use, how fast and automatically they process information, the particular cognitive tasks involved in processing information, and the division of cognitive problems into smaller, more precise steps.

The leading proponent of the neo-Piagetian view has been Canadian developmental psychologist Robbie Case (1992, 2000). Case accepts Piaget's four stages of cognitive development but emphasizes that a more precise description of changes within each stage is needed. He notes that children's and adolescents' growing ability to process information efficiently is linked to their brain growth and memory development. In particular, Case cites the increasing ability to hold information in working memory (a workbench for memory similar to short-term memory) and to manipulate it more effectively as critical to understanding cognitive development.

An outstanding teacher and education in the logic of science and mathematics are important cultural experiences that promote the development of operational thought. *Might Piaget have underestimated the roles of culture and schooling in children's cognitive development?*

Finally, culture and education exert stronger influences on development than Piaget envisioned (Gauvain, 2013). For example, the age at which individuals acquire conservation skills is associated to some extent with the degree to which their culture provides relevant educational practice (Cole, 2006). In many developing countries, educational opportunities are limited and formal operational thought is rare. You will read shortly about Lev Vygotsky's theory of cognitive development, in which culture is given a more prominent role than in Piaget's theory.

Cognitive Changes in Adulthood As we discussed earlier, according to Piaget adults and adolescents use the same type of reasoning. Adolescents and adults think in qualitatively the same way. Piaget did acknowledge that adults can be quantitatively more advanced in their knowledge. What are some ways that adults might be more advanced in their thinking than adolescents?

Realistic and Pragmatic Thinking Some developmentalists have proposed that as young adults move into the world of work, their way of thinking does change. One idea is that as they face the constraints of reality, which work promotes, their idealism decreases (Labouvie-Vief, 1986).

Reflective and Relativistic Thinking William Perry (1970, 1999) also described changes in cognition that take place in early adulthood. He said that adolescents often view the world in terms of polarities—right/wrong, we/they, or good/bad. As youth age into adulthood, they gradually move away from this type of absolutist thinking as they become aware of the diverse opinions and multiple perspectives of others. Thus, in Perry's view, the absolutist, dualistic thinking of adolescence gives way to the reflective, relativistic thinking of adulthood.

Expanding on Perry's view, Gisela Labouvie-Vief (2006) recently proposed that the increasing complexity of cultures in the past century has generated a greater need for more reflective, complex thinking that takes into account the changing nature of knowledge and challenges. She also emphasizes that the key aspects of cognitive development in emerging adulthood include deciding on a specific worldview, recognizing that the worldview is subjective, and understanding that diverse worldviews should be acknowledged. In her perspective,

neo-Piagetians Theorists who argue that Piaget got some things right but that his theory needs considerable revision. In their revision, they give more emphasis to information processing that involves attention, memory, and strategies; they also seek to provide more precise explanations of cognitive changes.

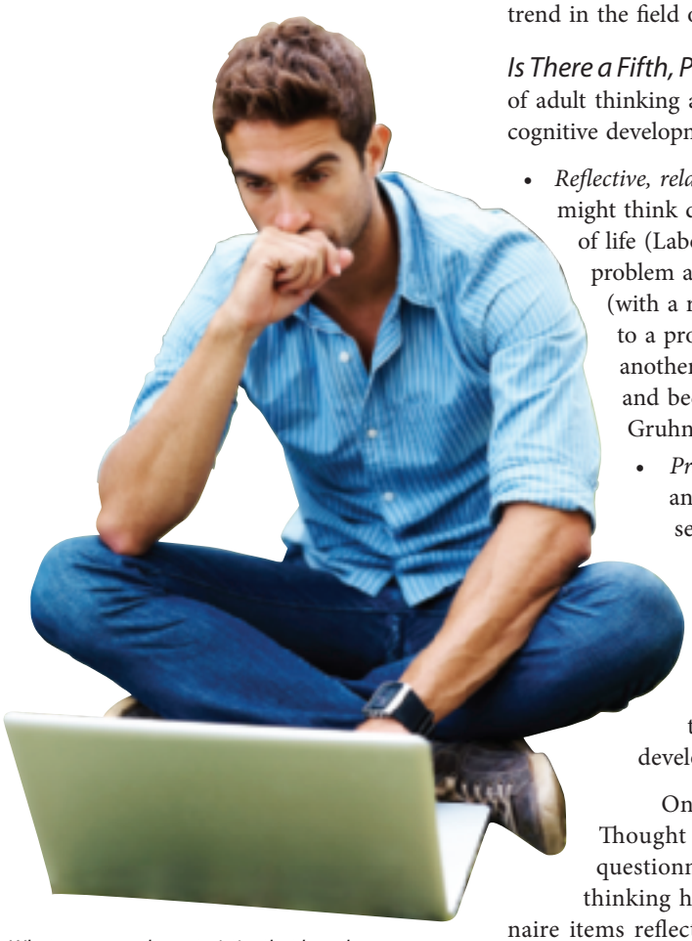
developmental **connection**

Emotion

Emotional fluctuations in early adolescence may be linked to hormone levels. As adolescents move into adulthood, their emotions become less extreme. Chapter 2, p. 60, Chapter 4, p. 157

considerable individual variation characterizes the thinking of emerging adults, with the highest level of thinking attained only by some. She argues that the level of education emerging adults achieve especially influences how likely they are to maximize their cognitive potential.

Cognition and Emotion Labouvie-Vief and her colleagues (Labouvie-Vief, 2009; Labouvie-Vief, Gruhn, & Studer, 2010) also argue that to understand cognitive changes in adulthood it is necessary to consider how emotional maturity might affect cognitive development. They conclude that although emerging and young adults become more aware that emotions influence their thinking, at this point thinking is often swayed too strongly by negative emotions that can produce distorted and self-serving perspectives. In this research, a subset of emerging adults who are high in empathy, flexibility, and autonomy are more likely to engage in complex, integrated cognitive-emotional thinking. Labouvie-Vief and her colleagues have found that the ability to think in this cognitively and emotionally balanced, advanced manner increases in middle adulthood. Further, they emphasize that in middle age, individuals become more inwardly reflective and less context-dependent in their thinking than they were as young adults. In the work of Labouvie-Vief and her colleagues, we see the effort to discover connections between cognitive and socioemotional development, which was described as an increasing trend in the field of life-span development in Chapter 1.



What are some characteristics that have been proposed for a fifth stage of cognitive development called postformal thought?

Is There a Fifth, Postformal Stage? Some theorists have pieced together these descriptions of adult thinking and have proposed that young adults move into a new qualitative stage of cognitive development, postformal thought (Sinnott, 2003). **Postformal thought** is:

- *Reflective, relativistic, and contextual.* As young adults engage in solving problems, they might think deeply about many aspects of work, politics, relationships, and other areas of life (Labouvie-Vief, 1986). They find that what might be the best solution to a problem at work (with a boss or co-worker) might not be the best solution at home (with a romantic partner). Thus, postformal thought holds that the correct answer to a problem requires reflective thinking and may vary from one situation to another. Some psychologists argue that reflective thinking continues to increase and becomes more internal and less contextual in middle age (Labouvie-Vief, Gruhn, & Studer, 2010; Mascalo & Fischer, 2010).
- *Provisional.* Many young adults also become more skeptical about the truth and seem unwilling to accept an answer as final. Thus, they come to see the search for truth as an ongoing and perhaps never-ending process.
- *Realistic.* Young adults understand that thinking can't always be abstract. In many instances, it must be realistic and pragmatic.
- *Recognized as being influenced by emotion.* Emerging and young adults are more likely than adolescents to understand that their thinking is influenced by emotions. However, too often negative emotions produce thinking that is distorted and self-serving at this point in development.

One effort to assess postformal thinking is the 10-item Complex Postformal Thought Questionnaire (Sinnott & Johnson, 1997). Figure 3.5 presents the questionnaire and gives you an opportunity to evaluate the extent to which your thinking has reached the postformal level. A recent study found that the questionnaire items reflect three main categories of postformal thinking: (1) taking into account multiple aspects of a problem or situation; (2) making a subjective choice in a particular problem situation; and (3) perceiving underlying complexities in a situation (Cartwright & others, 2009).

One study using the Complex Postformal Thought Questionnaire revealed that college students who had more cross-category friends (based on categories of gender, age, ethnicity, socioeconomic status, and sexual orientation) scored higher on the postformal thought measure than did their counterparts who had fewer cross-category friends (Galupo, Cartwright, & Savage, 2010). Cross-category friendships likely stimulate individuals to move beyond either/or thinking, critically evaluate stereotypical thinking, and consider alternative explanations.

postformal thought Thought that is reflective, relativistic, and contextual; provisional; realistic; and open to emotions and subjective.

wisdom Expert knowledge about the practical aspects of life that permits excellent judgment about important matters.

Respond to each of the items below in terms of how well they characterize your thinking from 1 = Not True (of Self) to 7 = Very True (of Self).	Not True 1	2	3	4	5	6	Very True 7
1. I see the paradoxes in life.							
2. I see more than one method that can be used to reach a goal.							
3. I am aware that I can decide which reality to experience at a particular time; but I know that reality is really multi-level and more complicated.							
4. There are many "right" ways to define any life experience; I must make a final decision on how I define the problems of life.							
5. I am aware that sometimes "succeeding" in the everyday world means finding a concrete answer to one of life's problems; but sometimes it means finding a correct path that would carry me through any problems of this type.							
6. Almost all problems can be solved by logic, but this may require different types of "logics."							
7. I tend to see several causes connected with any event.							
8. I see that a given dilemma always has several good solutions.							
9. I realize that I often have several goals in mind, or that life seems to have several goals in mind for me. So I go toward more than one in following my path in life.							
10. I can see the hidden logic in others' solutions to the problems of life, even if I don't agree with their solutions and follow my own path.							

FIGURE **3.5**

COMPLEX POSTFORMAL THOUGHT QUESTIONNAIRE. After you have responded to the items, total your score, which can range from 10 to 70. The higher your score, the more likely you are to engage in postformal thinking.

How strong is the evidence for a fifth, postformal stage of cognitive development? Researchers have found that young adults are more likely to engage in postformal thinking than adolescents are (Commons & Richards, 2003). But critics argue that research has yet to document that postformal thought is a qualitatively more advanced stage than formal operational thought.

Wisdom Paul Baltes and his colleagues (2006) define **wisdom** as expert knowledge about the practical aspects of life that permits excellent judgment about important matters. This practical knowledge involves exceptional insight about human development and life matters, good judgment, and an understanding of how to cope with difficult life problems. Thus, wisdom, more than standard conceptions of intelligence, focuses on life's pragmatic concerns and human condition.

In regard to wisdom, research by Baltes and his colleagues (Baltes & Kunzmann, 2007; Baltes, Lindenberger, & Staudinger, 2006; Baltes & Smith, 2008) has found that:

- High levels of wisdom are rare. *Few people, including older adults, attain a high level of wisdom. That only a small percentage of adults show wisdom supports the contention that it requires experience, practice, or complex skills.*
- The time frame of late adolescence and early adulthood is the main age window for wisdom to emerge. *No further advances in wisdom have been found for middle-aged and older adults beyond the level they attained as young adults, but this may have been because the problems studied were not sufficiently relevant to older adults' lives.*

What are some characteristics of wisdom?

- Factors other than age are critical for wisdom to develop to a high level. *For example, certain life experiences, such as being trained and working in a field concerned with difficult life problems and having wisdom-enhancing mentors, contribute to higher levels of wisdom. Also, people higher in wisdom have values that are more likely to consider the welfare of others rather than their own happiness.*
- Personality-related factors, such as openness to experience and creativity, are better predictors of wisdom than cognitive factors such as intelligence.

A recent study compared college students and older adults on a wisdom scale that consisted of three dimensions: cognitive, reflective, and affective (Ardelt, 2010, p. 199):

- *Cognitive* scale items measured the absence of cognitive wisdom and included items about not having the ability or being unwilling to understand something thoroughly ("ignorance is bliss," for example), and tending to perceive the world as either/or instead of more complex ("People are either good or bad," for example), and being unaware of ambiguity and uncertainty in life ("There is only one right way to do anything," for example).
- *Reflective* scale items evaluated having the ability and being willing to examine circumstances and issues from different perspectives ("I always try to look at all sides of a problem," for example) and the lack of self-examination and self-insight ("Things often go wrong for me through no fault of my own," for example).
- *Affective* scale items assessed positive and caring emotions ("Sometimes I feel a real compassion for everyone," for example) and the lack of those characteristics ("It's not really my problem if others are in trouble and need help," for example).

On the overall wisdom scale, which included an assessment of all three dimensions combined, no differences were found between the two age groups. However, older adults who were college educated scored higher on the reflective and affective, but not the cognitive, dimensions of wisdom than did the college students.

Robert J. Sternberg (2013a, c, d), whose theory of intelligence we will consider later in the chapter, argues that wisdom is linked to both practical and academic intelligence. In his view, academic intelligence is a necessary but in many cases insufficient requirement for wisdom. Practical knowledge about the realities of life also is needed for wisdom. For Sternberg, balance between self-interest, the interests of others, and contexts produces a common good. Thus, wise individuals don't just look out for themselves—they also need to consider others' needs and perspectives as well as the specific context involved. Sternberg assesses wisdom by presenting problems to individuals that require solutions highlighting various intrapersonal, interpersonal, and contextual interests. He also emphasizes that such aspects of wisdom should be taught in schools (Sternberg, 2013a, c, d). It is Sternberg's emphasis on using knowledge for the common good in a manner that addresses competing interests that mainly differentiates it from Baltes and his colleagues' view of wisdom.

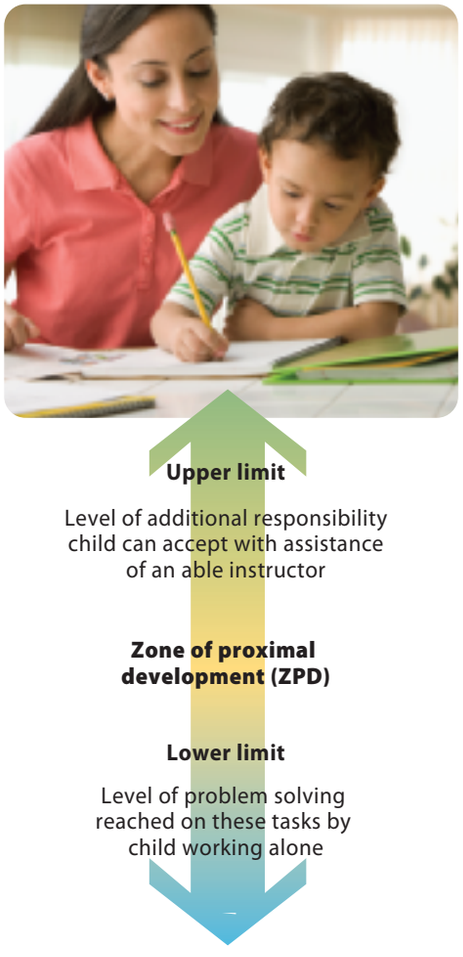


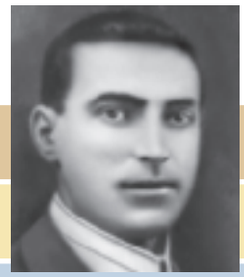
FIGURE **3.6**

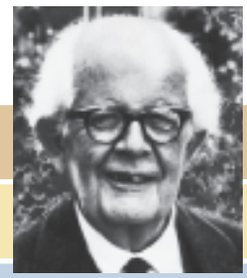
VYGOTSKY'S ZONE OF PROXIMAL DEVELOPMENT (ZPD). Vygotsky's zone of proximal development has a lower limit and an upper limit. Tasks in the ZPD are too difficult for the child or adolescent to perform alone. They require assistance from an adult or a more-skilled youth. As children and adolescents experience the verbal instruction or demonstration, they organize the information in their existing mental structures so they can eventually perform the skill or task alone.

VYGOTSKY'S THEORY

Lev Vygotsky's (1962) theory was introduced in Chapter 1, and it has stimulated considerable interest in the view that knowledge is *situated* and *collaborative* (Mahn & John-Steiner, 2013). That is, knowledge is distributed among people and their environments, which include objects, artifacts, tools, books, and the communities in which people live. This distribution suggests that knowing can best be advanced through interaction with others in cooperative activities.

One of Vygotsky's most important concepts is the **zone of proximal development (ZPD),** which refers to the range of tasks that are too difficult for an individual to master alone, but that can be mastered with the guidance and assistance of adults or more-skilled peers. Thus, the lower level of the ZPD is the level of problem solving reached by an adolescent working independently. The upper limit is the level of thinking the adolescent can accept with the assistance of an able instructor (see Figure 3.6). Vygotsky's emphasis on the ZPD underscored his belief in the importance of social influences on cognitive development (Daniels, 2011; Petrick-Steward, 2012).





	Vygotsky	Piaget
Sociocultural Context	Strong emphasis	Little emphasis
Constructivism	Social constructivist	Cognitive constructivist
Stages	No general stages of development proposed	Strong emphasis on stages (sensorimotor, preoperational, concrete operational, and formal operational)
Key Processes	Zone of proximal development, language, dialogue, tools of the culture	Schema, assimilation, accommodation, operations, conservation, classification
Role of Language	A major role; language plays a powerful role in shaping thought	Language has a minimal role; cognition primarily directs language
View on Education	Education plays a central role, helping children learn the tools of the culture	Education merely refines the child's cognitive skills that have already emerged
Teaching Implications	Teacher is a facilitator and guide, not a director; establish many opportunities for children to learn with the teacher and more-skilled peers	Also views teacher as a facilitator and guide, not a director; provide support for children to explore their world and discover knowledge

FIGURE **3.7**
COMPARISON OF VYGOTSKY'S AND PIAGET'S THEORIES

In Vygotsky's approach, formal schooling is but one of the cultural agents that determine an adolescent's growth. Parents, peers, the community, and the culture's technological orientation also influence adolescents' thinking (Rogoff & others, 2011). For example, parents' and peers' attitudes toward intellectual competence affect adolescents' motivation to acquire knowledge. So do the attitudes of teachers and other adults in the community.

Even though their theories were proposed at about the same time, most of the world learned about Vygotsky's theory later than they learned about Piaget's theory, so Vygotsky's theory has not yet been evaluated as thoroughly. Vygotsky's view of the importance of sociocultural influences on children's development fits with the current belief that it is important to evaluate the contextual factors in learning (Gauvain, 2013).

Although both theories are constructivist, Vygotsky's is a **social constructivist approach,** which emphasizes the social contexts of learning and the construction of knowledge through social interaction. In moving from Piaget to Vygotsky, the conceptual shift is from the individual to collaboration, social interaction, and sociocultural activity (Gauvain, 2011). The end point of cognitive development for Piaget is formal operational thought. For Vygotsky, the end point can differ, depending on which skills are considered to be the most important in a particular culture. For Piaget, children construct knowledge by transforming, organizing, and reorganizing previous knowledge. For Vygotsky, children and adolescents construct knowledge through social interaction (Mahn & John-Steiner, 2013). The implication of Piaget's theory for teaching is that children need support to explore their world and discover knowledge. The main implication of Vygotsky's theory for teaching is that students need many opportunities to learn with the teacher and more-skilled peers. In both Piaget's and Vygotsky's theories, teachers serve as facilitators and guides, rather than as directors and molders of learning. Figure 3.7 compares Vygotsky's and Piaget's theories.

Criticisms of Vygotsky's theory also have surfaced. Some critics point out that Vygotsky was not specific enough about age-related changes (Gauvain, 2013). Another criticism focuses on Vygotsky not adequately describing how changes in socioemotional capabilities contribute to cognitive development. Yet another criticism is that he overemphasized the role of language in thinking. Also, his emphasis on collaboration and guidance has potential pitfalls. Might facilitators be too helpful in some cases, as when a parent becomes too overbearing and controlling? Further, some adolescents might become lazy and expect help when they might have done something on their own.

zone of proximal development (ZPD) Vygotsky's concept that refers to the range of tasks that are too difficult for an individual to master alone, but that can be mastered with the guidance or assistance of adults or more-skilled peers.

social constructivist approach Approach that emphasizes the social contexts of learning and the construction of knowledge through social interaction.

Review *Connect* Reflect

LG2 Discuss the cognitive developmental view of adolescence

Review

- What is Piaget's view of adolescence? What are some contributions and criticisms of Piaget's theory? What are some possible cognitive changes in adulthood?
- What is Vygotsky's view of adolescence?

Connect

- Compare the concepts of postformal thought and wisdom.

Reflect *Your Own Personal Journey of Life*

- Think back to when you were 8 years old and 16 years old. Imagine that you are watching a political convention on television at these two different ages. In terms of Piaget's stages of cognitive development, how would your perceptions of the proceedings likely have differed when you were at these two different ages? What would you have "seen" and comprehended as an 8-year-old? What would you have "seen" and comprehended as a 16-year-old? What Piagetian concepts would these differences in your cognition reflect?

The Information-Processing View

LG3 Characterize the information-processing view of adolescence

Cognitive Resources | Attention and Memory | Executive Function

In Chapter 1, we briefly discussed the information-processing view. We saw that information processing includes how information gets into adolescents' minds, how it is stored, and how adolescents retrieve information to think about and solve problems.

Information processing is both a framework for thinking about adolescent development and a facet of that development. As a framework, the information-processing view includes certain ideas about how adolescents' minds work and how best to study those workings (Kuhn, 2013; Siegler, 2012, 2013). As a facet of development, information processing changes as children make the transition from adolescence to adulthood. Changes in attention and memory, for example, are essentially changes in the way individuals process information.

Deanna Kuhn (2009) has discussed some important characteristics of adolescents' information processing and thinking. In her view, in the later years of childhood, and continuing in adolescence, individuals approach cognitive levels that may or may not be achieved, in contrast to the largely universal cognitive levels that young children attain. By adolescence, considerable variation in cognitive functioning is present across individuals. This variability supports the argument that adolescents are producers of their own development to a greater extent than are children.

In our exploration of information processing, we will discuss developmental changes in attention, memory, and a number of higher-order cognitive processes involved in executive function. But first let's examine the importance of cognitive resources in processing information.

COGNITIVE RESOURCES

Information processing is influenced by both the capacity and the speed of processing. These two characteristics are often referred to as *cognitive resources*, and adolescents—especially older adolescents— are better than children at managing and deploying these resources in controlled and purposeful ways (Kuhn & Franklin, 2006).

Most information-processing psychologists argue that an increase in capacity improves processing of information (Halford & Andrews, 2011). For example, as adolescents' information-processing capacity increases, they likely can hold in mind several dimensions

connecting with adolescents

We Think More Than Adults Think We Do

I don't think adults understand how much kids think today. We just don't take something at face value. We want to understand why things are the way they are and the reasons behind things. We want it to be a better world and we are thinking all of the time how to make it that way. When we get to be adults, we will make the world better.

—Jason, age 15
Dallas, Texas

How does this comment support the argument that adolescents can hold several dimensions of a topic or problem in mind simultaneously?

of a topic or problem simultaneously, whereas younger children are more prone to focus on only one dimension.

What is the role of processing speed? Generally, fast processing is linked with good performance on cognitive tasks. However, some compensation for slower processing speed can be achieved through effective strategies.

There is abundant evidence that the speed with which cognitive tasks are completed improves dramatically across the childhood and adolescent years (Hommel, Li, & Li, 2004; Kail, 2007; Kuhn, 2009). In one study, 10-year-olds were approximately 1.8 times slower in processing information than young adults on tasks involving reaction time and abstract matching (Hale, 1990). Twelve-year-olds were approximately 1.5 times slower than young adults, but 15-year-olds processed information on the tasks as fast as the young adults. Also, a recent study of 8- to 13-year-old children revealed that processing speed increased with age, and further that the developmental change in processing speed preceded an increase in working memory capacity (Kail, 2007). Further, a recent study of 9- to 14-year-olds found that faster processing speed was linked to a higher level of oral reading fluency (Jacobson & others, 2011).

ATTENTION AND MEMORY

When adolescents process information quickly, they have to focus their attention on the information. And, if they need to use the information later, they will have to remember it. Attention and memory are key aspects of adolescents' information processing.

Attention

Attention is the concentration and focusing of mental effort. Individuals can allocate their attention in different ways (Fisher & others, 2013; Rueda & Posner, 2013). Psychologists have labeled these types of allocation as selective attention, divided attention, sustained attention, and executive attention.

- **Selective attention** is focusing on a specific aspect of experience that is relevant while ignoring others that are irrelevant. Focusing on one voice among many in a crowded room is an example of selective attention.
- **Divided attention** involves concentrating on more than one activity at the same time. An example of divided attention is text messaging while listening to an instructor's lecture.
- **Sustained attention** is the ability to maintain attention to a selected stimulus for a prolonged period of time. Staying focused on reading this chapter from start to finish without interruption is an example of sustained attention.

attention Concentration and focusing of mental resources.

selective attention Focusing on a specific aspect of experience that is relevant while ignoring others that are irrelevant.

divided attention Concentrating on more than one activity at the same time.

sustained attention The ability to maintain attention to a selected stimulus for a prolonged period of time.

What are some changes in attention during childhood and adolescence?

- **Executive attention** involves planning actions, allocating attention to goals, detecting and compensating for errors, monitoring progress on tasks, and dealing with novel or difficult circumstances. An example of executive attention is effectively deploying attention to engage in the aforementioned cognitive tasks while writing a 10-page paper for a history course.

Let's further explore divided, sustained, and executive attention. In one investigation, 12-year-olds were markedly better than 8-year-olds, and slightly worse than 20-year-olds, at dividing their attention between two tasks (Manis, Keating, & Morrison, 1980). Adolescents may have more resources available to them than children (through increased processing speed, capacity, and automaticity), or they may be more skilled at directing the resources.

As we described in Chapter 1, one trend involving divided attention is adolescents' multitasking, which in some cases involves dividing attention not just between two activities but between three or even more (Bauerlein, 2008). A major influence on the increase in multitasking is the availability of multiple electronic media. If a key task is at all complex and challenging, such as trying to figure out how to solve a homework problem, multitasking considerably reduces attention to the key task (Myers, 2008).

Is multitasking beneficial or distracting for adolescents?

Sustained and executive attention also are very important aspects of adolescent cognitive development. As adolescents are required to engage in larger, increasingly complex tasks that require longer time frames to complete, their ability to sustain attention is critical for succeeding on the tasks. An increase in executive attention supports the rapid increase in effortful control required to effectively engage in these complex academic tasks (Rothbart, 2011).

As with any cognitive process, there are wide individual differences in how effectively adolescents use these different types of attention in their everyday lives. For example, in Chapter 10, we will discuss *attention deficit hyperactivity disorder (ADHD)*, a disability in which adolescents have severe problems in effectively allocating attention.

developmental **connection**

Media

A recent study revealed that when media multitasking is taken into account, 11- to 14-year-olds use media nearly 12 hours a day (Rideout, Foehr, & Roberts, 2010). Chapter 12, p. 420

executive attention Type of attention that involves planning actions, allocating attention to goals, detecting and compensating for errors, monitoring progress on tasks, and dealing with novel or difficult circumstances.

Memory There are few moments when adolescents' lives are not steeped in memory. Memory is at work with each step adolescents take, each thought they think, and each word they utter. Memory is the retention of information over time. It is central to mental life and to information processing. To successfully learn and reason, adolescents need to hold on to information and retrieve it when necessary. Three important memory systems—short-term memory, working memory, and long-term memory—are involved in adolescents' learning.

Short-Term Memory *Short-term memory* is a limited-capacity memory system in which information is retained for as long as 30 seconds, unless the information is rehearsed (repeated), in which case it can be retained longer. A common way to assess short-term memory is to present a list of items to remember, which is often referred to as a memory span task. If you have taken an IQ test, you probably were asked to remember a string of numbers or words. You simply hear a short list of stimuli—usually digits—presented at a rapid pace (one per second, for example). Then you are asked to repeat the digits back. Using the memory span task, researchers have found that short-term memory increases extensively in early childhood and continues to increase in older children and adolescents, but at a slower pace. For example, in one investigation, memory span increased by 1½ digits between the ages of 7 and 12 (Dempster, 1981) (see Figure 3.8). Keep in mind, though, memory span's individual differences, which explain the use of IQ and various aptitude tests.

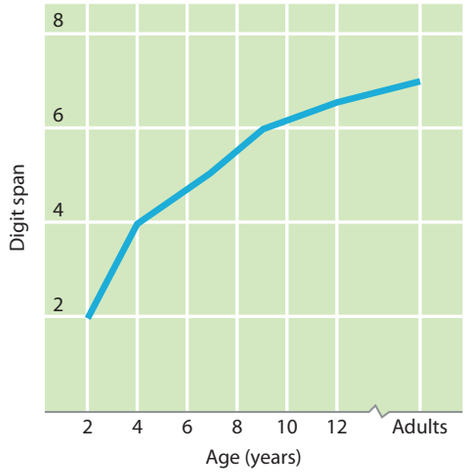


FIGURE **3.8**

DEVELOPMENTAL CHANGES IN MEMORY SPAN. In one study, memory span increased about three digits from 2 years of age to five digits at 7 years of age (Dempster, 1981). By 12 years of age, memory span had increased on average another 1½ digits.

Working Memory Short-term memory is like a passive storehouse with shelves to store information until it is moved to long-term memory. *Working memory* is a kind of mental "workbench" where individuals manipulate and assemble information when they make decisions, solve problems, and comprehend written and spoken language (Baddeley, 2008, 2010a, b, 2012) (see Figure 3.9). Many psychologists prefer the term *working memory* over *short-term memory* to describe how memory works. Working memory is described as more active and powerful in modifying information than is short-term memory.

Working memory is linked to many aspects of children's and adolescents' development (Myatchin & Lagae, 2013). A recent study revealed that working memory capacity at 9 to 10 years of age predicted foreign language comprehension two years later, at 11 to 12 years of age (Andersson, 2010). Another recent study found that the prefrontal cortex plays a more important role in working memory in late adolescence than in early adolescence (Finn & others, 2010).

In one study, the performances of individuals from 6 to 57 years of age were examined on both verbal and visuospatial working memory tasks (Swanson, 1999). As shown in Figure 3.10, working memory increased substantially from 8 through 24 years of age no matter what the task. Thus, the adolescent years are likely to be an important developmental period for improvement in working memory. Note that working memory continues to improve through the transition to adulthood and beyond.

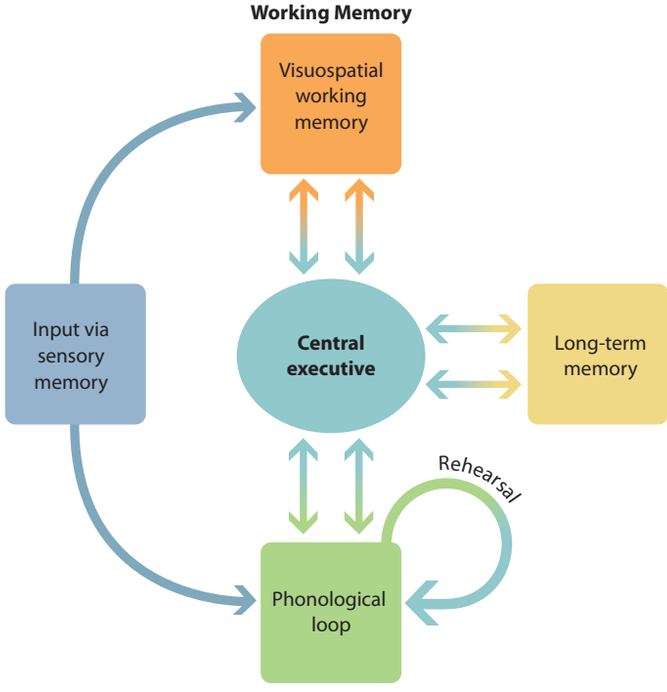


FIGURE **3.9**

WORKING MEMORY. In Baddeley's working memory model, working memory is like a mental workbench where a great deal of information processing is carried out. Working memory consists of three main components: the phonological loop and visuospatial working memory serve as assistants, helping the central executive do its work. Input from sensory memory goes to the phonological loop, where information about speech is stored and rehearsal takes place, and to visuospatial working memory, where visual and spatial information, including imagery, is stored. Working memory is a limited-capacity system, and information is stored there for only a brief time. Working memory interacts with long-term memory, using information from long-term memory in its work and transmitting information to long-term memory for longer storage.

Long-Term Memory *Long-term memory* is a relatively permanent memory system that holds huge amounts of information for a long period of time. Long-term memory increases substantially in the middle and late childhood years and improvement likely continues during adolescence, although this has not been well documented by researchers. If anything at all is known about long-term memory, it is that it depends on the learning activities engaged in when an individual is acquiring and remembering information (Pressley & Hilden, 2006). Most learning activities fit under the category of *strategies*, activities under the learner's conscious control. There are many such activities, but one of the most important is organization, the tendency to group or arrange items into categories. We will have more to discuss about strategies shortly.

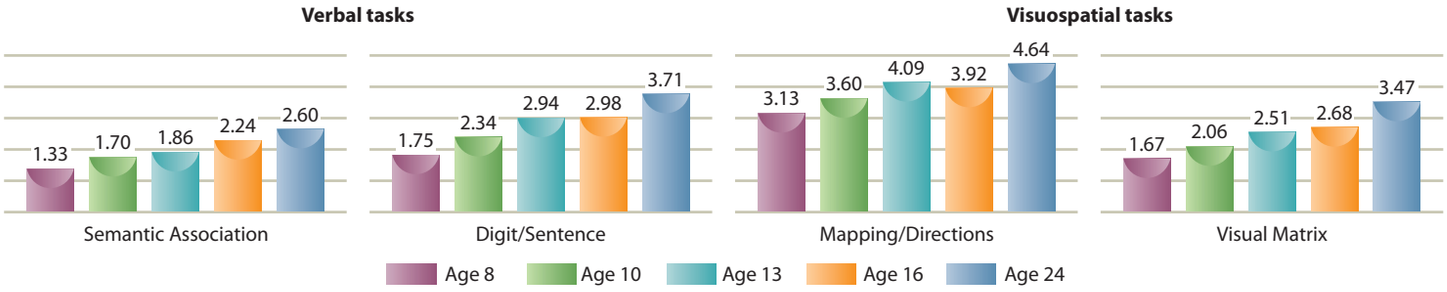


FIGURE 3.10

DEVELOPMENTAL CHANGES IN WORKING MEMORY. *Note:* The scores shown here are the means for each age group, and the age also represents a mean age. Higher scores reflect superior working memory performance.

EXECUTIVE FUNCTION

What characterizes executive function?

Attention and memory are important dimensions of information processing, but other dimensions also are important. Especially important in adolescent cognition are higher-order, complex cognitive processes that involve an umbrella-like concept called **executive function.** These cognitive processes are linked to the development of the brain's prefrontal cortex and involve managing one's thoughts to engage in goal-directed behavior and exercise self-control (Carlson, Zelazo, & Faja, 2013; Liew, 2012). Executive function is hard at work when adolescents are making decisions, thinking critically, and engaged in thinking about thinking.

Executive function becomes increasingly strong during adolescence (Kuhn, 2009; Kuhn & Franklin, 2006). This executive function

> assumes a role of monitoring and managing the deployment of cognitive resources as a function of task demands. As a result, cognitive development and learning itself become more effective. . . . Emergence and strengthening of this executive (function) is arguably the single most important and consequential intellectual development to occur in the second decade of life. (Kuhn & Franklin, 2006, p. 987)

Cognitive Control

Cognitive control involves effective control and flexible thinking in a number of areas, including controlling attention, reducing interfering thoughts, and being cognitively flexible (Diamond, 2013). Cognitive control also has been referred to as *inhibitory control* or *effortful control* to emphasize the ability to resist a strong inclination to do one thing but instead to do what is most effective (Diamond, 2013).

Across childhood and adolescence, cognitive control increases with age (Casey, Jones, & Somerville, 2011; Luna, Padmanabhan, & O'Hearn, 2010). The increase in cognitive control is thought to be due to the maturation of brain pathways and circuitry we considered earlier in the chapter. For example, one study found less diffusion and more focal activation in the prefrontal cortex from 7 to 30 years of age (Durston & others, 2006). The activation change was accompanied by increased efficiency in cognitive performance, especially in *cognitive control*.

Think about all the times adolescents and emerging adults need to engage in cognitive control, such as the following activities (Galinsky, 2010):

- making a real effort to stick with a task, avoiding interfering thoughts or environmental events, and instead doing what is most effective;
- stopping and thinking before acting to avoid blurting out something that they might later wish they hadn't said;
- continuing to work on something that is important but boring when there is something a lot more fun to do, but inhibiting their behavior and doing the boring but important task, saying to themselves, "I have to show the self-discipline to finish this."

A longitudinal study of an important dimension of executive function—inhibitory control—found that 3- to 11-year-old children who early in development showed better inhibitory control (able to wait their turn, not easily distracted, more persistent, and less impulsive) were

executive function An umbrella-like concept that involves higher-order, complex cognitive processes that include exercising cognitive control, making decisions, reasoning, thinking critically, thinking creatively, and metacognition.

cognitive control Involves effective control and flexible thinking in a number of areas, including controlling attention, reducing interfering thoughts, and being cognitively flexible.

Circle the number that best reflects how you think for each of the four items:

	Exactly Like You	Very Much Like You	Somewhat Like You	Not Too Much Like You	Not At All Like You
1. When I try something that doesn't work, it's hard for me to give it up and try another solution.	1	2	3	4	5
2. I adapt to change pretty easily.	5	4	3	2	1
3. When I can't convince someone of my point of view, I can usually understand why not.	5	4	3	2	1
4. I am not very quick to take on new ideas.	1	2	3	4	5

Add your numbers for each of the four items: Total Score: _____
If your overall score is between 20 and 15, then you rate high on cognitive flexibility. If you scored between 9 and 14, you are in the middle category, and if you scored 8 or below, you likely could improve.

FIGURE **3.11**
HOW COGNITIVELY FLEXIBLE ARE YOU?

more likely to still be in school, less likely to engage in risk-taking behavior, and less likely to be taking drugs in adolescence (Moffitt & others, 2011). Thirty years after they were initially assessed, the children with better inhibitory control had better physical and mental health (they were less likely to be overweight, for example), earned more money in their career, were more law-abiding, and were happier (Moffitt, 2012; Moffitt & others, 2011).

Control Attention and Reduce Interfering Thoughts Controlling attention is a key aspect of learning and thinking in adolescence and emerging adulthood (Bjorklund, 2012; Rueda & Posner, 2013). Distractions that can interfere with attention in adolescence and emerging adulthood come from the external environment (other students talking while the student is trying to listen to a lecture, or the student turning on a laptop during a lecture and looking at a new friend request on Facebook, for example) or intrusive distractions from competing thoughts in the individual's mind. Self-oriented thoughts, such as worrying, self-doubt, and intense emotionally laden thoughts may especially interfere with focusing attention on thinking tasks (Gillig & Sanders, 2011; Walsh, 2011).

Be Cognitively Flexible *Cognitive flexibility* involves being aware that options and alternatives are available and adapting to the situation. Before adolescents and emerging adults adapt their behavior in a situation, they need to become aware that they need to change their way of thinking and be motivated to do so. Having confidence in their ability to adapt their thinking to a particular situation, an aspect of *self-efficacy,* also is important in being cognitively flexible (Bandura, 2012). To evaluate how cognitively flexible you are, see Figure 3.11 (Galinsky, 2010).

Some critics argue that not much benefit is derived from placing various cognitive processes under the broader concept of executive function. Although we have described a number of components of executive function here—cognitive inhibition, cognitive flexibility, and so on—a consensus has not been reached on what the components are, how they are connected, and how they develop. That said, the concept of executive function is not likely to go away any time soon, and further research, especially meta-analyses, should provide a clearer picture of executive function and how it develops through the life span (Luszcz, 2011).

Decision Making Adolescence is a time of increased decision making—which friends to choose; which person to date; whether to have sex, buy a car, go to college; and so on (Chick & Reyna, 2012; Stanovich, West, & Toplak, 2012). How competent are adolescents at making decisions? In some reviews, older adolescents are described as more competent than younger adolescents, who in turn are more competent than children (Keating, 1990). Compared with children, young adolescents are more likely to generate different options, examine a situation from a variety of perspectives, anticipate the consequences of decisions, and consider the credibility of sources.

One study documents that older adolescents are better at decision making than younger adolescents are (Lewis, 1981). Eighth-, tenth-, and twelfth-grade students were presented

What are some of the decisions adolescents have to make? What characterizes their decision making?

with dilemmas involving the choice of a medical procedure. The oldest students were most likely to spontaneously mention a variety of risks, to recommend consultation with an outside specialist, and to anticipate future consequences. For example, when asked a question about whether to have cosmetic surgery, a twelfth-grader said that different aspects of the situation need to be examined along with its effects on the individual's future, especially relationships with other people. In contrast, an eighth-grader presented a more limited view, commenting on the surgery's effects on getting turned down for a date, the money involved, and being teased by peers.

In sum, older adolescents often make better decisions than do younger adolescents, who in turn, make better decisions than do children. The ability to regulate one's emotions during decision making, to remember prior decisions and their consequences, and to adapt subsequent decision making on the basis of those consequences appears to improve with age at least through the early adulthood years (Klaczynski, Byrnes, & Jacobs, 2001).

However, older adolescents' decision-making skills are far from perfect, but of course, we also are not perfect decision makers as adults (Kuhn, 2009). Adolescents and adults who are impulsive and seek sensation are often not very effective decision makers, for example (Galvan & others, 2007).

Being able to make competent decisions does not guarantee that individuals will make them in everyday life, where breadth of experience often comes into play. As an example, driver-training courses improve adolescents' cognitive and motor skills to levels equal to, or sometimes superior to, those of adults. However, driver training has not been effective in reducing adolescents' high rate of traffic accidents, although recently researchers have found that implementing a graduated driver licensing (GDL) program can reduce crash and fatality rates for adolescent drivers (Keating, 2007). GDL components include a learner's holding period, practice-driving certification, night-driving restriction, and passenger restriction. In addition to GDL, parental monitoring and expectations can reduce adolescents' driving accidents (Keating & Halpern-Felsher, 2008). For example, parents can restrict and monitor the presence of adolescents' peers in the vehicle.

Most people make better decisions when they are calm rather than emotionally aroused, which may especially be true for adolescents (Rivers, Reyna, & Mills, 2008; Steinberg & others, 2009). Recall from our discussion of brain development earlier in the chapter that adolescents have a tendency to be emotionally intense. Thus, the same adolescent who makes a wise decision when calm may make an unwise decision when emotionally aroused (Giedd, 2012). In the heat of the moment, then, adolescents' emotions are especially likely to overwhelm their decision-making ability.

The social context plays a key role in adolescent decision making (Albert & Steinberg, 2011a, b). For example, adolescents' willingness to make risky decisions is more likely to occur in contexts where substances and other temptations are readily available (Gerrard & others, 2008; Reyna & Rivers, 2008). Recent research reveals that the presence of peers in risk-taking situations increases the likelihood that adolescents will make risky decisions (Albert & Steinberg, 2011a, b). In one study of risk taking involving a simulated driving task, the presence of peers increased an adolescent's decision to engage in risky driving by 50 percent but had no effect on adults (Gardner & Steinberg, 2005). One view is that the presence of peers activates the brain's reward system, especially dopamine pathways (Albert & Steinberg, 2011a, b; Steinberg, 2010).

It also is important to consider how the stress level of situations and individual differences in risk taking can influence adolescents' decisions. Few research studies have examined how trait-like tendencies might influence the decisions adolescents make in stressful and risky situations. A recent study found that adolescents took more risks in stressful than nonstressful situations (Johnson, Dariotis, & Wang, 2012). However, risk taking in the stressful conditions was associated with the type of risk taker the adolescent was. In the stressful condition, impulsive risk takers were less accurate and planful; calculated risk takers took fewer risks; and conservative risk takers engaged in low risk taking in both the nonstressful and stressful conditions.

How do emotions and social contexts influence adolescents' decision making?

Adolescents need more opportunities to practice and discuss realistic decision making. Many real-world decisions on matters such as sex, drugs, and daredevil driving occur in an atmosphere of stress that includes time constraints and emotional involvement. One strategy for improving adolescent decision making in such circumstances is to provide more opportunities for them to engage in role-playing and group problem solving. Another strategy is for parents to involve adolescents in appropriate decision-making activities.

To better understand adolescent decision making, Valerie Reyna and her colleagues (Reyna & Brainerd, 2011; Reyna & Farley, 2006; Reyna & others, 2010, 2011) have proposed the **dual-process model,** which states that decision making is influenced by two cognitive systems—one analytical and one experiential—which compete with each other. The dual-process model emphasizes that it is the experiential system—monitoring and managing actual experiences—that benefits adolescents' decision making, not the analytical system. In this view, adolescents don't benefit from engaging in reflective, detailed, higher-level cognitive analysis about a decision, especially in high-risk, real-world contexts. In such contexts, adolescents just need to know that there are some circumstances that are so dangerous that they need to be avoided at all costs.

In the experiential system, in risky situations it is important for an adolescent to quickly get the *gist,* or meaning, of what is happening and glean that the situation is a dangerous context, which can cue personal values that will protect the adolescent from making a risky decision (Chick & Reyna, 2012). Further, adolescents who have a higher level of trait inhibition (self-control that helps them to manage their impulses effectively) and find themselves in risky contexts are less likely to engage in risk-taking behavior than their adolescent counterparts who have a lower level of trait inhibition (Chick & Reyna, 2012).

However, some experts on adolescent cognition argue that in many cases adolescents benefit from both analytical and experiential systems (Kuhn, 2009).

Critical Thinking

Critical thinking is thinking reflectively and productively and evaluating evidence (Sternberg & Sternberg, 2013; Galinsky, 2010). In this book, the third part of the Review *Connect* Reflect sections challenges you to think critically about a topic or an issue related to the discussion. Thinking critically includes asking not only what happened, but how and why; examining supposed "facts" to determine whether there is evidence to support them; evaluating what other people say rather than immediately accepting it as the truth; and asking questions and speculating beyond what is known to create new ideas and new information.

dual-process model States that decision making is influenced by two systems—one analytical and one experiential, which compete with each other; in this model, it is the experiential system—monitoring and managing actual experiences—that benefits adolescent decision making.

critical thinking Thinking reflectively and productively and evaluating the evidence.

Mindfulness According to Ellen Langer (2005), *mindfulness*—being alert, mentally present, and cognitively flexible while going through life's everyday activities and tasks—is an important aspect of thinking critically. Mindful adolescents maintain an active awareness of the circumstances in their life and are motivated to find the best solutions to tasks. They create new ideas, are open to new information, and operate from multiple perspectives. By contrast, adolescents who are not mindful are entrapped in old ideas, engage in automatic behavior, and operate from a single perspective.

Recently, Robert Roeser and Philip Zelazo (2012) have emphasized that mindfulness is an important mental process that children and adolescents can engage in to improve a number of cognitive and socioemotional skills, such as executive function, focused attention, emotion regulation, and empathy (Roeser & Zelazo, 2012). It has been proposed that mindfulness training could be implemented in schools, including the use of age-appropriate activities that increase children's and adolescents' reflection on moment-to-moment experiences and promotes self-regulation (Zelazo & Lyons, 2012). A recent study of young adolescents found that a higher level of mindfulness attention awareness (assessed low identification with statements such as "I could be experiencing some emotion and not be conscious until sometime later" and "I snack without being aware of what I'm eating") was associated with cognitive inhibition (Oberle & others, 2012).

How might mindfulness training improve adolescents' development?

In addition to mindfulness, yoga, meditation, and tai chi have been recently proposed as candidates for enhancing children's and adolescents' cognitive and socioemotional development. Together these activities are being grouped under the topic of *contemplative science*, a cross-disciplinary term that involves the study of how various types of mental and physical training might enhance children's development (Roeser & Zelazo, 2012).

Developmental Changes Adolescence is an important transitional period in the development of critical thinking (Keating, 1990). In one study of fifth-, eighth-, and eleventh-graders, critical thinking increased with age but still occurred only in 43 percent of eleventh-graders (Klaczynski & Narasimham, 1998). Many adolescents showed self-serving biases in their thinking.

Among the cognitive changes that allow improved critical thinking during adolescence are the following:

- Increased speed, automaticity, and capacity of information processing, which free cognitive resources for other purposes
- Greater breadth of content knowledge in a variety of domains
- Increased ability to construct new combinations of knowledge
- A greater range and more spontaneous use of strategies and procedures for obtaining and applying knowledge, such as planning, considering the alternatives, and cognitive monitoring

Although adolescence is an important period in the development of critical-thinking skills, if a solid base of fundamental skills (such as literacy and math skills) has not been developed during childhood, critical-thinking skills are unlikely to develop adequately in adolescence.

Schools Considerable interest has been directed to teaching critical thinking in schools (Fairweather & Cramond, 2011). Cognitive psychologist Robert J. Sternberg (1985) concludes that most school programs that teach critical thinking are flawed. He thinks that schools focus too much on formal reasoning tasks and not enough on the critical-thinking skills needed in everyday life. Among the critical-thinking skills that Sternberg notes that adolescents need in everyday life are these: recognizing that problems exist, defining problems more clearly, handling problems with no single right answer or any clear criteria for the point at which the problem is solved (such as selecting a rewarding

developmental **connection**

Exercise

Recent research indicates that more physically fit adolescents have better thinking skills, including those involving executive function, than less physically fit adolescents. Chapter 2, p. 70

connecting with careers

Laura Bickford, Secondary School Teacher

Laura Bickford teaches English and journalism in grades 9 to 12, and she is chair of the English Department at Nordhoff High School in Ojai, California.

Bickford believes it is especially important to encourage students to think. Indeed, she says that "the call to teach is the call to teach students how to think." She believes that teachers need to show students the value in asking their own questions, having discussions, and engaging in stimulating intellectual conversations. Bickford says that she also encourages students to engage in metacognitive strategies (knowing about knowing). For example, she asks students to comment on their learning after particular pieces of projects have been completed. She requires students to maintain reading logs so they can observe their own thinking as it happens.

Laura Bickford working with students who are writing papers.

For more information about the work that secondary school teachers do, see page 47 in the Careers in Adolescent Development appendix.

career), making decisions on issues of personal relevance (such as deciding to have a risky operation), obtaining information, thinking in groups, and developing long-term approaches for addressing long-term problems.

One way to encourage students to think critically is to present them with controversial topics or articles that present both sides of an issue to discuss (Kuhn & Franklin, 2006). Some teachers shy away from having students engage in these types of critical-thinking debates or discussions because it is not "polite" or "nice" (Winn, 2004). However, critical thinking is promoted when students encounter conflicting accounts of arguments and debates, which can motivate them to delve more deeply into a topic and attempt to resolve an issue (Kuhn, 2009; Kuhn & Franklin, 2006).

Getting students to think critically is not always an easy task. Many students come into a class with a history of passive learning, having been encouraged to recite the correct answer to a question rather than put forth the intellectual effort to think in more complex ways. By using more assignments that require students to focus on an issue, a question, or a problem, rather than just to recite facts, teachers stimulate students' ability to think critically.

To read about the work of one secondary school teacher who encourages students to think critically, see the *Connecting with Careers* profile.

"For God's sake, think! Why is he being so nice to you?"
© Sam Gross/The New Yorker Collection/
www.cartoonbank.com

Creative Thinking **Creativity** is the ability to think in novel ways and discover unique solutions to problems. Thus, intelligence, which we discuss shortly, is not the same thing as creativity. J. P. Guilford (1967) first made this distinction by contrasting **convergent thinking,** which produces one correct answer and is characteristic of the kind of thinking required on a conventional intelligence test, and **divergent thinking,** which produces many answers to the same question and is more characteristic of creativity. For example, a typical item on a conventional intelligence test is "How many quarters will you get in return for 60 dimes?" This question has only one correct answer. In contrast, the following questions have many possible

creativity The ability to think in novel and unusual ways and discover unique solutions to problems.

convergent thinking A pattern of thinking in which individuals produce one correct answer; characteristic of the items on conventional intelligence tests; coined by Guilford.

divergent thinking A pattern of thinking in which individuals produce many answers to the same question; more characteristic of creativity than convergent thinking; coined by Guilford.

"What do you mean 'What is it?' It's the spontaneous, unfettered expression of a young mind not yet bound by the restraints of narrative or pictorial representation." Sidney Harris. ScienceCartoonsPlus.com. Used with permission.

answers: "What image comes to mind when you hear the phrase *sitting alone in a dark room?*" or "Can you think of some unique uses for a paper clip?"

Are intelligence and creativity related? Although most creative adolescents are quite intelligent, the reverse is not necessarily true (Lubart, 2003). Many highly intelligent adolescents are not very creative.

A special concern is that adolescents' creative thinking appears to be declining. A study of approximately 300,000 U.S. children, adolescents, and adults found that creativity scores rose until 1990, but since then have been steadily declining (Kim, 2010). Among the likely causes of the creativity decline are the number of hours U.S. children and adolescents watch TV, play video games, connect on Facebook, and text message instead of engaging in creative activities, as well as the lack of emphasis on creative-thinking skills in schools (Gregorson, Kaufman, & Snyder, 2013; Kaufman & Sternberg, 2012, 2013) Some countries, though, are placing increasing emphasis on creative thinking in schools. For example, historically, creative thinking has typically been discouraged in Chinese schools. However, Chinese educators are now encouraging teachers to spend more classroom time on creative activities (Plucker, 2010).

An important teaching goal is to help students become more creative. Teachers need to recognize that students will show more creativity in some domains than in others (Kaufman & Sternberg, 2012, 2013). A student who shows creative-thinking skills in mathematics may not exhibit these skills in art, for example.

School environments that encourage independent work, are stimulating but not distracting, and make resources readily available are likely to encourage students' creativity. There is mounting concern that the U.S. government's No Child Left Behind legislation has harmed the development of students' creative thinking by focusing attention on memorization of materials to do well on standardized tests (Kaufman & Sternberg, 2012, 2013).

developmental **connection**

Schools

A number of criticisms of the government's No Child Left Behind legislation have been made. Chapter 10, p. 341

An adolescent boy painting in the streets of the African nation of Zanzibar. *If you wanted to work with adolescents to encourage their creativity, what strategies would you adopt?*

Here are some good strategies for increasing adolescents' creative-thinking skills:

- *Have adolescents engage in brainstorming and come up with as many ideas as possible.* Brainstorming is a technique in which individuals are encouraged to come up with creative ideas in a group, play off each other's ideas, and say practically anything that comes to mind. However, recognize that some adolescents are more creative when they work alone. Indeed, one review of research on brainstorming concluded that for many individuals, working alone can generate more ideas and better ideas than working in groups (Rickards & deCock, 2003). One reason for this is that in groups, some individuals contribute only a few ideas, whereas others do most of the creative thinking. Nonetheless, there may be benefits to brainstorming, such as team building, that support its use.
- *Introduce adolescents to environments that stimulate creativity.* Some settings nourish creativity; others depress it (Baer & Kaufman, 2013). People who encourage creativity often rely on adolescents' natural curiosity. They provide exercises and activities that stimulate adolescents to find insightful solutions to problems, rather than asking a lot of questions that require rote answers. Adults also encourage creativity by taking adolescents to locations where creativity is valued.
- *Don't overcontrol.* Teresa Amabile (1993) says that telling individuals exactly how to do things leaves them feeling that any originality is a mistake and any exploration is a waste of time. Letting adolescents select their interests and supporting their inclinations are less likely to destroy their natural curiosity than dictating which activities they should engage in.
- *Build adolescents' confidence.* To expand adolescents' creativity, encourage them to believe in their own ability to create something innovative and worthwhile. Building adolescents' confidence in their creative skills aligns with Bandura's (2012) concept of self-efficacy, the belief that one can master a situation and produce positive outcomes.

- *Encourage internal motivation*. The excessive use of prizes such as gold stars or money can stifle creativity by undermining the intrinsic pleasure adolescents derive from creative activities. Creative adolescents' motivation is the satisfaction generated by the work itself. Competition for prizes and formal evaluations often undermine intrinsic motivation and creativity (Amabile & Hennessey, 1992; Hennessey, 2011).
- *Guide adolescents to be persistent and to delay gratification*. Most highly successful creative products take years to develop. Most creative individuals work on ideas and projects for months and years without being rewarded for their efforts (Sternberg & Williams, 1996). Adolescents don't become experts at sports, music, or art overnight. It usually takes many years of working at something to become an expert at it; the same is true for a creative thinker who produces a unique, worthwhile product.
- *Encourage adolescents to take intellectual risks*. Creative individuals take intellectual risks and seek to discover or invent something never before discovered or invented (Sternberg & Williams, 1996). They risk spending extensive time on an idea or project that may not work. Adolescents' creativity benefits when they are not afraid of failing or getting something wrong (Baer & Kaufman, 2013).
- *Introduce adolescents to creative people*. Think about some of the most creative people in your community. Teachers can invite these people to their classrooms and ask them to describe what helps them become creative or to demonstrate their creative skills. A writer, poet, musician, scientist, and many others can bring their props and productions to the class, turning it into a theater for stimulating students' creativity.

developmental **connection**

Work

Intrinsic motivation comes from a combination of factors such as self-determination and personal choice, optimal experiences, interest, and cognitive engagement. Chapter 11, p. 371

Expertise Recently psychologists have shown increased interest in experts and novices in a specific knowledge domain (Guida & others, 2012; Moxley & others, 2012). An expert is the opposite of a novice (someone who is just beginning to learn a content area). What is it, exactly, that experts do so well? They are better than novices at the following activities (National Research Council, 1999):

- Detecting features and meaningful patterns of information
- Accumulating more content knowledge and organizing it in a manner that shows an understanding of the topic
- Retrieving important aspects of knowledge with little effort

In areas where children and adolescents are experts, their memory is often extremely good. In fact, it often exceeds that of adults who are novices in that content area. This superiority was documented in a study of 10-year-old chess experts (Chi, 1978). These children were excellent chess players, but not especially brilliant in other ways. As with most 10-year-olds, their memory spans for digits were shorter than an adult's. However, when they were presented with chessboards, they remembered the configurations far better than did the adults who were novices at chess (see Figure 3.12).

Experts' knowledge is organized around important ideas or concepts more than novices' knowledge is (National Research Council, 1999). This ability provides experts with a much deeper understanding of knowledge than novices possess. Experts in a specific area usually have far more elaborate networks of information about that area than novices do. The information they represent in memory has more nodes, more interconnections, and better hierarchical organization.

What determines whether someone becomes an expert? Can motivation and practice elevate someone to expert status? Or does expertise also require a great deal of talent?

One perspective asserts that a specific kind of practice—deliberate practice—is required to become an expert. Deliberate practice involves practice that is at an appropriate level of difficulty for the individual, provides corrective feedback, and allows opportunities for repetition (Ericsson & others, 2006). In one study of violinists at a music academy, the extent to which children engaged in deliberate practice differed for novices and experts (Ericsson, Krampe, & Tesch-Römer, 1993). The top violinists averaged 7,500 hours of deliberate practice by age 18, the good violinists only 5,300 hours. Many individuals give up on becoming an

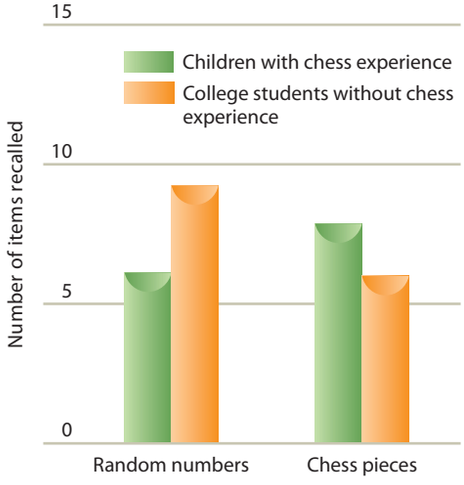


FIGURE **3.12**
MEMORY FOR NUMBERS AND CHESS PIECES

connecting with adolescents

Rochelle Ballantyne, 17-Year-Old Chess Star

Seventeen-year-old Rochelle Ballantyne, who lives in Brooklyn, New York, is close to becoming the first female African American to reach the level of chess master (Kastenbaum, 2012). She grew up in a single-parent family in a lower-income context. Her grandmother taught her to play chess because she didn't want Rochelle's impoverished background to prevent her from reaching her full potential. Rochelle was fortunate to attend I.S. 318, an inner-city public middle school where the chess team is one of the best in the United States. Rochelle already has won several national chess championships and she is a rising star in the world of chess. Rochelle's motivation and confidence are reflected in her recent comment: "When I push myself, then nothing can stop me."

Rochelle Ballantyne, 17-year-old chess champion from Brooklyn, New York, is a rising star in the world of chess. *How might her ability to process information about chess be different than for a novice chess player?*

How are talent and deliberate practice involved in expertise?

expert because they won't put forth the effort it takes to engage in extensive deliberate practice over a number of years.

Such extensive practice requires considerable motivation. Students who are not motivated to practice long hours are unlikely to become experts in a specific area. Thus, a student who complains about all of the work, doesn't persevere, and doesn't extensively practice solving math problems over a number of years is not going to become an expert in math. However, talent is also usually required to become an expert (Ruthsatz & others, 2008). Many individuals have attempted to become great musicians and athletes but have given up trying after only mediocre performances. Nonetheless, musicians such as Beethoven and athletes such as Tiger Woods would not have developed expertise in their fields without being highly motivated and engaging in extensive deliberate practice. Talent alone does not make someone an expert.

Metacognition You have studied some important ways in which adolescents process information. In this section, you will read about how adolescents monitor their information processing and think about thinking.

What Is Metacognition? Earlier in this chapter, in discussing Piaget's theory, you learned that adolescents increase their thinking about thinking. Cognitive psychologists call this kind of thought **metacognition**—that is, cognition about cognition, or "knowing about knowing" (Flavell, 2004). Metacognition can take many forms. It includes thinking about and knowing when and where to use particular strategies for learning or for solving problems. Conceptualization of metacognition includes several dimensions of executive function, such as planning (deciding on how much time to focus on the task, for example), evaluation (monitoring progress toward task completion, for example), and self-regulation (modifying strategies while working on the task, for example) (Dimmitt & McCormick, 2012).

Metacognition is increasingly recognized as a very important cognitive skill not only in adolescence but also in emerging adulthood (McCormick, Dimmitt, & Sullivan, 2013). In comparison with children, adolescents have an increased capacity to monitor and manage cognitive resources to effectively meet the demands of a learning task (Kuhn, 2009, 2013).

metacognition Cognition about cognition, or "knowing about knowing."

This increased metacognitive ability results in improved cognitive functioning and learning. A recent longitudinal study revealed that from 12 to 14 years of age, adolescents increasingly used metacognitive skills and applied them more effectively in math and history classes (van der Stel & Veenman, 2010). For example, 14-year-olds monitored their own text comprehension more frequently and did so more effectively than did their younger counterparts. Another recent study documented the importance of metacognitive skills, such as planning, strategies, and monitoring, in college students' ability to think critically (Magno, 2010).

Metacognitive skills have been taught to students to help them solve problems. In one study, for each of 30 daily lessons involving verbal math problems, a teacher guided low-achieving students in learning to recognize when they did not know the meaning of a word, did not have all the necessary information to solve a problem, did not know how to subdivide a problem into specific steps, or did not know how to carry out a computation (Cardelle-Elawar, 1992). After completing these lessons, the students who had received the metacognitive training had better math achievement and better attitudes toward math.

Strategies In addition to metamemory, metacognition includes knowledge about strategies. In the view of Michael Pressley (2003), the key to education is helping students learn a rich repertoire of strategies that result in solutions to problems. Good thinkers routinely use strategies and effective planning to solve problems. Good thinkers also know when and where to use strategies. Understanding when and where to use strategies often results from monitoring the learning situation.

Pressley and his colleagues (Pressley & others, 2001, 2003, 2004, 2007) spent considerable time in recent years observing strategy instruction by teachers and strategy use by students in elementary and secondary school classrooms. They conclude that strategy instruction is far less complete and intense than what students need in order to learn how to use strategies effectively. They argue that education ought to be restructured so that students are provided with more opportunities to become competent strategic learners.

As an example of how important strategies are for adolescents, a recent meta-analysis (use of statistical techniques to combine the results of studies) revealed that strategy instruction was the most successful intervention for improving the writing quality of fourth- through twelfth-grade students (Graham & Perin, 2007).

Domain-Specific Thinking Skills Our coverage of metacognition mainly emphasized the importance of some general cognitive skills, such as strategies and self-regulation, in becoming a better thinker. Indeed, researchers have found that metacognitive skills can be taught. For example, adolescents have been effectively taught to become aware of their thinking processes and engage in self-regulation of their learning (Schunk, 2012).

However, it also is very important to teach domain-specific thinking skills to adolescents (Mayer, 2012). In this regard, a review concluded that one of educational psychology's greatest accomplishments is the teaching of domain-specific thinking skills (Mayer & Wittrock, 2006). Thus, a rich tradition in quality education programs has been the teaching of thinking skills within specific subjects, such as writing, mathematics, science, and history (Brahier, 2013; Reutzel & Cooter, 2013). Researchers have found that "it is possible to analyze and teach the underlying cognitive processes required in tasks such as comprehending a passage, writing an essay, solving an arithmetic word problem, answering a scientific question, or explaining an historical event . . ." (Mayer & Wittrock, 2006).

Planning is an important general cognitive skill for adolescents and emerging adults to use, but they also benefit when they apply this and other cognitive skills to specific subjects (Halonen & Santrock, 2013; Mayer, 2012). For example, one study examined how prewriting activities can affect the quality of college students' writing (Kellogg, 1994). As indicated in Figure 3.13, the planning activity of outlining was the prewriting activity that helped writers the most.

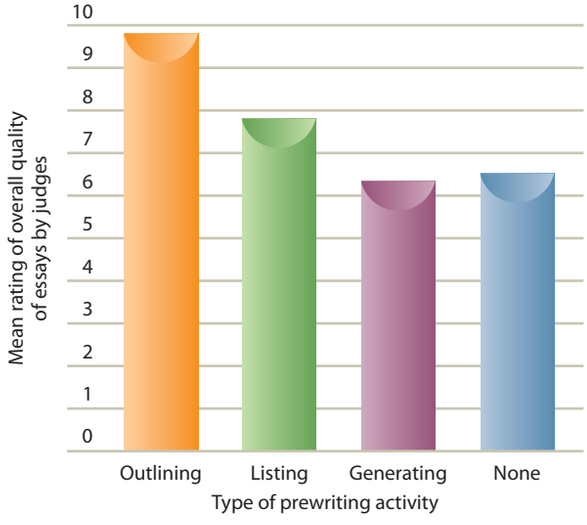


FIGURE **3.13**

THE RELATION OF PREWRITING ACTIVITIES TO ESSAY QUALITY. The most effective prewriting activity for college students was outlining, which involved creating an outline with relevant ideas under multilevel headings. Judges rated the quality of each essay from 1 (lowest) to 10 (highest).

Review *Connect* Reflect

LG3 Characterize the information-processing view of adolescence

Review

- What characterizes the development of cognitive resources?
- What developmental changes characterize attention and memory in adolescence?
- What is executive function?
- How can adolescent decision making be described?
- What characterizes critical thinking in adolescence?
- What distinguishes experts from novices, and how do individuals become experts?
- What is metacognition, and how does it change developmentally?
- What is self-regulatory learning?
- How important is domain-specific thinking?

Connect

- How does research on cognitive control shed light on adolescents' risk-taking behavior, described in Chapter 2?

Reflect *Your Own Personal Journey of Life*

- What were your study skills like during adolescence? How have your study skills changed since adolescence? Has metacognition played a role in improving your study skills?

The Psychometric/Intelligence View

LG4 Summarize the psychometric/intelligence view of adolescence

Intelligence Tests | Multiple Intelligences | Heredity and Environment

The two views of adolescent cognition that we have discussed so far—cognitive developmental and information processing—do not emphasize individual variations in intelligence. The **psychometric/intelligence view** does emphasize the importance of individual differences in intelligence; many advocates of this view favor the use of intelligence tests. An increasing issue in the field of intelligence involves pinning down what the components of intelligence really are.

How can intelligence be defined? **Intelligence** is the ability to solve problems and to adapt and learn from everyday experiences. But even this broad definition doesn't satisfy everyone. As you will see shortly, Robert Sternberg (2012; 2013b, e) proposes that practical know-how should be considered part of intelligence. In his view, intelligence involves weighing options carefully and acting judiciously, as well as developing strategies to improve shortcomings. Also, a definition of intelligence based on a theory such as Lev Vygotsky's, which we discussed earlier in the chapter, would have to include the ability to use the tools of the culture with help from more-skilled individuals. Because intelligence is such an abstract, broad concept, it is not surprising that there are so many different ways to define it.

Interest in intelligence has often focused on individual differences and assessment (Reynolds & Livingston, 2012). *Individual differences* are the stable, consistent ways in which people differ from each other. We can talk about individual differences in personality or any other domain, but it is in the domain of intelligence that the most attention has been directed at individual differences. For example, an intelligence test purports to inform us about whether an adolescent can reason better than others who have taken the test (Lohman & Lakin, 2011; Stanovich, West, & Toplak, 2011).

psychometric/intelligence view A view that emphasizes the importance of individual differences in intelligence; many advocates of this view also argue that intelligence should be assessed with intelligence tests.

intelligence The ability to solve problems and to adapt to and learn from everyday experiences; not everyone agrees on what constitutes intelligence.

mental age (MA) An individual's level of mental development relative to others; a concept developed by Binet.

intelligent quotient (IQ) A person's tested mental age divided by chronological age, multiplied by 100.

normal distribution A symmetrical distribution of values or scores, with a majority of scores falling in the middle of the possible range of scores and few scores appearing toward the extremes of the range.

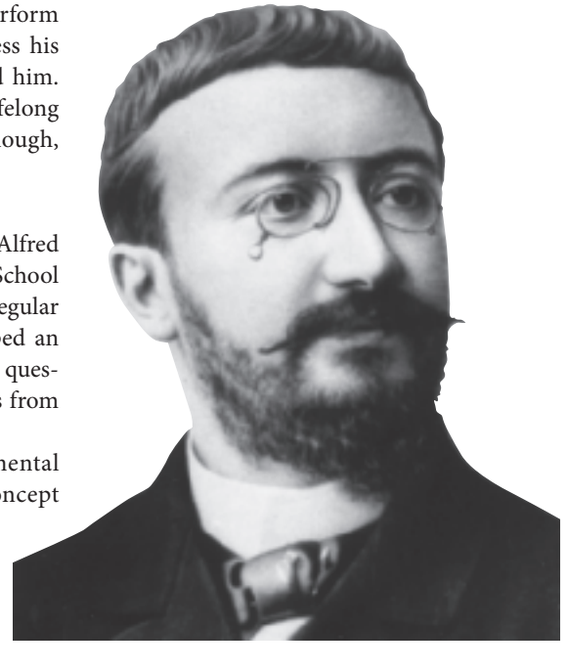
INTELLIGENCE TESTS

Robert Sternberg recalls being terrified of taking IQ tests as a child. He literally froze, he says, when the time came to take such tests. Even as an adult, Sternberg is stung by humiliation when he recalls in the sixth grade being asked to take an IQ test with fifth-graders.

Sternberg eventually overcame his anxieties about IQ tests. Not only did he begin to perform better on them, but at age 13 he devised his own IQ test and began using it to assess his classmates—that is, until the chief school-system psychologist found out and scolded him. Sternberg became so fascinated by intelligence that he made its study one of his lifelong pursuits. Later in this chapter we will discuss his theory of intelligence. To begin, though, let's step back in time to examine the first valid intelligence test.

The Binet Tests In 1904, the French Ministry of Education asked psychologist Alfred Binet to devise a method of identifying children who were unable to learn in school. School officials wanted to reduce crowding by placing students who did not benefit from regular classroom teaching in special schools. Binet and his student Theophile Simon developed an intelligence test to meet this request. The test is called the 1905 Scale. It consisted of 30 questions on topics ranging from the ability to touch one's ear to the ability to draw designs from memory and to define abstract concepts.

Binet developed the concept of **mental age (MA),** an individual's level of mental development relative to others. Not much later, in 1912, William Stern created the concept of **intelligence quotient (IQ),** a person's mental age divided by chronological age (CA), multiplied by 100. That is: IQ = MA/CA × 100. If mental age is the same as chronological age, then the person's IQ is 100. If mental age is above chronological age, then IQ is greater than 100. If mental age is below chronological age, then IQ is less than 100.



Alfred Binet constructed the first intelligence test after being asked to create a measure to identify children who were unlikely to benefit from instruction in France's schools.

The Binet test has been revised many times to incorporate advances in the understanding of intelligence and intelligence tests. These revisions are called the *Stanford-Binet tests* (Stanford University is where the revisions have been done). By administering the test to large numbers of people of different ages from different backgrounds, researchers have found that scores on the Stanford-Binet approximate a normal distribution (see Figure 3.14). A **normal distribution** is symmetrical, with a majority of the scores falling in the middle of the possible range of scores, and few scores appearing toward the extremes of the range.

In 2004, the test—now called the Stanford-Binet 5—was revised to analyze an individual's response in five content areas: fluid reasoning, knowledge, quantitative reasoning, visual-spatial reasoning, and working memory. A general composite score also is still obtained.

The Wechsler Scales Another set of widely used tests is called the *Wechsler scales*, developed by David Wechsler. They include the Wechsler Preschool and Primary Scale of Intelligence—Third Edition (WPPSI-III) to test children from 2 years 6 months to 7 years 3 months of age; the Wechsler Intelligence Scale for Children—Fourth Edition (WISC-IV) for children and adolescents 6 to 16 years of age; and the Wechsler Adult Intelligence Scale—Third Edition (WAIS-III) for adolescents and adults 16 to 89 years of age.

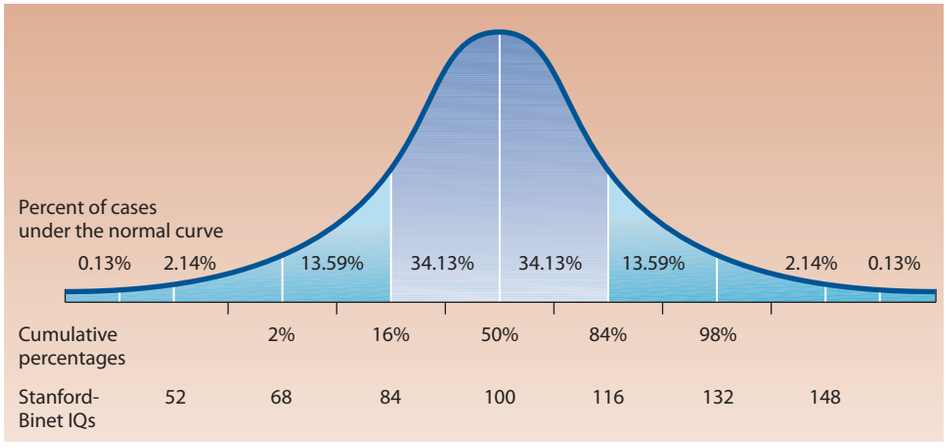


FIGURE **3.14**

THE NORMAL CURVE AND STANFORD-BINET IQ SCORES. The distribution of IQ scores approximates a normal curve. Most of the population falls in the middle range of scores, between 84 and 116. Notice that extremely high and extremely low scores are rare. Only about 1 in 50 individuals has an IQ higher than 132 or lower than 68.

Verbal Subscales

Similarities

An individual must think logically and abstractly to answer a number of questions about how things might be similar.

Example: "In what way are a lion and a tiger alike?"

Comprehension

This subscale is designed to measure an individual's judgment and common sense.

Example: "What is the advantage of keeping money in a bank?"

Nonverbal Subscales

Block Design

An individual must assemble a set of multicolored blocks to match designs that the examiner shows.
Visual-motor coordination, perceptual organization, and the ability to visualize spatially are assessed.

Example: "Use the four blocks on the left to make the pattern on the right."

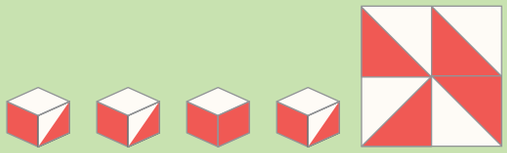


FIGURE **3.15**

SAMPLE SUBSCALES OF THE WECHSLER ADULT INTELLIGENCE SCALE—THIRD EDITION (WAIS-III). The Wechsler includes 11 subscales, 6 verbal and 5 nonverbal. Three of the subscales are shown here. Simulated items similar to those found in the Wechsler Adult Intelligence Scale—Third Edition (WAIS-III). Copyright © 1997 NCS Pearson, Inc. Reproduced with permission. All rights reserved. "Wechsler Adult Intelligence Scale" and "WAIS" are trademarks, in the USA and/or other countries, of Pearson Education, Inc. or its affiliates(s).

Not only do the Wechsler scales provide an overall IQ, but they also yield a number of additional composite scores (for example, the Verbal Comprehension Index, the Working Memory Index, and the Processing Speed Index), allowing the examiner to quickly see patterns of strengths and weaknesses in different areas of the student's intelligence. Three of the Wechsler subscales are shown in Figure 3.15.

Using Intelligence Tests Psychological tests are tools. Like all tools, their effectiveness depends on the knowledge, skill, and integrity of the user. A hammer can be used to build a beautiful kitchen cabinet, or it can be used as a weapon of assault. Like a hammer, psychological tests can be used for positive purposes or they can be badly abused. Here are some cautions about IQ that can help you avoid the pitfalls of using information about an adolescent's intelligence in negative ways:

- *Avoid stereotyping and expectations.* A special concern is that the scores on an IQ test easily can lead to stereotypes and expectations about adolescents. Sweeping generalizations are too often made on the basis of an IQ score. An IQ test should always be considered a measure of current performance. It is not a measure of fixed potential. Maturational changes and enriched environmental experiences can advance an adolescent's intelligence.
- *Know that IQ is not a sole indicator of competence.* Another concern about IQ tests occurs when they are used as the main or sole assessment of competence. A high IQ is not the ultimate human value. It is important to consider not only students' competence in such areas as verbal skills but also their practical skills, their relationship skills, and their moral values (Mayer & others, 2011).

MULTIPLE INTELLIGENCES

Is it more appropriate to think of an adolescent's intelligence as a general ability or as a number of specific abilities? Robert Sternberg and Howard Gardner have proposed influential theories that describe specific types of intelligence. The concept of emotional intelligence also has been proposed as a type of intelligence that differs from what is measured by traditional intelligence tests.

Robert J. Sternberg, who developed the triarchic theory of intelligence.

Sternberg's Triarchic Theory Robert J. Sternberg (1986, 2004, 2010, 2012; 2013d, e, 2014a, b) developed the **triarchic theory of intelligence,** which states that intelligence comes in three forms: (1) *analytical intelligence*, which refers to the ability to analyze, judge, evaluate, compare, and contrast; (2) *creative intelligence*, which consists of the ability to create, design, invent, originate, and imagine; and (3) *practical intelligence*, which involves the ability to use, apply, implement, and put ideas into practice.

Sternberg (2013d, e) says that students with different triarchic patterns perform differently in school. Students with high analytic ability tend to be favored in conventional schools. They often do well in classes in which the teacher lectures and gives objective tests. They often are considered smart students, typically get good grades, do well on traditional IQ tests and the SAT, and later gain admission to competitive colleges.

Students who are high in creative intelligence often are not in the top rung of their class. Creatively intelligent students might not conform to the expectations that teachers have about how assignments should be done. They give unique answers, for which they might get reprimanded or marked down.

Like students high in creative intelligence, students who are practically intelligent often do not relate well to the demands of school. However, these students frequently do well outside the classroom's walls. Their social skills and common sense may allow them

to become successful managers, entrepreneurs, or politicians, despite undistinguished school records.

Sternberg (2012, 2014a, b) argues that it is important for classroom instruction to give students opportunities to learn by exercising all three types of intelligence.

"You're wise, but you lack tree smarts."
© Donald Reilly/The New Yorker Collection/
www.cartoonbank.com

Gardner's Eight Frames of Mind Howard Gardner (1983, 1993, 2002) suggests there are eight types of intelligence, or "frames of mind." These are described here, with examples of the types of vocations in which they are reflected as strengths (Campbell, Campbell, & Dickinson, 2004):

- *Verbal*. The ability to think in words and use language to express meaning (occupations: authors, journalists, speakers)
- *Mathematical*. The ability to carry out mathematical operations (occupations: scientists, engineers, accountants)
- *Spatial*. The ability to think three-dimensionally (occupations: architects, artists, sailors)
- *Bodily-kinesthetic*. The ability to manipulate objects and be physically adept (occupations: surgeons, craftspeople, dancers, athletes)
- *Musical*. A sensitivity to pitch, melody, rhythm, and tone (occupations: composers, musicians).
- *Interpersonal*. The ability to understand and effectively interact with others (occupations: successful teachers, mental health professionals)
- *Intrapersonal*. The ability to understand oneself (occupations: theologians, psychologists)
- *Naturalist*: The ability to observe patterns in nature and understand natural and human-made systems (occupations: farmers, botanists, ecologists, landscapers)

According to Gardner, everyone has all of these intelligences but to varying degrees. As a result, we prefer to learn and process information in different ways. People learn best when they can apply their strong intelligences to the task.

Which of Gardner's eight intelligences are adolescent girls using in this situation?

Both Gardner's and Sternberg's theories include one or more categories related to social intelligence. In Gardner's theory, the categories are interpersonal intelligence and intrapersonal intelligence; in Sternberg's theory, practical intelligence. Another theory that emphasizes interpersonal, intrapersonal, and practical aspects of intelligence is called **emotional intelligence,** which has been popularized by Daniel Goleman (1995) in his book *Emotional Intelligence*. The concept of emotional intelligence was initially developed by Peter Salovey and John Mayer (1990), who define it as the ability to perceive and express emotion accurately and adaptively (such as taking the perspective of others), to understand emotion and emotional knowledge (such as understanding the roles that emotions play in friendship and marriage), to use feelings to facilitate thought (such as being in a positive mood, which is linked to creative thinking), and to manage emotions in oneself and others (such as being able to control one's anger). In one study, assessment of emotional intelligence predicted high school students' final grades in their courses (Gil-Olarte Marquez, Palomera Martin, & Brackett, 2006).

There continues to be considerable interest in the concept of emotional intelligence (Kilgore & others, 2012; Lomas & others, 2012). A recent study of college students revealed that both a general mental abilities test and an emotional intelligence assessment were linked to academic performance, although the general mental abilities test was a better predictor of success (Song & others, 2010). In this study, emotional intelligence was related to the quality of peer relations. Critics argue that too often emotional intelligence broadens the concept of intelligence too far and that its accuracy has not been adequately assessed and researched (Matthews, Zeidner, & Roberts, 2006, 2011).

triarchic theory of intelligence Sternberg's view that intelligence comes in three main forms: analytical, creative, and practical.

emotional intelligence The ability to perceive and express emotion accurately and adaptively, to understand emotion and emotional knowledge, to use feelings to facilitate thought, and to manage emotions in oneself and others.

Do People Have One or Many Intelligences? Figure 3.16 provides a comparison of Sternberg's, Gardner's, and Mayer/Salovey/Goleman's views of intelligence. Notice that Sternberg's view is unique in emphasizing creative intelligence and that

Sternberg	Gardner	Mayer/ Salovey/Goleman
Analytical	Verbal Mathematical	
Creative	Spatial Movement Musical	
Practical	Interpersonal Intrapersonal	Emotional
	Naturalistic	

FIGURE **3.16**

COMPARISON OF STERNBERG'S, GARDNER'S, AND MAYER/SALOVEY/GOLEMAN'S VIEWS

Gardner's includes a number of types of intelligence that are not addressed by the other views. These theories of multiple intelligences have much to offer. They have stimulated us to think more broadly about what makes up people's intelligence and competence (Sternberg, 2013d, f, 2014a, b). And they have motivated educators to develop programs that instruct students in different domains (Campbell, 2008).

Theories of multiple intelligences have their critics (Jensen, 2008). Some critics argue that the research base to support these theories has not yet developed. In particular, some critics say that Gardner's classification seems arbitrary. For example, if musical skills represent a type of intelligence, why don't we also refer to chess intelligence, prize-fighter intelligence, and so on?

A number of psychologists still support the concept of *g* (general intelligence) (Irwin & others, 2012; Lynn, 2012). For example, one expert on intelligence, Nathan Brody (2007) argues that people who excel at one type of intellectual task are likely to excel in other intellectual tasks. Thus, individuals who do well at memorizing lists of digits are also likely to be good at solving verbal problems and spatial layout problems. This general intelligence includes abstract reasoning or thinking, the capacity to acquire knowledge, and problem-solving ability (Brody, 2007; Carroll, 1993).

Some experts who argue for the existence of general intelligence conclude that individuals also have specific intellectual abilities (Brody, 2007; Chiappe & MacDonald, 2005; Hunt, 2011). In one study, John Carroll (1993) conducted an extensive examination of intellectual abilities and concluded that all intellectual abilities are related to each other, a view that supports the concept of general intelligence, but he also pointed out that there are many specialized abilities as well. Some of these specialized abilities, such as spatial abilities and mechanical abilities, are not adequately reflected in the curriculum of most schools. In sum, controversy still surrounds the question of whether it is more accurate to conceptualize intelligence as a general ability, as specific abilities, or as both (Roberts & Lipnevich, 2012; Sternberg, 2013d, f, 2014a, b). Sternberg (2013b, e) actually accepts that there is a *g* in the kinds of analytical tasks that traditional IQ tests assess but thinks that the range of intellectual tasks those tests measure is too narrow.

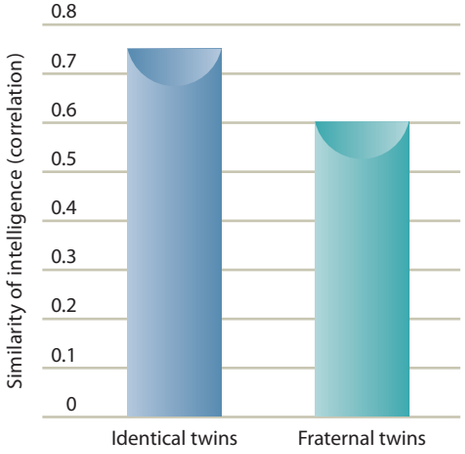


FIGURE **3.17**

CORRELATION BETWEEN INTELLIGENCE TEST SCORES AND TWIN STATUS. The graph represents a summary of research findings that have compared the intelligence test scores of identical and fraternal twins. An approximate 0.15 difference has been found, with a higher correlation for identical twins (0.75) and a lower correlation for fraternal twins (0.60).

HEREDITY AND ENVIRONMENT

An ongoing issue involving intelligence is the extent to which it is due to heredity or to environment. In Chapter 2, you read about how difficult it is to tease apart these influences, but that has not kept psychologists from trying to untangle them.

Heredity How strong is the effect of heredity on intelligence? A committee of respected researchers convened by the American Psychological Association concluded that by late adolescence, research studies reveal a strong influence of heredity on intelligence (Neisser & others, 1996). However, most research on heredity and environment does not include environments that differ radically. Thus, it is not surprising that many studies of heredity, environment, and intelligence show environment to be a fairly weak influence on intelligence (Fraser, 1995).

One strategy for examining the role of heredity in intelligence is to compare the IQs of identical and fraternal twins. Recall from Chapter 2 that identical twins have exactly the same genetic makeup, but fraternal twins do not. If intelligence is genetically determined, say some investigators, identical twins' IQs should be more similar than the intelligence of fraternal twins. Researchers have found that the IQs of identical twins are more similar than those of fraternal twins, but in some studies the difference is not very large (Grigorenko, 2000) (see Figure 3.17).

Have scientists been able to pinpoint specific genes that are linked to intelligence? A recent research review concluded that there may be more than 1,000 genes that affect intelligence, each possibly having a small influence on an individual's intelligence (Davies & others, 2011). However, researchers have not been able to identify the specific genes that contribute to intelligence (Deary, 2012).

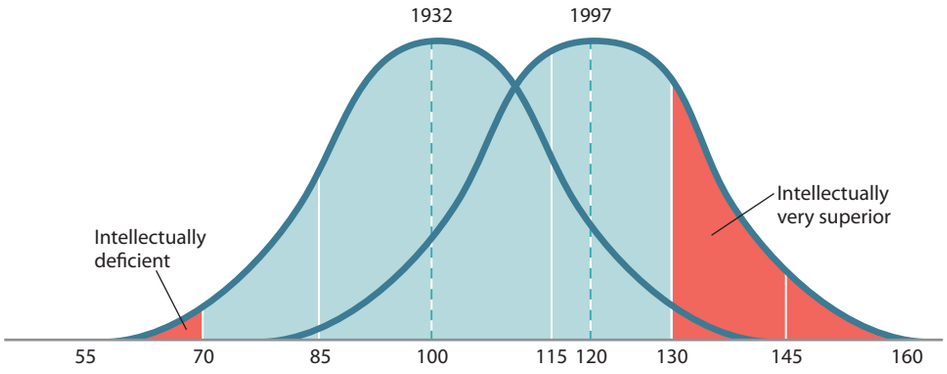


FIGURE **3.18**

THE INCREASE IN IQ SCORES FROM 1932 TO 1997. As measured by the Stanford-Binet intelligence test, American children seem to be getting smarter. Scores of a group tested in 1932 fell along a bell-shaped curve with half below 100 and half above. Studies show that if children took that same test today, half would score above 120 on the 1932 scale. Very few of them would score in the "intellectually deficient" end, on the left side, and about one-fourth would rank in the "very superior" range.

Environment One of the ways that environmental influences on intelligence have been studied is to examine changes in IQ when certain groups of individuals experience improved conditions in their lives. For example, a recent research analysis found a 12- to 18-point increase when children are adopted from low-income families into middle- and upper-income families (Nisbett & others, 2012). Further, as African Americans have gained social, economic, and educational opportunities, the gap between African Americans and non-Latino Whites on standardized intelligence tests has begun to narrow. A recent research review concluded that the IQ gap between African American and non-Latino Whites has been reduced considerably in recent years (Nisbett & others, 2012). This gap especially narrows in college, where African American and non-Latino White students often experience more similar environments than in the elementary and high school years.

Another way to study the environment's influence on intelligence is to compare adolescents who have experienced different amounts of schooling. Schooling does influence intelligence, with the largest effects occurring when adolescents have had no formal education for an extended period, which is linked to lower intelligence (Ceci & Gilstrap, 2000).

Another possible effect of education can be seen in rapidly increasing IQ test scores around the world (Flynn, 1999, 2007, 2011, 2013). IQ scores have been increasing so fast that a high percentage of people regarded as having average intelligence at the turn of the century would be considered below average in intelligence today (see Figure 3.18). If a representative sample of people today took the Stanford-Binet test used in 1932, about one-fourth would be defined as having very superior intelligence, a label usually accorded to fewer than 3 percent of the population. Because the increase has taken place in a relatively short time, it can't be due to heredity, but rather may be due to increasing levels of education attained by a much greater percentage of the world's population or to other environmental factors such as the explosion of information to which people are exposed (Rönnlund & Nilsson, 2008). The worldwide increase in intelligence test scores that has occurred over a short time frame has been called the *Flynn effect* after the researcher who discovered it—James Flynn (1999, 2007, 2011, 2013).

Heredity and Environment Interaction Today, most researchers agree that genetics and environment interact to influence intelligence (Mandelman & Grigorenko, 2011). For many adolescents, this means that positive modifications in environment can change their IQ scores considerably. Although genetic endowment may always influence adolescents' intellectual ability, the environmental influences and opportunities provided to adolescents do make a difference.

developmental **connection**

Nature and Nurture

The epigenetic view emphasizes that development is an ongoing, bidirectional interchange between heredity and environment. Chapter 2, p. 82

Review *Connect* Reflect

LG4 Summarize the psychometric/intelligence view of adolescence

Review

- What is intelligence? What are the main individual tests of intelligence? What are some strategies in interpreting intelligence test scores?
- What theories of multiple intelligences have been developed? Do people have one intelligence or many intelligences?
- What roles do heredity and environment play in intelligence?

Connect

- Compare creative and critical thinking.

Reflect *Your Own Personal Journey of Life*

- Apply Gardner's, Sternberg's, and Mayer/Salovey/Goleman's categories of intelligence to yourself as an adolescent and emerging adult. Write a description of yourself based on each of these views.

Social Cognition

LG5 Explain how social cognition is involved in adolescent development

Adolescent Egocentrism

Social Cognition in the Remainder of the Text

Social cognition refers to the way individuals conceptualize and reason about their social worlds—the people they watch and interact with, their relationships with those people, the groups they participate in, and the way they reason about themselves and others. Our discussion will focus on adolescent egocentrism and our coverage of social cognition in the remainder of the text.

ADOLESCENT EGOCENTRISM

Adolescent egocentrism is the heightened self-consciousness of adolescents, which is reflected in their belief that others are as interested in them as they are in themselves, and in their sense of personal uniqueness and invulnerability. David Elkind (1976) argues that adolescent egocentrism can be dissected into two types of social thinking—imaginary audience and personal fable.

The *imaginary audience* refers to the aspect of adolescent egocentrism that involves attention-getting behavior—the attempt to be noticed, visible, and "onstage." An adolescent boy might think that others are as aware of a few hairs that are out of place as he is. An adolescent girl walks into her classroom and thinks that all eyes are riveted on her complexion. Adolescents especially sense that they are onstage in early adolescence, believing they are the main actors and all others are the audience. You may recall the story of my daughter, Tracy, from the beginning of the chapter. Tracy was exhibiting adolescent egocentrism when she perceived that every person in the restaurant was looking at her single out-of-place hair.

According to Elkind, the *personal fable* is the part of adolescent egocentrism that involves an adolescent's sense of personal uniqueness and invulnerability. Adolescents' sense of personal uniqueness makes them feel that no one can understand how they really feel. For example, an adolescent girl thinks that her mother cannot possibly sense the hurt she feels because her boyfriend has broken up with her. As part of their effort to retain a sense of personal uniqueness, adolescents might craft stories about themselves that are filled with fantasy, immersing themselves in a world that is far removed from reality. Personal fables frequently show up in adolescent diaries.

Elkind (1985) argued that the imaginary audience and personal fable reflect the cognitive egocentrism involved in the transition to formal operational thought. However, Daniel Lapsley and his colleagues (Hill, Duggan, & Lapsley, 2012; Hill & Lapsley, 2010; Lapsley & Hill, 2010;

social cognition The way individuals conceptualize and reason about their social worlds—the people they watch and interact with, their relationships with those people, the groups they participate in, and the way they reason about themselves and others.

adolescent egocentrism The heightened self-consciousness of adolescents, which is reflected in their belief that others are as interested in them as they themselves are, and in their sense of personal uniqueness and invulnerability.

connecting with adolescents

Are Social Media an Amplification Tool for Adolescent Egocentrism?

Are teens drawn to social media to express their imaginary audience and personal fable's sense of uniqueness? A recent analysis concluded that amassing a large number of friends (audience) may help to validate adolescents' perception that their life is a stage and everyone is watching them (Psychster Inc., 2010). A look at a teen's home Twitter comments may suggest to many adults that what teens are reporting is often rather mundane and uninteresting. Typical tweets might include updates like the following: "Studying heavy. Not happy tonight." or "At Starbucks with Jesse. Lattes are great." Possibly for adolescents, though, such tweets are not trivial but rather an expression of the personal fable's sense of uniqueness.

Consider also the Web site *DoesThisLookStupid.com,* which is very popular with adolescents. The teens don't visit the Web site to obtain fashion tips from others wearing clothes similar to theirs. Rather, they think their sense of style is so distinctive that they feel the need to post photos of what they are wearing that day to obtain feedback. As part of this process, the teens assume that everyone actually cares about what they are wearing.

What do you think? Are social media, such as Facebook and Twitter, amplifying the expression of adolescents' imaginary audience and personal fable's sense of uniqueness? (Source: Psychster Inc., 2010)

Lapsley & Stey, 2012) conclude that the distortions in the imaginary audience and personal fable involve the adolescent's ego. As they increasingly develop their own self and identity apart from their parents, their personal fable ideation likely reflects an adaptive narcissism that supports their ego. What role, then, does the personal fable play in adolescent adjustment? See the *Connecting with Health and Well-Being* interlude.

In early research, Elkind found that adolescent egocentrism peaked in early adolescence and then declined (Elkind & Bowen, 1979). However, a recent study of more than 2,300 adolescents and emerging adults from 11 to 21 years of age revealed that adolescent egocentrism was still prominent in the 18- to 21-year-olds (emerging adults) and the results varied by gender (Schwartz, Maynard, & Uzelac, 2008). For example, emerging adult males scored higher on the imaginary audience scale than did males in late adolescence (15- to 18-year-olds), but no age differences on this scale occurred for females.

What characterizes adolescent egocentrism?

SOCIAL COGNITION IN THE REMAINDER OF THE TEXT

Interest in social cognition has blossomed, and the approach has infiltrated many aspects of the study of adolescent development. In the overview of the self and identity in Chapter 4, social cognition's role in understanding the self and identity is explored. In the evaluation of moral development in Chapter 7, considerable time is devoted to discussing Kohlberg's theory, which is a prominent aspect of the study of social cognition in adolescence. Further, in the discussion of families in Chapter 8, the emerging cognitive abilities of the adolescent are evaluated in concert with parent-adolescent conflict and parenting strategies. Also, in the description of peer relations in Chapter 9, the importance of social knowledge and social information processing in peer relations is highlighted.

In the next chapter, you will read extensively about the changes that occur in self-understanding during adolescence. As described in this chapter, the development of the brain coupled with advances in information processing provides a foundation for adolescent self-understanding, which gradually becomes more conscious and reflective.

developmental **connection**

Identity

Major changes in self-understanding take place in the adolescent years. Chapter 4, p. 132

connecting with health and well-being

What Role Does the Personal Fable Play in Adolescent Adjustment?

Some developmentalists conclude that the sense of uniqueness and invincibility that egocentrism generates is responsible for some of the seemingly reckless behavior of adolescents, including drag racing, drug use, failure to use contraceptives during intercourse, and suicide (Dolcini & others, 1989). For example, one study found that eleventh- and twelfth-grade females who were high in adolescent egocentrism were more likely to say they would not get pregnant from engaging in sex without contraception than were their counterparts who were low in adolescent egocentrism (Arnett, 1990).

A study of sixth- through twelfth-graders examined whether aspects of the personal fable were linked to various aspects of adolescent adjustment (Aalsma, Lapsley, & Flannery, 2006). A sense of invulnerability was linked to engaging in risky behaviors such as smoking cigarettes, drinking alcohol, and engaging in acts of delinquency, whereas a sense of personal uniqueness was related to depression and suicidal thoughts. A subsequent study confirmed the findings of the first with regard to the correlation between personal uniqueness, depression, and suicidal thoughts. (Goossens & others, 2002).

These findings indicate that personal uniqueness fables should be treated as a risk factor for psychological problems, especially depression and suicidal tendencies in girls (Aalsma, Lapsley, & Flannery, 2006). Treating invulnerability as a risk factor for adjustment problems is less certain because in the earlier study just described (Aalsma, Lapsley, & Flannery, 2006), a sense of invulnerability was associated not only with risky behavior but also with some positive aspects of adjustment, such as coping and self-worth.

Further reason to question the accuracy of the invulnerability aspect of the personal fable is provided by other research that reveals many adolescents don't consider themselves invulnerable (de Bruin, Parker, & Fischhoff, 2007). Indeed, an increasing number of research studies suggest that, rather than perceiving themselves to be invulnerable, adolescents tend to portray themselves as vulnerable to experiencing a premature death (Jamieson & Romer, 2008; Reyna & Rivers, 2008). For example, in a recent study, 12- to 18-year-olds were asked about their chance of dying in the next year and prior to age 20 (Fischhoff & others, 2010). The adolescents greatly overestimated their chance of dying.

Some researchers have questioned the view that invulnerability is a unitary concept and have argued rather that it consists of two dimensions (Duggan & others, 2000; Lapsley & Hill, 2010):

- *Danger invulnerability,* which describes adolescents' sense of indestructibility and tendency to take on physical risks (driving recklessly at high speeds, for example).
- *Psychological invulnerability,* which captures an adolescent's perceived invulnerability related to personal or psychological distress (getting one's feelings hurt, for example).

How are personal uniqueness and invulnerability linked to adolescent adjustment and problems?

A recent study revealed that adolescents who scored high on a danger invulnerability scale were more likely to engage in juvenile delinquency and/or substance abuse, or to be depressed (Lapsley & Hill, 2010). In this study, adolescents who scored high on psychological invulnerability were less likely to be depressed, had higher self-esteem, and maintained better interpersonal relationships. In terms of psychological invulnerability, adolescents often benefit from the normal developmental challenges of exploring identity options, making new friends, asking someone to go out on a date, and learning a new skill. All of these important adolescent tasks include risk and failure as an option, but if successful result in enhanced self-image.

In the view of Daniel Lapsley and his colleagues (Hill, Duggan, & Lapsley, 2012; Lapsley & Stey, 2012), the separation-individuation process—which involves adolescents separating from their parents and developing independence and identity—is responsible for the findings just discussed, rather than attributing these characteristics to cognitive developmental changes. With respect to personal fables, they argue that invulnerability and personal uniqueness are forms of adolescent narcissism.

Do these findings about the two dimensions of perceived invulnerability have practical applications? For instance, could they help identify adolescents at risk for engaging in self-destructive behavior such as delinquency and substance abuse?

Review *Connect* Reflect

LG5 Explain how social cognition is involved in adolescent development

Review

- What characterizes adolescent egocentrism?
- How is social cognition related to other topics discussed in this text?

Connect

- Compare and contrast the concepts of the imaginary audience and the personal fable.

Reflect *Your Own Personal Journey of Life*

- Think about your friends in early adolescence, late adolescence, and emerging adulthood. Did adolescent egocentrism decline for all of them as they moved through late adolescence and emerging adulthood? Explain how it might especially be maladaptive if adolescent egocentrism continues to strongly characterize the outlook of individuals in the emerging adult years.

reach your **learning goals**

The Brain and Cognitive Development

The Brain

LG1 Describe the developmental changes in the brain during adolescence

The Neuroconstructivist View

- This increasingly popular view states that biological processes and environmental conditions influence the brain's development; the brain has plasticity; and cognitive development is closely linked with brain development.

Neurons

- Neurons, the basic units of the nervous system, are made up of a cell body, dendrites, and an axon. Myelination is the process by which the axon portion of the neuron becomes covered and insulated with a layer of fat cells, which increases the speed and efficiency of information processing in the nervous system. Myelination continues to increase during adolescence. Synaptogenesis in the prefrontal cortex, where reasoning and self-regulation occur, also continues through adolescence.

Brain Structure, Cognition, and Emotion

- The corpus callosum, a large bundle of axon fibers that connects the brain's left and right hemispheres, thickens in adolescence, and this thickening improves the adolescent's ability to process information. The prefrontal cortex, the highest level of the frontal lobes that is involved in reasoning, decision making, and self-control, matures much later (continuing to develop in emerging adulthood) than the amygdala, the part of the limbic system that is the seat of emotions such as anger. The later development of the prefrontal cortex combined with the earlier maturity of the amygdala may explain the difficulty adolescents have in putting the brakes on their emotional intensity.

Experience and Plasticity

- Experience plays an important role in development of the brain in childhood and adolescence. Although early experiences are very important in the development of the brain, the brain retains considerable plasticity in adolescence. New brain cells may be generated during adolescence. The earlier brain injury occurs, the more successful recovery is likely to be.

The Cognitive Developmental View

LG2 Discuss the cognitive developmental view of adolescence

Piaget's Theory

- Piaget's widely acclaimed theory stresses the concepts of adaptation, schemas, assimilation, accommodation, and equilibration. Piaget said that individuals develop through four cognitive stages: sensorimotor, preoperational, concrete operational, and formal operational.

Formal operational thought, which Piaget expected to appear from 11 to 15 years of age, is characterized by abstract, idealistic, and hypothetical-deductive thinking. Some experts argue that formal operational thought has two phases: early and late. Individual variation in adolescent cognition is extensive. Many young adolescents are still consolidating their concrete operational thought or are early formal operational thinkers rather than full-fledged ones. Piaget's ideas have been applied to education. In terms of Piaget's contributions, we owe to him the entire field of cognitive development and a masterful list of concepts. He also was a genius at observing children. Criticisms of Piaget's theory focus on estimates of competence, stages, training to reason at higher stages, and the role of culture and education. Neo-Piagetians have proposed some substantial changes in Piaget's theory. Some experts argue that the idealism of Piaget's formal operational stage declines in young adults, being replaced by more realistic, pragmatic thinking. Perry said that adolescents often engage in dualistic, absolutist thinking, whereas young adults are more likely to think reflectively and relativistically. Postformal thought is reflective, relativistic, and contextual; provisional; realistic; and open to emotions and subjective.

Wisdom is expert knowledge about the practical aspects of life that permits excellent judgment about important matters. Baltes and his colleagues have found that high levels of wisdom are rare, the time frame of late adolescence and early adulthood is the main age window for wisdom to emerge, factors other than age are critical for a high level of wisdom to develop, and personality-related factors are better predictors of wisdom than cognitive factors such as intelligence. Sternberg argues that wisdom involves both academic and practical aspects of intelligence. His balance theory emphasizes making competent decisions that take into account self-interest, the interests of others, and contexts to produce a common good. Sternberg argues that wisdom should be taught in schools.

Vygotsky's Theory

- Vygotsky's view stimulated considerable interest in the idea that knowledge is situated and collaborative. One of his important concepts is the zone of proximal development, which involves guidance by more skilled peers and adults. Vygotsky argued that learning the skills of the culture is a key aspect of development. Piaget's and Vygotsky's views are both constructivist, although Vygotsky's view is a stronger social constructivist view than Piaget's. In both views, teachers should be facilitators, not directors, of learning. Criticisms of Vygotsky's view focus on facilitators possibly being too helpful and adolescents expecting others to do things for them.

The Information-Processing View

LG3 Characterize the information-processing view of adolescence

Cognitive Resources

- Capacity and speed of processing, often referred to as cognitive resources, increase across childhood and adolescence. Changes in the brain serve as biological foundations for developmental changes in cognitive resources. In terms of capacity, the increase is reflected in older children and adolescents being able to hold in mind simultaneously several dimensions of a topic. A reaction-time task has often been used to assess speed of processing. Processing speed continues to improve in adolescence.

Attention and Memory

- Attention is the focusing of mental resources. Adolescents typically have better attentional skills than children do, although there are wide individual differences in how effectively adolescents deploy their attention. Four ways that adolescents can allocate their attention are selective attention, divided attention, sustained attention, and executive attention. Multitasking is an example of divided attention and it can harm adolescents' attention when they are engaging in a challenging task. Adolescents have better short-term memory, working memory, and long-term memory than children do.

Executive Function

- Higher-order cognitive processes such as exercising cognitive control, making decisions, reasoning, thinking critically, thinking creatively, and metacognition are often called executive function. Adolescence is characterized by a number of advances in executive function. Cognitive control involves aspects such as focusing attention, reducing interfering thoughts, and being cognitively flexible. Across childhood and adolescence, cognitive control (inhibition) increases with age and this increase is likely due to the maturation of the prefrontal cortex. Older adolescents make better decisions than younger adolescents, who in turn are better at this than children are. Being able to make competent decisions,

however, does not mean adolescents will make such decisions in everyday life, where breadth of experience comes into play. Adolescents often make better decisions when they are calm than when they are emotionally aroused. Social contexts, especially the presence of peers, influence adolescent decision making. Critical thinking involves thinking reflectively and productively and evaluating the evidence. Mindfulness is an important aspect of thinking critically. Cognitive and physical training, such as mindfulness and yoga, are increasingly being recommended to improve adolescents' functioning. Adolescence is an important transitional period in critical thinking because of such cognitive changes as increased speed, automaticity, and capacity of information processing; more breadth of content knowledge; increased ability to construct new combinations of knowledge; and a greater range and spontaneous use of strategies. Thinking creatively is the ability to think in novel and unusual ways and discover unique solutions to problems. Guilford distinguished between convergent and divergent thinking. A number of strategies, including brainstorming, not overcontrolling, encouraging internal control, and introducing adolescents to creative people, can be used to stimulate creative thinking. An expert is the opposite of a novice (someone who is just beginning to learn a content area). Experts are better than novices at detecting features and meaningful patterns of information, accumulating more content knowledge and organizing it effectively, and retrieving important aspects of knowledge with little effort. Becoming an expert usually involves talent and deliberate practice and motivation. Metacognition is cognition about cognition, or knowing about knowing. In Pressley's view, the key to education is helping students learn a rich repertoire of strategies that can be applied in solving problems. Adolescents' thinking skills benefit when they are taught general metacognitive skills and domain-specific thinking skills.

The Psychometric/Intelligence View

LG4 Summarize the psychometric/intelligence view of adolescence

Intelligence Tests

- Intelligence is the ability to solve problems and to adapt and learn from everyday experiences. A key aspect of intelligence focuses on its individual variations. Traditionally, intelligence has been measured by tests designed to compare people's performance on cognitive tasks. Alfred Binet developed the first intelligence test and created the concept of mental age. William Stern developed the concept of IQ for use with the Binet test. Revisions of the Binet test are called the Stanford-Binet. The test scores on the Stanford-Binet approximate a normal distribution. The Wechsler scales, created by David Wechsler, are the other main intelligence assessment tool. These tests provide an overall IQ and other composite scores, including the Working Memory Index and the Information Processing Speed Index. The single number provided by many IQ tests can lead to false expectations, and IQ test scores should be only one type of information used to evaluate an adolescent.

Multiple Intelligences

- Sternberg's triarchic theory states that there are three main types of intelligence: analytical, creative, and practical. Gardner has proposed that there are eight types of intelligence: verbal, mathematical, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, and naturalist. Emotional intelligence is the ability to perceive and express emotion accurately and adaptively, to understand emotion and emotional knowledge, to use feelings to facilitate thought, and to manage emotions in oneself and others. The multiple intelligences approaches have broadened the definition of intelligence and motivated educators to develop programs that instruct students in different domains. Critics maintain that the multiple intelligence theories have classifications that seem arbitrary and factors that really aren't part of intelligence, such as musical skills and creativity.

Heredity and Environment

- Many studies show that by late adolescence intelligence is strongly influenced by heredity, but many of these studies do not reflect environments that are radically different. A well-documented environmental influence on intelligence is schooling. Also, probably because of increased education, intelligence test scores have risen considerably around the world in recent decades—an increase called the Flynn effect—and this supports the role of environment in intelligence. In sum, intelligence is influenced by heredity and environment.

Social Cognition

LG5 Explain how social cognition is involved in adolescent development

Adolescent Egocentrism

- Social cognition refers to how people conceptualize and reason about their social world, including the relation of the self to others. Adolescent egocentrism is adolescents' heightened self-consciousness, mirrored in their belief that others are as interested in them as they are. According to Elkind, adolescent egocentrism consists of an imaginary audience and a personal fable. Researchers have recently found that adolescents actually overestimate their chance of experiencing a premature death, indicating that they perceive themselves to be far less invulnerable than Elkind's personal fable indicates. An alternative to Elkind's cognitive egocentrism view is the view that the imaginary audience and personal fable are mainly the result of changes in perspective taking and the adolescent's ego. Also, recently invulnerability has been described as having two dimensions—danger invulnerability and psychological invulnerability—which have different outcomes for adolescence.

Social Cognition in the Remainder of the Text

- We study social cognition throughout this text, especially in chapters on the self and identity, moral development, peers, and families.

key terms

neuroconstructivist view 89
neurons 89
myelination 89
synapses 89
corpus callosum 91
prefrontal cortex 91
limbic system 91
amygdala 91
schema 93
assimilation 93
accommodation 93
equilibration 93
sensorimotor stage 94
preoperational stage 94
concrete operational stage 94
formal operational stage 95
hypothetical-deductive reasoning 95
neo-Piagetians 97
postformal thought 98
wisdom 98
zone of proximal development (ZPD) 101
social constructivist approach 101
attention 103
selective attention 103
divided attention 103
sustained attention 103
executive attention 104
executive function 106
cognitive control 106
dual-process model 109
critical thinking 109
creativity 111
convergent thinking 111
divergent thinking 111
metacognition 114
psychometric/intelligence view 116
intelligence 116
mental age (MA) 116
intelligence quotient (IQ) 116
normal distribution 116
triarchic theory of intelligence 119
emotional intelligence 119
social cognition 122
adolescent egocentrism 122

key people

Charles Nelson 90
Laurence Steinberg 91
Jay Giedd 91
Elizabeth Sowell 91
Jean Piaget 93
Robbie Case 97
William Perry 97
Gisela Labouvie-Vief 97
Paul Baltes 99
Robert Sternberg 100
Lev Vygotsky 100
Deanna Kuhn 102
Valerie Reyna 109
Ellen Langer 110
Robert Roeser 110
Philip Zelazo 110
J. P. Guilford 111
Michael Pressley 115
Alfred Binet 117
William Stern 117
David Wechsler 117
Howard Gardner 119
Daniel Goleman 119
Peter Salovey 119
John Mayer 119
Nathan Brody 120
David Elkind 122
Daniel Lapsley 122

resources for **improving the lives of adolescents**

The Adolescent Brain (2012)
Edited by Valerie Reyna and others
Washington, DC: American Psychological Association

Leading experts discuss the rapidly expanding field of developmental cognitive neuroscience in adolescence and emerging adulthood. Chapters focus on links between the changing brain and learning, reasoning, and decision making.

Adolescent Thinking
Deanna Kuhn
In R. M. Lerner & L. Steinberg (Eds.), *Handbook of Adolescent Psychology* (2009, 3rd ed.)
New York: Wiley

An in-depth examination of the important changes in executive function and other aspects of cognitive development in adolescence.

Child Development Perspectives **(2012, Vol. 6, Issue 2, 105–173)**
A number of articles address the recent interest in executive function in adolescence and the use of cognitive and physical training activities, such as mindfulness and yoga, to improve adolescents' functioning,

self-**assessment**

The Student Online Learning Center includes the following self-assessments for further exploration:

- *Exploring Changes in My Thinking from Adolescence to Adulthood*
- *My Study Skills*
- *Examining My Creative Thinking*
- *Evaluating Myself on Gardner's Eight Types of Intelligence*
- *How Emotionally Intelligent Am I?*