CHAPTER 2

COGNITIVE AND LANGUAGE DEVELOPMENT

Ah! What would the world be to us
If the children were no more?
We should dread the desert behind us
Worse than the dark before.

—Henry Wadsworth Longfellow
American Poet, 19th Century

Chapter **Outline**

An Overview of Child Development (1)

Exploring What Development Is
Processes and Periods
Developmental Issues
Development and Education

Cognitive Development (2)

The Brain
Piaget's Theory
Vygotsky's Theory

Language Development (3)

What Is Language?
Biological and Environmental Influences
Language Development

Learning **Goals**

1. Define development and explain the main processes, periods, and issues in development, as well as links between development and education.
2. Discuss the development of the brain and compare the cognitive developmental theories of Jean Piaget and Lev Vygotsky.
3. Identify the key features of language, the biological and environmental influences on language, and the typical growth of child's language.

Teaching **Stories** Donene Polson

In this chapter you will study Lev Vygotsky's sociocultural cognitive theory of development. Donene Polson's classroom reflects Vygotsky's emphasis on the importance of collaboration among a community of learners. Donene teaches at Washington Elementary School in Salt Lake City, an innovative school that emphasizes the importance of people learning together (Rogoff, Turkanis, & Bartlett, 2001). Children as well as adults plan learning activities. Throughout the day at school, students work in small groups.

Donene loves working in a school where students, teachers, and parents work as a community to help children learn (Polson, 2001). Before the school year begins, she meets with parents at each family's home to prepare for the upcoming year, getting acquainted and establishing schedules to determine when parents can contribute to classroom instruction. At monthly teacher-parent meetings, Donene and the parents plan the curriculum and discuss children's progress. They brainstorm about community resources that can be used to promote children's learning.

Many students come back to tell Donene that experiences in her classroom made important contributions to their development and learning. For example, Luisa Magarian reflected on how her experience in Donene's classroom helped her work with others in high school:

> From having responsibility in groups, kids learn how to deal with problems and listen to each other or try to understand different points of view. They learn how to help a group work smoothly and how to keep people interested in what they are doing. . . . As coeditor of the student news magazine at my high school, I have to balance my eagerness to get things done with patience to work with other students. (Rogoff, Turkanis, & Bartlett, 2001, pp. 84–85)

As Donene Polson's story shows, theories of cognitive development can form the basis of innovative instructional programs.

Preview

Examining the shape of children's development allows us to understand it better. This chapter—the first of two on development—focuses on children's cognitive and language development. Before we delve into these topics, though, we need to explore some basic ideas about development.

1 AN OVERVIEW OF CHILD DEVELOPMENT

Exploring What Development Is | Processes and Periods | Developmental Issues | Development and Education

Twentieth-century Spanish-born American philosopher George Santayana once reflected, "Children are on a different plane. They belong to a generation and way of feeling properly their own." Let's explore what that plane is like.

EXPLORING WHAT DEVELOPMENT IS

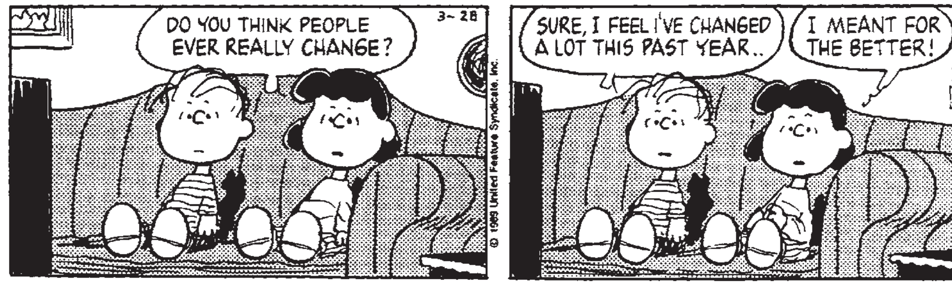
Why study children's development? As a teacher, you will be responsible for a new wave of children each year in your classroom. The more you learn about children's development, the more you can understand at what level it is appropriate to teach them.

Just what do psychologists mean when they speak of a person's "development"? **Development** is the pattern of biological, cognitive, and socioemotional changes that begins at conception and continues through the life span. Most development involves growth, although it also eventually involves decay (dying).

development The pattern of biological, cognitive, and socioemotional processes that begins at conception and continues through the life span. Most development involves growth, although it also eventually involves decay (dying).

PROCESSES AND PERIODS

The pattern of child development is complex because it is the product of several processes: biological, cognitive, and socioemotional. Development also can be described in terms of periods.



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Children are the legacy we leave for the time we will not live to see.

—Aristotle
Greek Philosopher, 4th Century B.C.

Biological, Cognitive, and Socioemotional Processes *Biological processes* produce changes in the child's body and underlie brain development, height and weight gains, motor skills, and puberty's hormonal changes. Genetic inheritance plays a large part.

Cognitive processes involve changes in the child's thinking, intelligence, and language. Cognitive developmental processes enable a growing child to memorize a poem, figure out how to solve a math problem, come up with a creative strategy, or speak meaningfully connected sentences.

Socioemotional processes involve changes in the child's relationships with other people, changes in emotion, and changes in personality. Parents' nurturance toward their child, a boy's aggressive attack on a peer, a girl's development of assertiveness, and an adolescent's feelings of joy after getting good grades all reflect socioemotional processes in development.

Biological, cognitive, and socioemotional processes are inextricably intertwined (Diamond, Casey, & Munakata, 2011). Consider a child smiling in response to a parent's touch. This response depends on biological processes (the physical nature of touch and responsiveness to it), cognitive processes (the ability to understand intentional acts), and socioemotional processes (the act of smiling often reflects a positive emotional feeling, and smiling helps to connect us in positive ways with other human beings). Two rapidly emerging fields further explore this connection across biological, cognitive, and socioemotional processes:

- *developmental cognitive neuroscience,* which explores links between development, cognitive processes, and the brain (Diamond, Casey, & Munakato, 2011; Nelson, 2011), For example, later in this chapter you will learn about connections between developmental changes in regions of the brain and children's thinking.
- *developmental social neuroscience,* which examines connections between socioemotional processes, development, and the brain (Bell, Greene, & Wolfe, 2010; de Haan & Gunnar, 2009). For example, later in this chapter you will read about developmental changes in the brain and adolescents' decision making and risk-taking behavior.

DEVELOPMENT

Periods of Development For the purposes of organization and understanding, we commonly describe development in terms of periods. In the most widely used system of classification, the developmental periods are infancy, early childhood, middle and late childhood, adolescence, early adulthood, middle adulthood, and late adulthood.

Infancy extends from birth to 18 to 24 months. It is a time of extreme dependence on adults. Many activities are just beginning, such as language development, symbolic thought, sensorimotor coordination, and social learning.

Early childhood (sometimes called the *preschool years*) extends from the end of infancy to about 5 years. During this period, children become more self-sufficient, develop school readiness skills (such as learning to follow instructions and identify

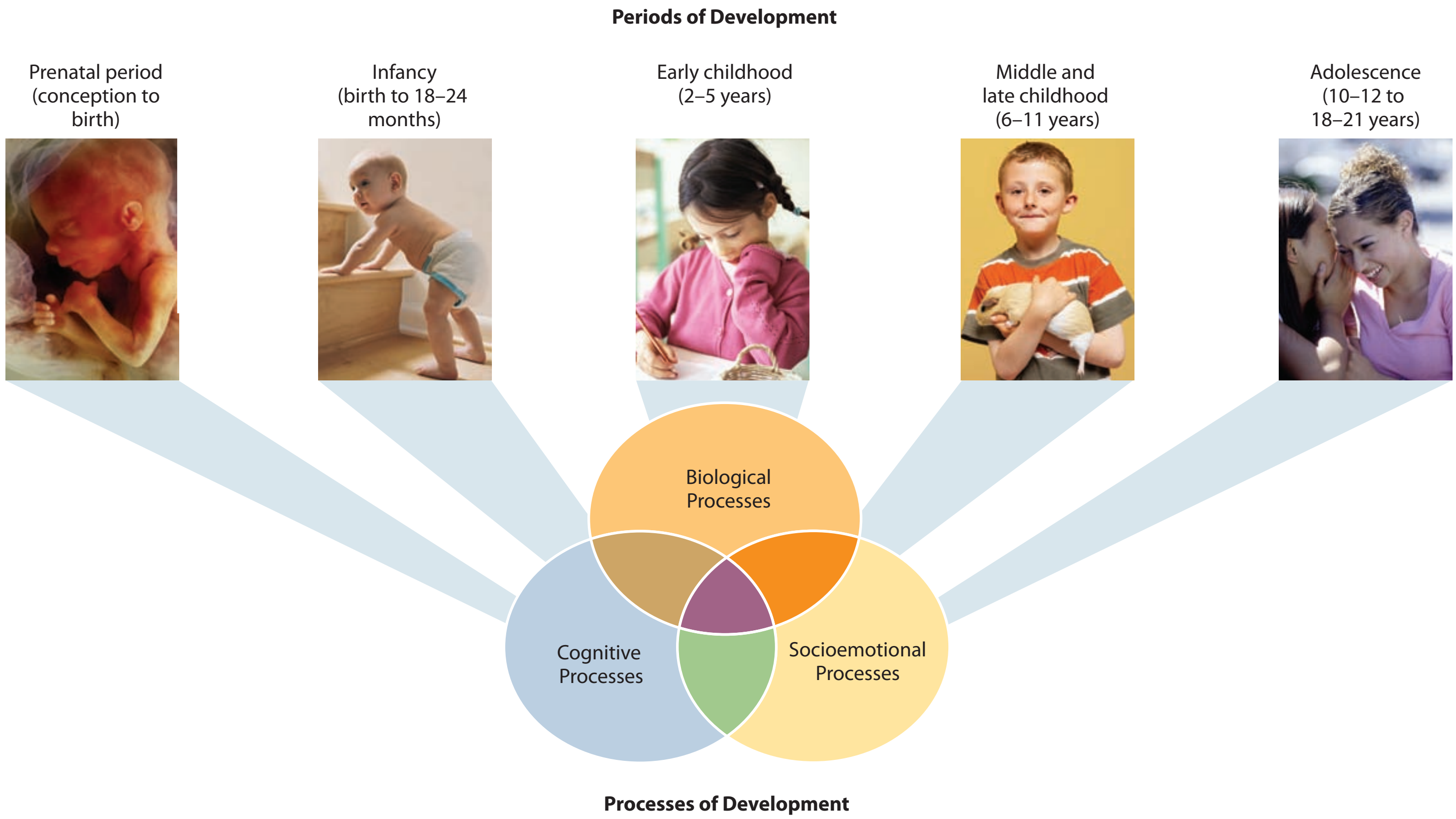


FIGURE 2.1 PERIODS AND PROCESSES OF DEVELOPMENT

Development moves through the infancy, early childhood, middle and late childhood, and adolescence periods. These periods of development are the result of biological, cognitive, and socioemotional processes.

letters), and spend many hours with peers. First grade typically marks the end of early childhood.

Middle and late childhood (sometimes called the *elementary school years*) extends from about 6 to 11 years of age. Children master the fundamental skills of reading, writing, and math, achievement becomes a more central theme, and self-control increases. In this period, children interact more with the wider social world beyond their family.

Adolescence involves the transition from childhood to adulthood. It begins around ages 10 to 12 and ends around 18 to 21. Adolescence starts with rapid physical changes, including height and weight gains and development of sexual functions. Adolescents intensely pursue independence and seek their own identity. Their thought becomes more abstract, logical, and idealistic.

Adult developmental periods have been described, but we have confined our discussion to the periods most relevant for children's and adolescents' education. The child and adolescent periods of human development are shown in Figure 2.1 along with the processes of development (biological, cognitive, and socioemotional). The interplay of these processes produces the periods of human development.

DEVELOPMENTAL ISSUES

Despite all of the knowledge that developmentalists have acquired, debate continues about the relative importance of factors that influence the developmental processes and about how the periods of development are related. The most important issues in the study of children's development include nature and nurture, continuity and discontinuity, and early and later experience.

Nature and Nurture The **nature-nurture issue** involves the debate about whether development is primarily influenced by nature or by nurture (Cosmides, 2011; Eagly & Wood, 2011). *Nature* refers to an organism's biological inheritance, *nurture* to its environmental experiences. Almost no one today argues that development can be explained by nature or nurture alone. But some ("nature" proponents) claim that the most important influence on development is biological inheritance, and others ("nurture" proponents) claim that environmental experiences are the most important influence.

According to the nature proponents, the range of environments can be vast, but a genetic blueprint produces commonalities in growth and development (Mader, 2011). We walk before we talk, speak one word before two words, grow rapidly in infancy and less so in early childhood, and experience a rush of sexual hormones in puberty. Extreme environments—those that are psychologically barren or hostile—can stunt development, but nature proponents emphasize the influence of tendencies that are genetically wired into humans.

By contrast, other psychologists emphasize the importance of nurture, or environmental experiences, to development (Grusec, 2011; Kopp, 2011). Experiences run the gamut from the individual's biological environment (nutrition, medical care, drugs, and physical accidents) to the social environment (family, peers, schools, community, media, and culture). For example, a child's diet can affect how tall the child grows and even how effectively the child can think and solve problems.

Children are busy becoming something they have not quite grasped yet, something which keeps changing.

—Alastair Reid
American Poet, 20th Century

Are children completely at the mercy of their genes and environment as they develop? Their genetic heritage and environmental experiences are pervasive influences on their development. However, children are more than the outcomes of their heredity and the environment they experience; they also can author a unique developmental path by changing the environment. As one psychologist recently concluded,

> In reality, we are both the creatures and creators of our worlds. We are . . . the products of our genes and environments. Nevertheless, . . . the stream of causation that shapes the future runs through our present choices. . . . Mind matters. . . . Our hopes, goals, and expectations influence our future. (Myers, 2010, p. 168)

Continuity and Discontinuity The **continuity-discontinuity issue** focuses on the extent to which development involves gradual, cumulative change (continuity) or distinct stages (discontinuity). For the most part, developmentalists who emphasize nurture usually describe development as a gradual, continuous process, like the seedling's growth into an oak. Those who emphasize nature often describe development as a series of distinct stages, like the change from caterpillar to butterfly.

Consider continuity first. A child's first word, though seemingly an abrupt, discontinuous event, is actually the result of weeks and months of growth and practice. Puberty, another seemingly abrupt, discontinuous occurrence, is actually a gradual process occurring over several years.

Viewed in terms of discontinuity, each person is described as passing through a sequence of stages in which change is qualitatively rather than quantitatively different. A child moves at some point from not being able to think abstractly about the world to being able to. This is a qualitative, discontinuous change in development, not a quantitative, continuous change.

Early and Later Experience The **early-later experience issue** focuses on the degree to which early experiences (especially in infancy) or later experiences are the key determinants of the child's development. That is, if infants experience harmful circumstances, can those experiences be overcome by later, positive ones? Or are the early experiences so critical—possibly because they are the infant's first, prototypical experiences—that they cannot be overridden by a later, better environment?

The early-later experience issue has a long history and continues to be hotly debated among developmentalists (Kopp, 2011; Schaie, 2011). Some developmentalists

nature-nurture issue Nature refers to an organism's biological inheritance, nurture to environmental influences. The "nature" proponents claim biological inheritance is the most important influence on development; the "nurture" proponents claim environmental experiences are the most important.

continuity-discontinuity issue The issue regarding whether development involves gradual, cumulative change (continuity) or distinct stages (discontinuity).

early-later experience issue The issue of the degree to which early experiences (especially infancy) or later experiences are the key determinants of the child's development.

argue that, unless infants experience warm, nurturing care during the first year or so of life, their development will never quite be optimal (Sroufe, 2007). In contrast, later-experience advocates argue that children are malleable throughout development, and that later sensitive caregiving is just as important as earlier sensitive caregiving.

Evaluating the Developmental Issues Most developmentalists recognize that it is unwise to take an extreme position on the issues of nature and nurture, continuity and discontinuity, and early and later experiences. Development is not all nature or all nurture, not all continuity or all discontinuity, and not all early or later experiences. However, there is still spirited debate about how strongly development is influenced by each of these factors (Goldsmith, 2011; Phillips & Lowenstein, 2011).

DEVELOPMENT AND EDUCATION

In Chapter 1 we briefly described the importance of engaging in developmentally appropriate teaching practices. Here we expand on this important topic.

Developmentally appropriate teaching takes place at a level that is neither too difficult and stressful nor too easy and boring for the child's developmental level (Bredekamp, 2011). One of the challenges of developmentally appropriate teaching is that you likely will have children with an age range of several years and a range of abilities and skills in the classes you teach. Competent teachers are aware of these developmental differences. Rather than characterizing students as "advanced," "average," and "slow," they recognize that their development and ability are complex, and children often do not display the same competence across different skills.

Thinking Back/Thinking Forward

New guidelines exist for developmentally appropriate education (NAEYC, 2009). Chapter 3, p. 86

Splintered development refers to the circumstances in which development is uneven across domains (Horowitz & others, 2005). One student may have excellent math skills but poor writing skills. Within the area of language, another student may have excellent verbal language skills but not have good reading and writing skills. Yet another student may do well in science but lack social skills.

Cognitively advanced students whose socioemotional development is at a level expected for much younger children present a special challenge. For example, a student may excel at science, math, and language but be immature emotionally. Such a child may not have any friends and be neglected or rejected by peers. This student will benefit considerably from having a teacher who helps her or him learn how to manage emotions and behave in more socially appropriate ways.

As we discuss development in this chapter and the next, keep in mind how the developmental changes we describe can help you understand the optimal level for teaching and learning. For example, it is not a good strategy to try to push children to read before they are developmentally ready—but when they are ready, reading materials should be presented at the appropriate level (Bredekamp, 2011; Jalongo, 2011).

splintered development The circumstances in which development is uneven across domains.

Review, Reflect, and Practice

1 Define development and explain the main processes, periods, and issues in development, as well as links between development and education.

REVIEW

- What is the nature of development?
- What three broad processes interact in a child's development? What general periods do children go through between birth and the end of adolescence?

(continued)

Review, Reflect, and Practice

REVIEW (CONTINUED)

- What are the main developmental issues? What conclusions can be reached about these issues?
- What implications does the concept of development have for the notion of "appropriate" learning?

REFLECT

- Give an example of how a cognitive process could influence a socioemotional process in the age of children you plan to teach. Then give an example of how a socioemotional process could influence a cognitive process in this age group.

PRAXIS™ PRACTICE

1. Mr. Huxtaby is giving a talk on development to a parent-teacher organization. In his talk, which of the following is he most likely to describe as not being an example of development?
   a. pubertal change
   b. improvement in memory
   c. change in friendship
   d. an inherited tendency to be shy
2. Ms. Halle teaches third grade. Which period of development is likely to be of most interest to her?
   a. infancy
   b. early childhood
   c. middle childhood and late childhood
   d. adolescence
3. Piaget argued that children progress through a series of cognitive development stages. In contrast, Skinner stressed that individuals simply learn more as time goes on. Which developmental issue is highlighted in their disagreement?
   a. continuity and discontinuity
   b. early and later experience
   c. nature and nurture
   d. biological and socioemotional development
4. Alexander's scores on standardized mathematics achievement tests are always very high—among the highest in the nation. In contrast, his scores on reading achievement tests indicate that he is about average. This is an example of
   a. developmentally appropriate teaching.
   b. early versus later development.
   c. nature versus nurture.
   d. splintered development.

Please see the answer key at the end of the book.

2 COGNITIVE DEVELOPMENT

The Brain | Piaget's Theory | Vygotsky's Theory

Twentieth-century American poet Marianne Moore said that the mind is "an enchanting thing." How this enchanting thing develops has intrigued many psychologists. First, we explore increasing interest in the development of the brain and then turn to two major cognitive theories—Piaget's and Vygotsky's.

THE BRAIN

Until recently little was known about how the brain changes as children develop. Not long ago scientists thought that genes determine how children's brains are "wired." Whatever brain heredity dealt them, children were essentially stuck with it. This view, however, turned out to be wrong. Instead, the brain has considerable *plasticity*, or the ability to change, and its development depends on experience (Nelson, 2011; Toga & Mazziotta, 2011). In other words, what children do can change the development of their brain.

Development of Neurons and Brain Regions The number and size of the brain's nerve endings continue to grow at least into adolescence. Some of the brain's increase in size also is due to **myelination,** the process of encasing many cells in the brain with a myelin sheath (see Figure 2.2). This process increases the speed at which information travels through the nervous system (Schnaar & Lopez, 2009). Myelination in brain areas important in focusing attention is not complete until about 10 years of age. The implications for teaching are that children will have difficulty focusing their attention and maintaining it for very long in early childhood, but their attention will improve as they move through the elementary school years. The most extensive increase in myelination, which occurs in the brain's frontal lobes, where reasoning and thinking occur, takes place during adolescence (Giedd & others, 2009).

Another important aspect of the brain's development at the cellular level is the dramatic increase in connections between neurons (nerve cells) (Turrigiano, 2010). *Synapses* are tiny gaps between neurons where connections between neurons are made. Researchers have discovered an interesting aspect of synaptic connections. Nearly twice as many of these connections are made than ever will be used (Huttenlocher & Dabholkar, 1997). The connections that are used become strengthened and will survive, whereas the unused ones will be replaced by other pathways or disappear. That is, in the language of neuroscience, these connections will be "pruned." Figure 2.3 vividly shows the dramatic growth and later pruning of synapses in the visual, auditory, and prefrontal cortex areas of the brain. These areas are critical for higher-order cognitive functioning such as learning, memory, and reasoning.

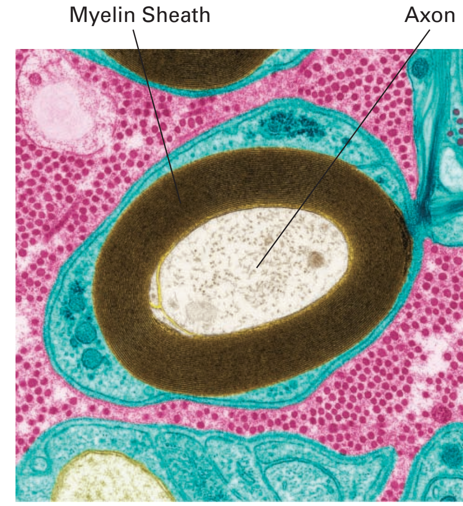


FIGURE 2.2 MYELINATED NERVE

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?*

DEVELOPMENT

myelination The process of encasing many cells in the brain with a myelin sheath that increases the speed at which information travels through the nervous system.

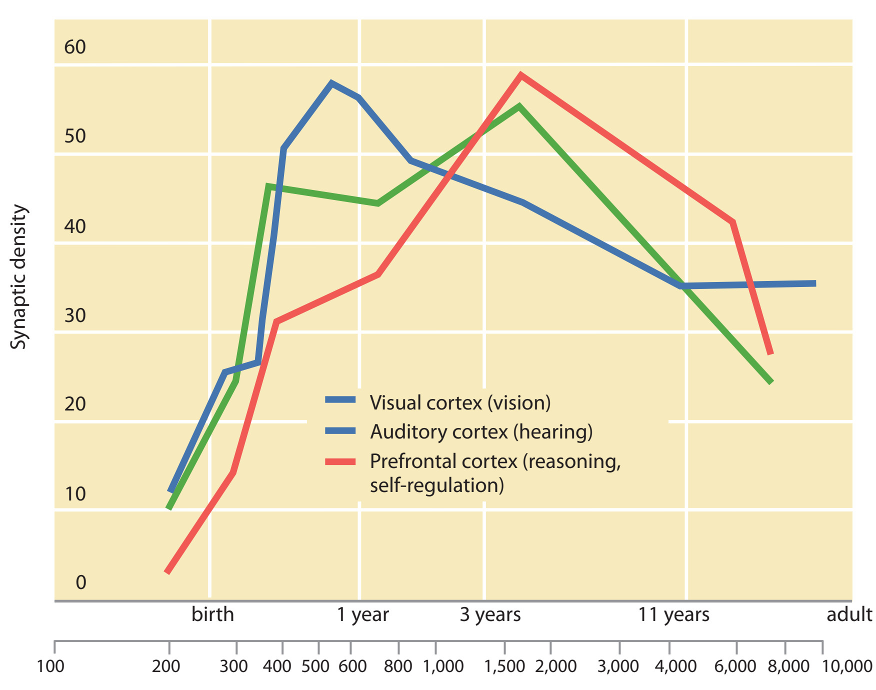


FIGURE 2.3 SYNAPTIC DENSITY IN HUMAN BRAIN FROM INFANCY TO ADULTHOOD

The graph shows the dramatic increase and then pruning of synaptic density for three regions of the brain: visual cortex, auditory cortex, and prefrontal cortex. Synaptic density is believed to be an important indication of the extent of connectivity between neurons.

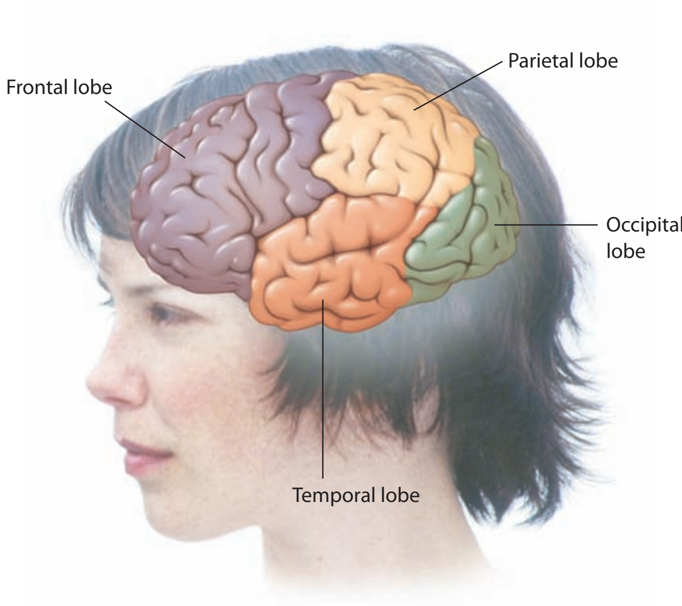


FIGURE 2.4 THE BRAIN'S FOUR LOBES

Shown here are the locations of the brain's four lobes: frontal, occipital, temporal, and parietal.

Thinking Back/Thinking Forward

A surge of interest has occurred in discovering the aspects of the brain that are involved in intelligence. Chapter 4, p. 121

Notice that in the prefrontal cortex (discussed further later on), where higher-level thinking and self-regulation take place, it is not until middle to late adolescence that the adult density of the synapses is achieved.

Figure 2.4 shows the location of the brain's four lobes. As just indicated, growth in the prefrontal cortex (the highest region of the frontal lobes) continues through adolescence. Rapid growth in the temporal lobes (language processing) and parietal lobes (spatial location) occurs from age 6 through puberty.

Brain Development in Middle and Late Childhood Total brain volume stabilizes by the end of middle and late childhood, but significant changes in various structures and regions of the brain continue to occur (Gogtay & Thompson, 2010). In particular, the brain pathways and circuitry involving the prefrontal cortex continue to increase in middle and late childhood (Durston & Casey, 2006). These advances in the prefrontal cortex are linked to children's improved attention, reasoning, and cognitive control (Diamond, Casey, & Munakata, 2011).

Developmental neuroscientist Mark Johnson and his colleagues (2009) recently proposed that the prefrontal cortex likely orchestrates the functions of many other brain regions during development. As part of this neural leadership, organizational role, the prefrontal cortex may provide an advantage to neural connections and networks that include the prefrontal cortex. In their view, the prefrontal cortex likely coordinates the best neural connections for solving a problem.

Links between the changing brain and children's cognitive development involve activation of some brain areas so that they increase in activity while others decrease (Goswami, 2011; Nelson, 2011). One shift in activation that occurs as children develop in middle and late childhood is from diffuse, larger areas to more focal, smaller areas. This shift is characterized by the synaptic pruning mentioned earlier, in which areas of the brain not being used lose synaptic connections and those being used show an increase in connections. The increased focal activation is linked to improved cognitive performance, especially in *cognitive control,* which involves flexible and effective control in a number of areas (Durston & others, 2006). These areas include controlling attention, reducing interfering thoughts, inhibiting motor actions, and being flexible in switching between competing choices (Diamond, Casey, & Munakata, 2011).

Brain Development in Adolescence Along with the rest of the body, the brain is changing during adolescence. Earlier we indicated that connections between neurons become "pruned" as children and adolescents develop. What results from this pruning is that by the end of adolescence individuals have "fewer, more selective, more effective connections between neurons 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.

Scientists have recently discovered that adolescents' brains undergo significant structural changes (Giedd & others, 2009; Jackson-Newsom & Shelton, 2010). The **corpus callosum,** where fibers connect the brain's left and right hemispheres, thickens in adolescence, and this improves adolescents' ability to process information. We described advances in the development of the **prefrontal cortex**—the highest level of the frontal lobes involved in reasoning, decision making, and self-control—earlier in this section. However, the prefrontal cortex doesn't finish maturing until the emerging adult years, approximately 18 to 25 years of age, or later, but the **amygdala**—the seat of emotions such as anger—matures earlier than the prefrontal cortex. Figure 2.5 shows the locations of the corpus callosum, prefrontal cortex, and amygdala.

corpus callosum Where fibers connect the brain's left and right hemispheres.

prefrontal cortex The highest level in the frontal lobes; involved in reasoning, decision making, and self-control.

amygdala The seat of emotions in the brain.

Leading researcher Charles Nelson (2011) 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. This means that the brain region for putting the brakes on risky, impulsive behavior is still under construction during adolescence (Giedd & others, 2009). Or consider this interpretation of the development of emotion and cognition in adolescence: "early activation of strong 'turbo-charged' feelings with a relatively unskilled set of 'driving skills' or cognitive abilities to modulate strong emotions and motivation" (Dahl, 2004, p. 18). This developmental disjunction may account for increased risk taking and other problems in adolescence (Steinberg, 2009). "Some things just take time to develop and mature judgment is probably one of them" (Steinberg, 2004, p. 56).

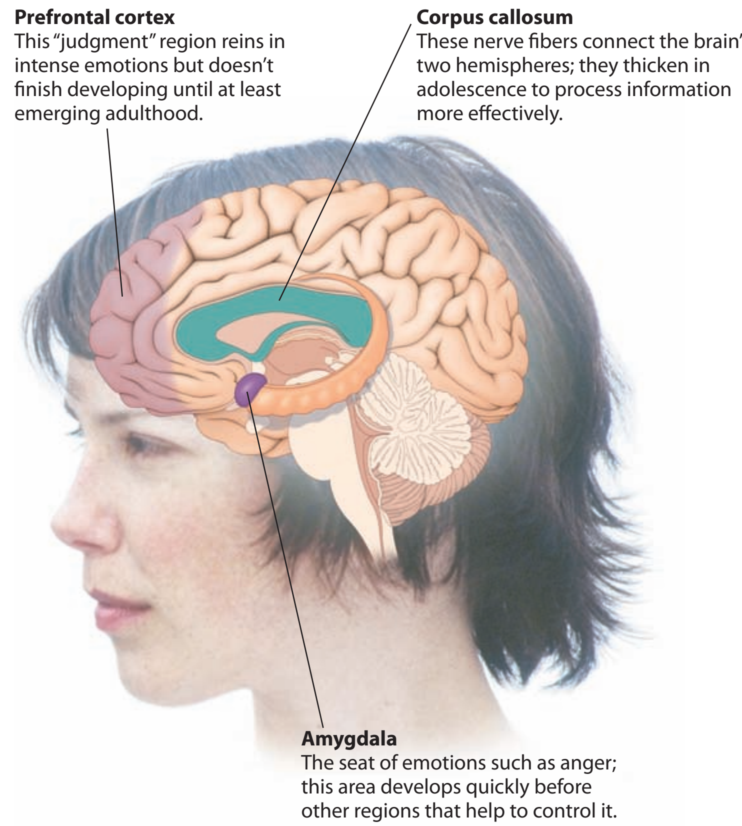


FIGURE 2.5 CHANGES IN ADOLESCENT BRAIN

Lateralization The cerebral cortex (the highest level of the brain) is divided into two halves, or hemispheres (see Figure 2.6). **Lateralization** is the specialization of functions in each hemisphere of the brain (van Ettinger-Veenstra & others, 2010). In individuals with an intact brain, there is a specialization of function in some areas.

The most extensive research on the brain's two hemispheres involves language. In most individuals, speech and grammar are localized to the left hemisphere (Carota & others, 2010; Gazzaniga, 2010). However, not all language processing is carried out in the brain's left hemisphere (Phan & Vicario, 2010). For example, understanding such aspects of language as appropriate use of language in different contexts, evaluation of the emotional expressiveness of language, and much of humor involves the right hemisphere (Kensinger & Choi, 2009). Also, when children lose much of their left hemisphere because of an accident, surgery for epilepsy, or other reasons, the right hemisphere in many cases can reconfigure itself for increased language processing (Staudt, 2010).

Because of the differences in functioning of the brain's two hemispheres, people commonly use the phrases "left-brained" and "right-brained" to say which hemisphere is dominant. Unfortunately, much of this talk is seriously exaggerated. For example, laypeople and the media commonly exaggerate hemispheric specialization by claiming that the left brain is logical and the right brain is creative. However, most complex functioning—such as logical and creative thinking—in normal people involves communication between both sides of the brain (Baars & Gage, 2010). Scientists who study the brain are typically very cautious with terms such as *left-brained* and *right-brained* because the brain is more complex than those terms suggest.

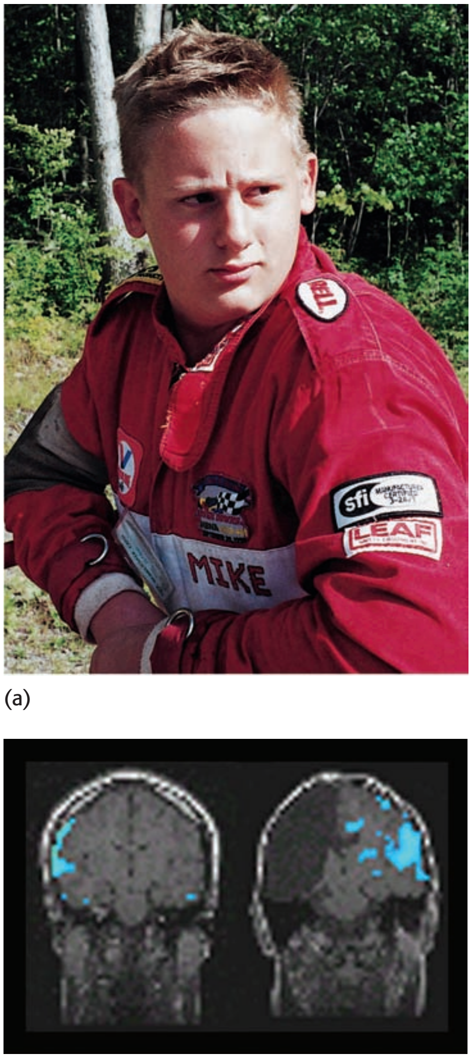
FIGURE 2.6 HUMAN BRAIN'S HEMISPHERES

The two halves (hemispheres) of the human brain are clearly seen in this photograph.

Plasticity As we have seen, the brain has *plasticity* (Nelson, 2011; Toga & Mazziotta, 2011). What children do can change the development of their brain. By engaging students in optimal learning environments, you can stimulate the development of their brain (Goswami, 2010).

The remarkable case of Michael Rehbein illustrates the brain's plasticity. When Michael was 4½, he began to experience uncontrollable seizures—as many as 400 a day. Doctors said that the only solution was to remove the left hemisphere of his brain, where the seizures were occurring. Michael had his first major surgery at age 7 and another at age 10. Although recovery was slow, his right hemisphere began to reorganize and eventually took over functions such as speech that normally occur in

lateralization The specialization of functions in each hemisphere of the brain.



(a)

(b)

FIGURE 2.7 PLASTICITY IN BRAIN'S HEMISPHERES

(*a*) Michael Rehbein at 14 years of age. (*b*) Michael's right hemisphere (*right*) has reorganized to take over the language functions normally carried out by corresponding areas in the left hemisphere of an intact brain (*left*). However, the right hemisphere is not as efficient as the left, and more areas of the brain are recruited to process speech.

the brain's left hemisphere (see Figure 2.7). Individuals like Michael are living proof of the growing brain's remarkable plasticity and ability to adapt and recover from a loss of brain tissue.

The Brain and Children's Education Unfortunately, too often statements about the implications of brain science for children's education have been speculative at best and often far removed from what neuroscientists know about the brain (Geake, 2010). 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 (Sousa, 1995).

Another commonly promoted link between neuroscience and brain education is that there is a critical, or sensitive, period—a biological window of opportunity—when learning is easier, more effective, and more easily retained than later in development. However, some experts on the development of the brain and learning conclude that the critical-period view is exaggerated (Blakemore & Choudhury, 2006). One leading neuroscientist even told educators that although children's brains acquire a great deal of information during the early years, most learning likely takes place after synaptic formation stabilizes, which is after the age of 10 (Goldman-Rakic, 1996).

A major issue involving the development of the brain is which comes first, biological changes in the brain or experiences that stimulate these changes (Lerner, Boyd, & Du, 2008)? Consider a recent study in which the prefrontal cortex thickened and more brain connections formed when adolescents resisted peer pressure (Paus & others, 2008). Scientists have yet to determine whether the brain changes come first or whether the brain changes are the result of experiences with peers, parents, and others. Once again, we encounter the nature-nurture issue that is so prominent in examining children's and adolescents' development.

Given all of the hype and hyperbole about brain education in the media, what can we conclude from the current state of knowledge in applying the rapidly increasing research on the brain's development to education?

- *Both early and later experiences, including educational experiences, are very important in the brain's development.* Significant changes occur at the cellular and structural level in the brain through adolescence (Paus, 2009).
- *Synaptic connections between neurons can change dramatically as a consequence of the learning experiences of children and adolescents* (Nelson, 2011). Connections between neurons that are used when children focus their attention, remember, and think as they are reading, writing, and doing math are strengthened; those that aren't used are replaced by other pathways or disappear.
- *Development at the highest level of the brain—the prefrontal cortex, where such important cognitive processes as thinking, reasoning, and decision making primarily occur—continues at least through the adolescent years* (Steinberg, 2009). This development in the prefrontal cortex moves from being more diffuse to more focal and involves increased efficiency of processing information (Diamond, Casey, & Munakata, 2011). As activation in the prefrontal cortex becomes more focused, cognitive control increases. This is exemplified in children being able to focus their attention more effectively and ignore distractions while they are learning as they become older.
- *Despite the increased focal activation of the prefrontal cortex as children grow older, changes in the brain during adolescence present a challenge to increased cognitive control.* In adolescence, the earlier maturation of the amygdala, which is involved in processing of emotions, and the more drawn-out development of the prefrontal cortex, provides an explanation of the difficulty adolescents have in controlling their emotions and their tendency to engage in risk taking (Steinberg, 2009).

- *Brain functioning occurs along specific pathways and involves integration of function.* According to leading experts Kurt Fischer and Mary Helen Immordino-Yang (2008),

> One of the lessons of educational neuroscience, even at this early point in its development, is that children learn along specific pathways, but they do not act or think in compartments. . . . On the one hand, they develop their learning along specific pathways defined by particular content, such as mathematics or history, but on the other hand they make connections between those pathways.

Reading is an excellent example of how brain functioning occurs along specific pathways and is integrated (Goswami, 2011). Consider a child who is asked by a teacher to read aloud to the class. Input from the child's eyes is transmitted to the child's brain, then passed through many brain systems, which translate the patterns of black and white into codes for letters, words, and associations. The output occurs in the form of messages to the child's lips and tongue. The child's own gift of speech is possible because brain systems are organized in ways that permit language processing.

These conclusions suggest that education throughout the childhood and adolescent years can benefit children's and adolescents' learning and cognitive development (Howard-Jones, 2010; Nelson, 2011). Where appropriate throughout the rest of the book, we will describe research on the development of the brain and children's education.

schemas In Piaget's theory, actions or mental representations that organize knowledge.

PIAGET'S THEORY

Poet Noah Perry once asked, "Who knows the thoughts of a child?" More than anyone, the famous Swiss psychologist Jean Piaget (1896–1980) knew.

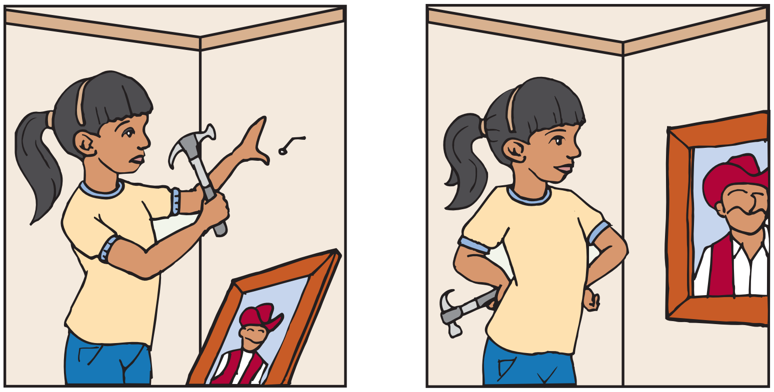
Cognitive Processes

What processes do children use as they construct their knowledge of the world? Piaget stressed that these processes are especially important in this regard: schemas, assimilation and accommodation, organization, and equilibration.

Schemas Piaget (1954) said that as the child seeks to construct an understanding of the world, the developing brain creates **schemas.** These are actions or mental representations that organize knowledge. In Piaget's theory, *behavioral schemas* (physical activities) characterize infancy, and *mental schemas* (cognitive activities) develop in childhood. A baby's schemas are structured by simple actions that can be performed on objects, such as sucking, looking, and grasping. Older children have schemas that include strategies and plans for solving problems. For example, a 6-year-old might have a schema that involves the strategy of classifying objects by size, shape, or color. By the time we have reached adulthood, we have constructed an enormous number of diverse schemas, ranging from how to drive a car, to how to balance a budget, to the concept of fairness.

What are some applications of research on the brain's development to children's and adolescents' education?

Assimilation and Accommodation To explain how children use and adapt their schemas, Piaget offered two concepts: assimilation and accommodation.



Assimilation occurs when people incorporate new information into their existing schematic knowledge. *How might this 8-year-old girl first attempt to use the hammer and nail, based on her preexisting schematic knowledge about these objects?*

Accommodation occurs when people adjust their knowledge schemas to new information. *How might the girl adjust her schemas regarding hammers and nails during her successful effort to hang the picture?*

FIGURE 2.8 ASSIMILATION AND ACCOMMODATION

Assimilation occurs when children incorporate new information into their existing schemas. **Accommodation** occurs when children adjust their schemas to fit new information and experiences.

Consider an 8-year-old girl who is given a hammer and nail to hang a picture on the wall. She has never used a hammer, but from observing others do this she realizes that a hammer is an object to be held, that it is swung by the handle to hit the nail, and that it usually is swung a number of times. Recognizing each of these things, she fits her behavior into this schema she already has (assimilation). But the hammer is heavy, so she holds it near the top. She swings too hard and the nail bends, so she adjusts the pressure of her strikes. These adjustments reflect her ability to slightly alter her conception of the world (accommodation). Just as both assimilation and accommodation are required in this example, so are they required in many of the child's thinking challenges (see Figure 2.8).

Organization To make sense out of their world, said Piaget, children cognitively organize their experiences. **Organization** in Piaget's theory is the grouping of isolated behaviors and thoughts into a higher-order system. Continual refinement of this organization is an inherent part of development. A boy with only a vague idea about how to use a hammer also may have a vague idea about how to use other tools. After learning how to use each one, he relates these uses, organizing his knowledge.

Equilibration and Stages of Development **Equilibration** is a mechanism that Piaget proposed to explain how children shift from one stage of thought to the next. The shift occurs as children experience cognitive conflict, or *disequilibrium,* in trying to understand the world. Eventually, they resolve the conflict and reach a balance, or *equilibrium,* of thought. Piaget pointed out that there is considerable movement between states of cognitive equilibrium and disequilibrium as assimilation and accommodation work in concert to produce cognitive change. For example, if a child believes that the amount of a liquid changes simply because the liquid is poured into a container with a different shape—for instance, from a container that is short and wide into a container that is tall and narrow—she might be puzzled by such issues as where the "extra" liquid came from and whether there is actually more liquid to drink. The child will eventually resolve these puzzles as her thought becomes more advanced. In the everyday world, the child is constantly faced with such counterexamples and inconsistencies.

Assimilation and accommodation always take the child to a higher ground. For Piaget, the motivation for change is an internal search for equilibrium. As old schemas are adjusted and new schemas are developed, the child organizes and reorganizes the old and new schemas. Eventually, the organization is fundamentally different from the old organization; it is a new way of thinking.

Thus, the result of these processes, according to Piaget, is that individuals go through four stages of development. A different way of understanding the world makes one stage more advanced than another. Cognition is *qualitatively* different in one stage compared with another. In other words, the way children reason at one stage is different from the way they reason at another stage.

Piagetian Stages

Each of Piaget's stages is age-related and consists of distinct ways of thinking. Piaget proposed four stages of cognitive development: sensorimotor, preoperational, concrete operational, and formal operational (see Figure 2.9).

assimilation Piagetian concept of the incorporation of new information into existing knowledge (schemas).

accommodation Piagetian concept of adjusting schemas to fit new information and experiences.

organization Piaget's concept of grouping isolated behaviors into a higher-order, more smoothly functioning cognitive system; the grouping or arranging of items into categories.

equilibration A mechanism that Piaget proposed to explain how children shift from one stage of thought to the next. The shift occurs as children experience cognitive conflict, or disequilibrium, in trying to understand the world. Eventually, they resolve the conflict and reach a balance, or equilibrium, of thought.

Sensorimotor Stage	Preoperational Stage	Concrete Operational Stage	Formal Operational Stage
The infant constructs an understanding of the world by coordinating sensory experiences with physical actions. An infant progresses from reflexive, instinctual action at birth to the beginning of symbolic thought toward the end of the stage.	The child begins to represent the world with words and images. These words and images reflect increased symbolic thinking and go beyond the connection of sensory information and physical action.	The child can now reason logically about concrete events and classify objects into different sets.	The adolescent reasons in more abstract, idealistic, and logical ways.
Birth to 2 Years of Age	**2 to 7 Years of Age**	**7 to 11 Years of Age**	**11 Years of Age Through Adulthood**

FIGURE **2.9** PIAGET'S FOUR STAGES OF COGNITIVE DEVELOPMENT

The Sensorimotor Stage 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 their sensory experiences (such as seeing and hearing) with their motor actions (reaching, touching)—hence the term sensorimotor. At the beginning of this stage, infants show little more than reflexive patterns to adapt to the world. By the end of the stage, they display far more complex sensorimotor patterns.

DEVELOPMENT

The Preoperational Stage The **preoperational stage** is the second Piagetian stage. Lasting approximately from about 2 to 7 years of age, it is more symbolic than sensorimotor thought but does not involve operational thought. However, it is egocentric and intuitive rather than logical.

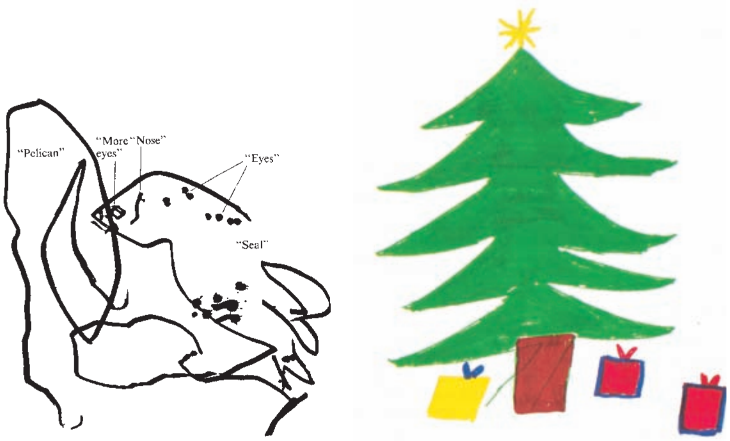
Preoperational thought can be subdivided into two substages: symbolic function and intuitive thought. The **symbolic function substage** occurs roughly between 2 and 4 years of age. In this substage, the young child gains the ability to represent mentally an object that is not present. This stretches the child's mental world to new dimensions. Expanded use of language and the emergence of pretend play are other examples of an increase in symbolic thought during this early childhood substage. Young children begin to use scribbled designs to represent people, houses, cars, clouds, and many other aspects of the world. Possibly because young children are not very concerned about reality, their drawings are fanciful and inventive (Winner, 1986). One 3½ year-old looked at the scribble he had just drawn and described it as a pelican kissing a seal (see Figure 2.10a). In the elementary school years, children's drawings become more realistic, neat, and precise (see Figure 2.10b).

Even though young children make distinctive progress in this substage, their preoperational thought still has an important limitation: egocentrism. *Egocentrism* is the inability to distinguish between one's own perspective and someone else's

sensorimotor stage The first Piagetian stage, lasting from birth to about 2 years of age, in which infants construct an understanding of the world by coordinating sensory experiences with motor actions.

preoperational stage The second Piagetian stage, lasting from about 2 to 7 years of age, symbolic thought increases, but operational thought is not yet present.

symbolic function substage The first substage of preoperational thought, occurring between about 2 to 4 years of age; the ability to represent an object not present develops and symbolic thinking increases; egocentrism is present.



(a) (b)

FIGURE 2.10 DEVELOPMENTAL CHANGES IN CHILDREN'S DRAWINGS

(*a*) A 3½-year-old's symbolic drawing. Halfway into this drawing, the 3½-year-old artist said it was "a pelican kissing a seal." (*b*) This 11-year-old's drawing is neater and more realistic but also less inventive.

"I still don't have all the answers, but I'm beginning to ask the right questions."

perspective. Piaget and Barbel Inhelder (1969) initially studied young children's egocentrism by devising the three-mountains task (see Figure 2.11). The child walks around the model of the mountains and becomes familiar with what the mountains look like from different perspectives. The child also can see that there are different objects on the mountains. The child then is seated on one side of the table on which the mountains are placed. The experimenter moves a doll to different locations around the table. At each location, the child is asked to select from a series of photos the one that most accurately reflects the view the doll is seeing. Children in the preoperational stage often pick the view that reflects where they are sitting rather than the doll's view.

What further cognitive changes take place in the preoperational stage? The **intuitive thought substage** is the second substage of preoperational thought, starting at about 4 years of age and lasting until about 7 years of age. At this substage, children begin to use primitive reasoning and want to know the answers to all sorts of questions. Piaget called this substage *intuitive* because the children seem so sure about their knowledge and understanding yet are unaware of how they know what they know. That is, they say they know something but know it without the use of rational thinking.

An example of young children's limitation in reasoning ability is the difficulty they have putting things into correct categories. Look at the collection of objects in Figure 2.12a. You would probably respond to the direction "Put the things together that you believe belong together" by grouping the objects by size and shape. Your sorting might look something like that shown in Figure 2.12b. Faced with a similar collection of objects that can be sorted on the basis of two or more properties, preoperational children seldom are capable of using these properties consistently to sort the objects into appropriate groupings.

Many of these preoperational examples show a characteristic of thought called **centration,** which involves focusing (or centering) attention on one characteristic to the exclusion of all others. Centration is most clearly present in preoperational children's lack of **conservation,** the idea that some characteristic of an object stays the same even though the object might change in appearance. For example, to adults it is obvious that a certain amount of liquid stays the same regardless of a container's

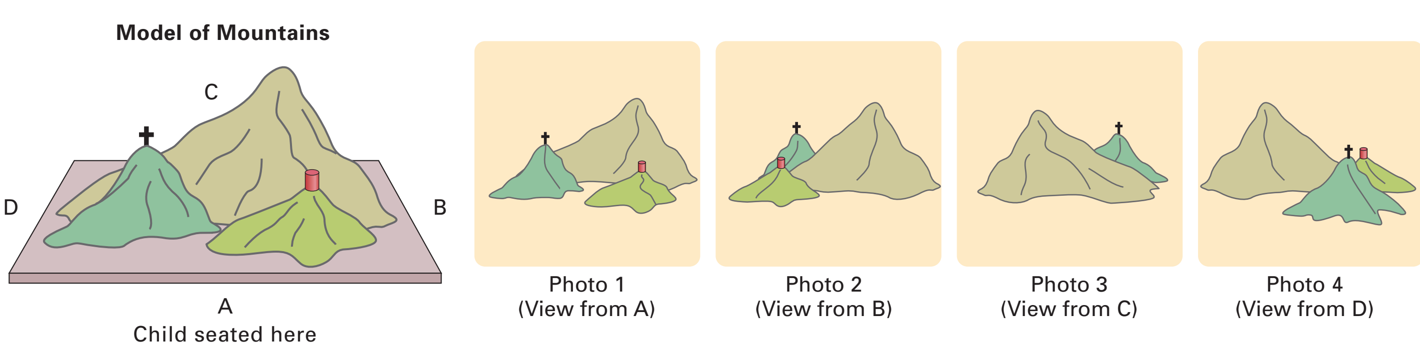


FIGURE 2.11 THE THREE-MOUNTAINS TASK

The mountain model on the far left shows the child's perspective from view A, where he or she is sitting. The four squares represent photos showing the mountains from four different viewpoints of the model—A, B, C, and D. The experimenter asks the child to identity the photo in which the mountains look as they would from position B. To identity the photo correctly, the child has to take the perspective of a person sitting at spot B. Invariably, a child who thinks in a preoperational way cannot perform this task. When asked what a view of the mountains looks like from position B, the child selects Photo 1, taken from location A (the child's own view at the time) instead of Photo 2, the correct view.

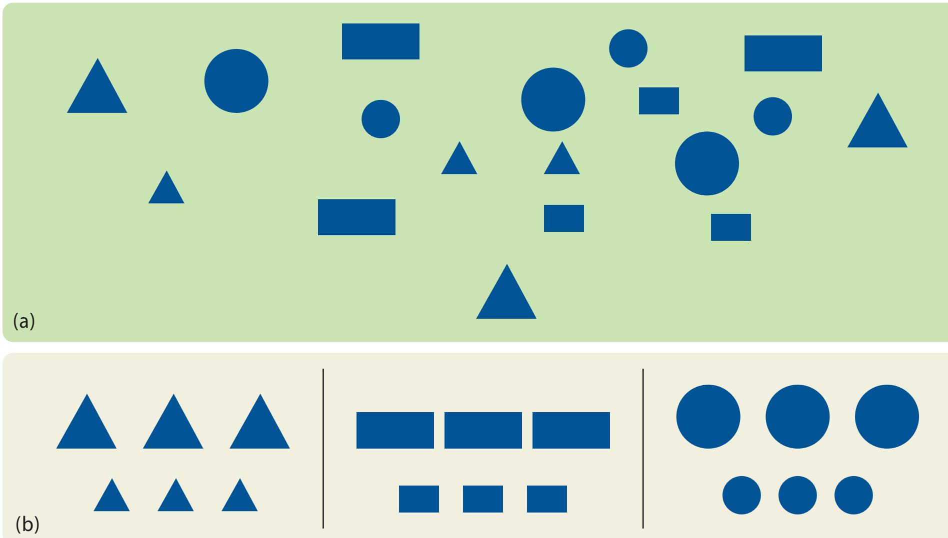


FIGURE 2.12 ARRAYS

(*a*) A random array of objects. (*b*) An ordered array of objects.

shape. But this is not obvious at all to young children. Rather, they are struck by the height of the liquid in the container. In this type of conservation task (Piaget's most famous), a child is presented with two identical beakers, each filled to the same level with liquid (see Figure 2.13). The child is asked if the beakers have the same amount of liquid. The child usually says yes. Then the liquid from one beaker is poured into a third beaker, which is taller and thinner. The child now is asked if the amount of liquid in the tall, thin beaker is equal to the liquid that remains in the second original beaker. Children younger than 7 or 8 usually say no. They justify their answer

intuitive thought substage The second substage of preoperational thought, lasting from about 4 to 7 years of age. Children begin to use primitive reasoning and want to know the answer to all sorts of questions. They seem so sure about their knowledge in this substage but are unaware of how they know what they know.

centration Focusing, or centering, attention on one characteristic to the exclusion of all others; characteristic of preoperational thinking.

conservation The idea that some characteristic of an object stays the same even though the object might change in appearance; a cognitive ability that develops in the concrete operational stage, according to Piaget.

FIGURE 2.13 PIAGET'S CONSERVATION TASK

The beaker test is a well-known Piagetian test to determine whether a child can think operationally—that is, can mentally reverse actions and show conservation of the substance. (*a*) Two identical beakers are presented to the child. Then, the experimenter pours the liquid from B into C, which is taller and thinner than A or B. (*b*) The child is asked if these beakers (A and C) have the same amount of liquid. The preoperational child says "no." When asked to point to the beaker that has more liquid, the preoperational child points to the tall, thin beaker.

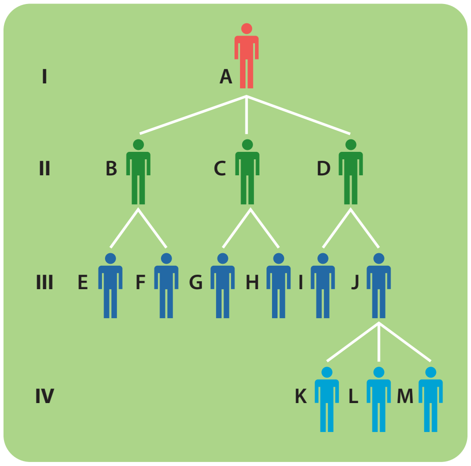


FIGURE 2.14 CLASSIFICATION: AN IMPORTANT ABILITY IN CONCRETE OPERATIONAL THOUGHT

A family tree of four generations (*I to IV*): The preoperational child has trouble classifying the members of the four generations; the concrete operational child can classify the members vertically, horizontally, and obliquely (up and down and across). For example, the concrete operational child understands that a family member can be a son, a brother, and a father, all at the same time.

by referring to the differing height or width of the beakers. Older children usually answer yes. They justify their answers appropriately: If you poured the liquid back, the amount would still be the same.

In Piaget's view, failing the conservation of liquid task indicates that the child is at the preoperational stage of thinking. Passing the test suggests the child is at the *concrete operational stage* of thinking (discussed later on).

According to Piaget, preoperational children also cannot perform what he called *operations*—mental representations that are reversible. For example, in the beaker task, preschool children have difficulty understanding that reversing an action brings about the original conditions from which the action began. Two other examples should further help you understand Piaget's concepts of operations. A young child might know that $4 + 2 = 6$ but not understand that the reverse, $6 - 2 = 4$, is true. Or let's say a preschooler walks to his friend's house each day but always gets a ride home. If asked to walk home from his friend's house, he probably would reply that he didn't know the way because he never had walked home before.

Some developmentalists do not believe Piaget was entirely correct in his estimate of when conservation skills emerge. For example, Rochel Gelman (1969) trained preschool children to attend to relevant aspects of the conservation task. This improved their conservation skills.

Further, children show considerable variation in attaining conservation skills. Researchers have found that 50 percent of children develop conservation of mass at 6 to 9 years of age, 50 percent demonstrate conservation of length at 4 to 9 years of age, 50 percent show conservation of area at 7 to 9 years of age, and 50 percent of children don't attain conservation of weight until 8 to 10 years of age (Horowitz & others, 2005; Sroufe & others, 1992).

Yet another characteristic of preoperational children is that they ask a lot of questions. The barrage begins around age 3. By about 5, they have just about exhausted the adults around them with "Why?" "Why" questions signal the emergence of the child's interest in figuring out why things are the way they are. Following is a sampling of 4- to 6-year-olds' questions (Elkind, 1976):

"What makes you grow up?"

"Who was the mother when everybody was a baby?"

"Why do leaves fall?"

"Why does the sun shine?"

The Concrete Operational Stage The **concrete operational stage,** the third Piagetian stage of cognitive development, lasts from about 7 to about 11 years of age. Concrete operational thought involves using operations. Logical reasoning replaces intuitive reasoning, but only in concrete situations. Classification skills are present, but abstract problems go unsolved.

A concrete operation is a reversible mental action pertaining to real, concrete objects. Concrete operations allow the child to coordinate several characteristics rather than focus on a single property of an object. At the concrete operational level, children can do mentally what they previously could do only physically, and they can reverse concrete operations.

An important concrete operation is classifying or dividing things into different sets or subsets and considering their interrelationships. Reasoning about a family tree of four generations, for example, reveals a child's concrete operational skills (Furth & Wachs, 1975). The family tree shown in Figure 2.14 suggests that the grandfather (A) has three children (B, C, and D), each of whom has two children (E through J), and one of these children (J) has three children (K, L, and M). Concrete operational thinkers understand the classification. For example, they can reason that person J can at the same time be father, brother, and grandson. A preoperational thinker cannot.

concrete operational stage Piaget's third cognitive developmental stage, occurring between about 7 to 11 years of age. At this stage, the child thinks operationally, and logical reasoning replaces intuitive thought but only in concrete situations; classification skills are present, but abstract problems present difficulties.

TEACHING CONNECTIONS: Best Practices
Strategies for Working with Preoperational Thinkers

As you have just read, young children think on a different plane than older children. Following are some effective strategies for advancing young children's thinking.

1. *Allow children to experiment freely with materials.* For example, give children various sizes of cups and a sandbox or water table. As they pour the sand or water back and forth between the cups, they will begin to understand the concepts of reversibility and conservation. If children are allowed to "play" with materials at a science table, they are likely to begin classifying objects.
2. *Ask children to make comparisons.* These might involve such concepts as bigger, taller, wider, heavier, and longer.
3. *Give children experience in ordering operations.* For example, have children line up in rows from tall to short and vice versa. Bring in various examples of animal and plant life cycles, such as several photographs of butterfly development or the sprouting of beans or kernels of corn.
4. *Have children draw scenes with perspective.* Encourage them to make the objects in their drawings appear to be at the same location as in the scene they are viewing. For example, if they see a horse at the end of a field, they should place the horse in the same location in the drawing.
5. *Construct an inclined plane or a hill.* Let children roll marbles of various sizes down the plane. Ask them to compare how quickly the different-size marbles reach the bottom. This should help them understand the concept of speed.
6. *Ask children to justify their answers when they draw conclusions.* For example, when they say that pouring a liquid from a short, wide container into a tall, thin container makes the liquid change in volume, ask, "Why do you think so?" or "How could you prove this to one of your friends?" This will help them to think more logically.

Some Piagetian tasks require children to reason about relations between classes. One such task is **seriation,** the concrete operation that involves ordering stimuli along some quantitative dimension (such as length). To see if students can serialize, a teacher might place eight sticks of different lengths in a haphazard way on a table. The teacher then asks the student to order the sticks by length. Many young children end up with two or three small groups of "big" sticks or "little" sticks rather than a correct ordering of all eight sticks. Another mistaken strategy they use is to evenly line up the tops of the sticks but ignore the bottoms. The concrete operational thinker simultaneously understands that each stick must be longer than the one that precedes it and shorter than the one that follows it.

Transitivity involves the ability to reason about and logically combine relationships. If a relation holds between a first object and a second object, and also holds between the second object and a third object, then it also holds between the first and third objects. For example, consider three sticks (A, B, and C) of differing lengths. A is the longest, B is intermediate in length, and C is the shortest. Does the child understand that if A is longer than B, and B is longer than C, then A is longer than C? In Piaget's theory, concrete operational thinkers do; preoperational thinkers do not.

The Formal Operational Stage The **formal operational stage,** which emerges at about 11 to 15 years of age, is Piaget's fourth and final cognitive stage. At this stage, individuals move beyond reasoning only about concrete experiences and think in more abstract, idealistic, and logical ways.

The abstract quality of formal operational thinking is evident in verbal problem solving. The concrete operational thinker needs to see the concrete elements A, B, and C to make the logical inference that if $A = B$ and $B = C$, then $A = C$. In contrast, the formal operational thinker can solve this problem when it is verbally presented.

Accompanying the abstract nature of formal operational thought are the abilities to idealize and imagine possibilities. At this stage, adolescents engage in extended

seriation A concrete operation that involves ordering stimuli along some quantitative dimension.

transitivity The ability to reason and logically combine relationships.

formal operational stage Piaget's fourth cognitive developmental stage, which emerges between about 11 and 15 years of age; thought is more abstract, idealistic, and logical in this stage.

TEACHING CONNECTIONS: Best Practices

Strategies for Working with Concrete Operational Thinkers

As you have just learned, for most of elementary school, children think at a concrete operational level, which is a different level than young children and adolescents. Following are some effective strategies for advancing children's thinking at the concrete operational level.

1. *Encourage students to discover concepts and principles.* Ask relevant questions about what is being studied to help them focus on some aspect of their learning. Refrain from telling students the answers to their questions outright. Try to get them to reach the answers through their own thinking.
2. *Involve children in operational tasks.* These include adding, subtracting, multiplying, dividing, ordering, seriating, and reversing. Make the reversibility of these operations explicit for the children. For instance, show them that subtracting is the reverse of adding. Use concrete materials (i.e. manipulatives) for these tasks, possibly introducing math symbols later.
3. *Plan activities in which students practice the concept of ascending and descending classification hierarchies.* Have students list the following in order of size (such as largest to smallest): city of Atlanta, state of Georgia, country of United States, western hemisphere, and planet Earth.
4. *Include activities that require conservation of area, weight, and displaced volume.* Realize that there is considerable variation in children's attainment of conservation across different domains.
5. *Continue to ask students to justify their answers when they solve problems.* Help them to check the validity and accuracy of their conclusions.

speculation about the ideal qualities they desire in themselves and others. These idealistic thoughts can merge into fantasy. Many adolescents become impatient with their newfound ideals and the problems of how to live them out.

At the same time that adolescents are thinking more abstractly and idealistically, they also are beginning to think more logically. As formal operational thinkers, they think more like scientists. They devise plans to solve problems and systematically test

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?

solutions. Piaget's term **hypothetical-deductive reasoning** embodies the concept that adolescents can develop hypotheses (best hunches) about ways to solve problems and systematically reach a conclusion. Formal operational thinkers test their hypotheses with judiciously chosen questions and tests. In contrast, concrete operational thinkers often fail to understand the relation between a hypothesis and a well-chosen test of it, stubbornly clinging to ideas that already have been discounted.

A form of egocentrism also emerges in adolescence (Elkind, 1978). *Adolescent egocentrism* is the heightened self-consciousness reflected in adolescents' beliefs that others are as interested in them as they themselves are. Adolescent egocentrism also includes a sense of personal uniqueness. It involves the desire to be noticed, visible, and "on stage."

Egocentrism is a normal adolescent occurrence, more common in the middle school than in high school years. However, for some individuals, adolescent egocentrism can contribute to reckless behavior, including suicidal thoughts, drug use, and failure to use contraceptives during sexual intercourse. Egocentricity may lead some adolescents to think that they are invulnerable.

However, reason to question the accuracy of the invulnerability aspect of the personal fable is provided by research that reveals many adolescents don't consider themselves invulnerable (Reyna & Rivers, 2008). Indeed, recent research suggests that rather than perceiving themselves to be invulnerable, most adolescents tend to portray themselves as vulnerable to experiencing a premature death (Fischoff & others, 2010).

I recently asked teachers to describe how they apply Piaget's cognitive stages to their classroom. Following are their comments:

What characterizes adolescent egocentrism?

EARLY CHILDHOOD When I teach songs to preschool students who are in the preoperational stage, I use PowerPoint slides projected on the board. The slides have either all the words of the song included, or just key words. I also include corresponding clip art and pictures on the page borders.

—Connie Christy, *Aynor Elementary School (Preschool Program)*

RESEARCH

ELEMENTARY SCHOOL: GRADES K–5 In my second-grade science class, I use the following method to help students move from concrete thinking to more abstract thinking: Children are given tasks and asked to discuss what happened (for example, the object sank or floated; when something is added to a system, the outcome changes). Then a theory or idea is developed from the actual observations. When children observe an occurrence and explain what was seen, they can more easily move from the concrete to the more abstract. Although these methods and others like it work well with my students, I need to repeat them often.

—Janine Guida Poutre, *Clinton Elementary School*

MIDDLE SCHOOL: GRADES 6–8 I challenge my seventh-grade students to share examples of how they've applied our classroom lessons to the real world. They can earn extra credit for doing so, but seem to care less about the points than they do about the opportunity to share their accomplishments. For example, after completing a unit on Progressivism, a student shared how he had gone online on his home computer and donated money to help Darfur refugees. He had previously planned to use this

hypothetical-deductive reasoning Piaget's formal operational concept that adolescents can develop hypotheses to solve problems and systematically reach (deduce) a conclusion.

TEACHING CONNECTIONS: Best Practices
Strategies for Working with Formal Operational Thinkers

As you have just learned, adolescents think on a different plane than children. Following are some effective strategies for working with adolescents who are formal operational thinkers.

1. *Realize that most adolescents are not full-fledged formal operational thinkers.* Thus, many of the teaching strategies discussed earlier regarding the education of concrete operational thinkers still apply to many young adolescents. As discussed in Through the Eyes of Teachers, Jerri Hall, a math teacher at Miller Magnet High School in Georgia, emphasizes that when a curriculum is too formal and too abstract, it will go over students' heads.

THROUGH THE EYES OF TEACHERS
Piaget as a Guide

I use Piaget's developmental theory as a guide in helping children learn math. In the sixth, seventh, and eighth grades, children are moving from the concrete to the abstract stage in their cognitive processes; therefore, when I teach, I try to use different methods to aid my students to understand a concept. For example, I use fraction circles to help students understand how to add, subtract, multiply, and divide fractions, and the students are allowed to use these until they become proficient with the algorithms. I try to incorporate hands-on experiences in which students discover the rules themselves, rather than just teaching the methods and having the students practice them with drill. It is extremely important for students to understand the why behind a mathematical rule so they can better understand the concept.

2. *Propose a problem and invite students to form hypotheses about how to solve it.* For example, a teacher might say, "Imagine that a girl has no friends. What should she do?"
3. *Present a problem and suggest several ways it might be approached.* Then ask questions that stimulate students to evaluate the approaches. For example, describe several ways to investigate a robbery, and ask students to evaluate which way is best and why.
4. *Demonstrate how to conduct experiments that require the separation and control of variables. Later ask students to conduct their own experiments.* These might involve science concepts or simple student-generated research questions, such as "which chewing gum retains its flavor the longest?"
5. *Encourage students to create hierarchical outlines when you ask them to write papers.* Make sure they understand how to organize their writing in terms of general and specific points. The abstractness of formal operational thinking also means that teachers with students at this level can encourage them to use metaphors.

money to buy himself a new guitar. This student took the theory of social activism from the Progressive era 100 years ago and applied it to his life today. This student's actions clearly demonstrate Piaget's formal operational stage in action.

—Mark Fodness, *Bemidji Middle School*

HIGH SCHOOL: GRADES 9–12 My high school art students take part in creativity competitions in which they build, create, explore, problem-solve, and perform solutions to challenges presented to them. The competition—Destination Imagination—has challenged my students to brainstorm ideas and solutions to seemingly impossible tasks. As a result of their participation in this event, they have won regional and state titles along with the world championship.

—Dennis Peterson, *Deer River High School*

TECHNOLOGY

Piaget, Constructivism, and Technology Recall from Chapter 1 that the basic idea of *constructivism* is that students learn best when they are actively constructing information and knowledge. Piaget's theory is a strong constructivist view. Early in the application of technology to children's learning, Seymour Papert (1980), who studied with Piaget for five years, created the Logo programming language for

Children at a Computer Clubhouse, one of 100 Computer Clubhouses worldwide, that provides students from low-income communities opportunities to creatively use technology to explore their ideas and develop their skills.

Source: www.computerclubhouse.org/

computers that was based on Piaget's constructivist view. A small robot labeled the "Logo Turtle" guided children in constructing solutions to problems. Today, all sorts of robotic kits are available, as well as Scratch (http://scratch.mit.edu/), an online programming and communication space for children, LifeLong Kindergarten (http://llk.media.mit.edu/projects.php), which has a number of creative projects for students of varying ages, and the Computer Clubhouse (www.computerclubhouse.org/), an international consortium of computer clubs linked over the Internet for 10–18-year-olds from low-income communities, providing a creative and safe out-of-school learning environment with adult mentors. Many others claim constructivism as their foundation and are used in schools worldwide.

Evaluating Piaget's Theory What were Piaget's main contributions? Has his theory withstood the test of time?

Contributions Piaget is a giant in the field of developmental psychology. We owe to him the present field of children's cognitive development. We also owe to him a long list of masterful concepts, including assimilation and accommodation, object permanence, egocentrism, conservation, and hypothetical-deductive reasoning. Along with William James and John Dewey, Piaget contributed to the current vision of children as active, constructive thinkers (Miller, 2011).

Piaget was a genius when it came to observing children. His careful observations showed us inventive ways to discover how children act on and adapt to their world. His work revealed some important things to look for in cognitive development, such as the shift from preoperational to concrete operational thinking, and showed us how children need to make their experiences fit their schemas (cognitive frameworks) while simultaneously adapting their schemas to experience.

Piaget is shown here with his family. Piaget's careful observations of his three children—Lucienne, Laurent, and Jacqueline—contributed to the development of his cognitive theory.

Having an outstanding teacher and gaining a good 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?*

Criticisms Piaget's theory has not gone unchallenged. Questions have been raised in the following areas:

- *Estimates of children's competence.* Some cognitive abilities emerge earlier than Piaget thought, others later (Carpenter, 2011). Conservation of number has been demonstrated as early as age 3, although Piaget did not think it emerged until 7. Young children are not as uniformly "pre-" this and "pre-" that (precausal, preoperational) as Piaget thought (Flavell, Miller, & Miller, 2002). Other cognitive abilities can emerge later than Piaget thought. Many adolescents still think in concrete operational ways or are just beginning to master formal operations (Kuhn, 2009).
- *Stages.* Piaget conceived of stages as unitary structures of thought. Some concrete operational concepts, however, do not appear at the same time. For example, children do not learn to conserve at the same time as they learn to cross-classify.
- *Training children to reason at a higher level.* Some children who are at one cognitive stage (such as preoperational) can be trained to reason at a higher cognitive stage (such as concrete operational). However, Piaget argued that such training is only superficial and ineffective unless the child is at a maturational transition point between the stages (Gelman & Opfer, 2004).
- *Culture and education.* Culture and education exert stronger influences on children's development than Piaget envisioned. For example, the age at which children acquire conservation skills is related to the extent to which their culture provides relevant practice (Cole, 2006). An outstanding teacher can guide students' learning experiences that will help them move to a higher cognitive stage.

Despite the criticisms, some developmental psychologists conclude that we should not throw out Piaget altogether (Miller, 2011). These **neo-Piagetians** argue that Piaget got some things right although his theory needs considerable revision. In their revision of Piaget, neo-Piagetians emphasize how children process information through attention, memory, and strategies (Case, 2000). They especially stress that a more accurate vision of children's thinking requires more knowledge of strategies, how fast and how automatically children process information, the particular cognitive task involved, and the division of cognitive problems into smaller, more precise steps (Morra & others, 2008).

Despite such problems, Piaget's theory is a very useful one. As we see next, there are many ways to apply his ideas to educating children.

Thinking Back/Thinking Forward

The information-processing approach emphasizes that children develop a gradually increasing capacity for processing information. Chapter 8, p. 254

DEVELOPMENT

neo-Piagetians Developmental psychologists who believe that Piaget got some things right but that his theory needs considerable revision; emphasize how to process information through attention, memory, and strategies.

zone of proximal development (ZPD) Vygotsky's term for the range of tasks that are too difficult for children to master alone but that can be mastered with guidance and assistance from adults or more-skilled children.

VYGOTSKY'S THEORY

In addition to Piaget's theory, another major developmental theory that focuses on children's cognition is Russian Lev Vygotsky's theory. In Vygotsky's theory children's cognitive development is shaped by the cultural context in which they live (Gauvain & Parke, 2010).

The Zone of Proximal Development Vygotsky's belief in the importance of social influences, especially instruction, on children's cognitive development is reflected in his concept of the zone of proximal development. **Zone of proximal development (ZPD)** is Vygotsky's term for the range of tasks that are too difficult for the child to master alone but that can be learned with guidance and assistance of adults or more-skilled children. Thus, the lower limit of the ZPD is the level of skill reached by the child working independently. The upper limit is the level of additional responsibility the child can accept with the assistance of an able instructor

TEACHING CONNECTIONS: Best Practices

Strategies for Applying Piaget's Theory to Children's Education

Earlier in this chapter, you learned about applying Piaget's theory to teaching children at different stages of cognitive development. Following are five general strategies based on Piaget's theory for educating children.

1. *Take a constructivist approach.* In a constructivist approach, Piaget emphasized that children learn best when they are active and seek solutions for themselves. Piaget opposed teaching methods that treat children as passive receptacles. The educational implication of Piaget's view is that in all subjects students learn best by making discoveries, reflecting on them, and discussing them, rather than blindly imitating the teacher or doing things by rote.
2. *Facilitate rather than direct learning*. Effective teachers design situations that allow students to learn by doing. These situations promote students' thinking and discovery. Teachers listen, watch, and question students to help them gain better understanding. They ask relevant questions to stimulate students' thinking and ask them to explain their answers. As described in Through the Eyes of Teachers, Suzanne Ransleben creates imaginative classroom situations to facilitate students' learning.

THROUGH THE EYES OF TEACHERS

Stimulating Students' Thinking and Discovery

Suzanne Ransleben teaches ninth- and tenth-grade English in Corpus Christi, Texas. She designs classroom situations that stimulate students' reflective thinking and discovery.

Suzanne Ransleben, teaching English.

Suzanne created Grammar Football to make diagramming sentences more interesting for students and has students decipher song lyrics to help them better understand how to write poetry. When students first encounter Shakespeare, "they paint interpretations of their favorite line from *Romeo and Juliet*" (Source: Wong Briggs, 2004, p. 7D)

3. *Consider the child's knowledge and level of thinking.* Students do not come to class with empty heads. They have many ideas about the physical and natural world including concepts of space, time, quantity, and causality. These ideas differ from the ideas of adults. Teachers need to interpret what a student is saying and respond with discourse close to the student's level. Asking the children to do something for which they are not ready will not promote cognitive development. It will merely frustrate the children.
4. *Promote the student's intellectual health.* When Piaget came to lecture in the United States, he was asked, "What can I do to get my child to a higher cognitive stage sooner?" He was asked this question so often in the United States compared with other countries that he called it the American question. For Piaget, children's learning should occur naturally. Children should not be pushed and pressured into achieving too much too early in their development, before they are maturationally ready.
5. *Turn the classroom into a setting of exploration and discovery.* What do actual classrooms look like when the teachers adopt Piaget's views? Several first- and second-grade math classrooms provide some good examples (Kamii, 1985, 1989). The teachers emphasize students' own exploration and discovery. The classrooms are less structured than what we think of as a typical classroom. Workbooks and predetermined assignments are not used. Rather, the teachers observe the students' interests and natural participation in activities to determine what the course of learning will be. For example, a math lesson might be constructed around counting the day's lunch money or dividing supplies among students. Often games are prominently used in the classroom to stimulate mathematical thinking.

(see Figure 2.15). The ZPD captures the child's cognitive skills that are in the process of maturing and can be accomplished only with the assistance of a more-skilled person (Daniels, 2011).

Teaching in the ZPD reflects the concept of developmentally appropriate teaching we described earlier in the chapter. It involves being aware of "where students

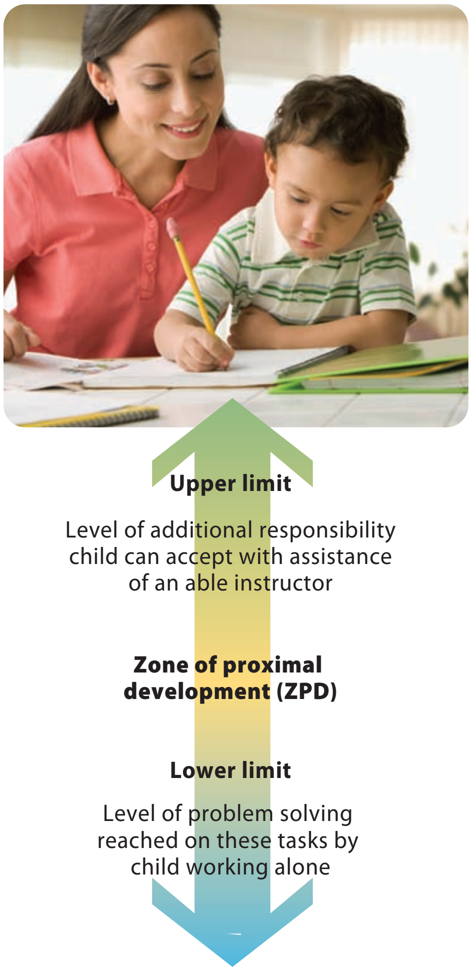


FIGURE 2.15 VYGOTSKY'S ZONE OF PROXIMAL DEVELOPMENT

Vygotsky's zone of proximal development has a lower limit and an upper limit. Tasks in the ZPD are too difficult for the child to perform alone. They require assistance from an adult or a more-skilled child. As children 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.

are in the process of their development and taking advantage of their readiness. It is also about teaching to enable developmental readiness, not just waiting for students to be ready" (Horowitz & others, 2005, p. 105).

Scaffolding Closely linked to the idea of the ZPD is the concept of scaffolding. **Scaffolding** means changing the level of support. Over the course of a teaching session, a more-skilled person (a teacher or advanced peer) adjusts the amount of guidance to fit the child's current performance. When the student is learning a new task, the skilled person may use direct instruction. As the student's competence increases, less guidance is given. Scaffolding is often used to help students attain the upper limits of their ZPD.

Asking probing questions is an excellent way to scaffold students' learning and help them to develop more sophisticated thinking skills. A teacher might ask a student such questions as "What would an example of that be?" "Why do you think that is so?" "Now, what's the next thing you need to do?" and "How can you connect those?" Over time, students should begin internalizing these kinds of probes and improve monitoring their own work (Horowitz & others, 2005).

Many teachers who successfully use scaffolding circulate around the classroom, giving "just-in-time" assistance to individuals, or detecting a class-wide misconception and then leading a discussion to correct the problem. They also give "children time to grapple with problems" and guide them when they observe that the child can no longer make progress (Horowitz & others, 2005, pp. 106–107).

Language and Thought In Vygotksy's view, language plays an important role in a child's development (Gredler, 2009). According to Vygotsky, children use speech not only for social communication, but also to help them solve tasks. Vygotsky (1962) further argued that young children use language to plan, guide, and monitor their behavior. This use of language for self-regulation is called *private speech*. For example, young children talk aloud to themselves about such things as their toys and the tasks they are trying to complete. Thus, when working on a puzzle, a child might say, "This piece doesn't go; maybe I'll try that one." A few minutes later she utters, "This is hard." For Piaget private speech is egocentric and immature, but for Vygotsky it is an important tool of thought during the early childhood years (John-Steiner, 2007).

Vygotsky said that language and thought initially develop independently of each other and then merge. He emphasized that all mental functions have external, or social, origins. Children must use language to communicate with others before they can focus inward on their own thoughts. Children also must communicate externally and use language for a long period of time before they can make the transition from external to internal speech. This transition period occurs between 3 and 7 years of age and involves talking to oneself. After a while, the self-talk becomes second nature to children, and they can act without verbalizing. When this occurs, children have internalized their egocentric speech in the form of *inner speech,* which becomes their thoughts.

Vygotsky argued that children who use private speech are more socially competent than those who don't. He believed that private speech represents an early transition in becoming more socially communicative. For Vygotsky, when young children talk to themselves, they are using language to govern their behavior and guide themselves.

Piaget held that self-talk is egocentric and reflects immaturity. However, researchers have found support for Vygotsky's view that private speech plays a positive role in children's development (Winsler, Carlton, & Barry, 2000). Researchers have revealed that children use private speech more when tasks are difficult, after they make mistakes, and when they are not sure how to proceed (Berk, 1994). They also have found that children who use private speech are more attentive and improve their performance more than children who do not use private speech (Berk & Spuhl, 1995).

scaffolding A technique that involves changing the level of support for learning. A teacher or more-advanced peer adjusts the amount of guidance to fit the student's current performance.

I recently asked teachers how they apply Vygotsky's theory to their classroom. After reading their responses about Vygotsky, you might want to compare these responses with teachers' responses about how they apply Piaget's theory in their classroom that were described earlier in the chapter.

EARLY CHILDHOOD In teaching music to preschoolers, I use private speech to help children learn unfamiliar rhythms. When my young students are learning a new rhythm pattern on the African drums, for example, they don't count the eighth and quarter notes, because that is too difficult. Instead, I suggest certain words for them to repeat in rhythmic patterns to learn the beat, or they can come up with their own words to match the new rhythm. My guidance allows children to improve their understanding of musical rhythm.

—CONNIE CHRISTY, *Aynor Elementary School (Preschool Program)*

ELEMENTARY SCHOOL: GRADES K–5 One way to maximize students' zone of proximal development is by flexible grouping. In flexible grouping, groups change often based on need, interest, and so on. I use different group styles—for example, whole class, small group, homogenous groups, and heterogeneous groups. Variance in group members and group styles allows all students to be instructed within their zone of proximal development. This may be on grade level in one area, above grade level in another, and below grade level in still another. The point is that flexible grouping allows me to give students of varying levels the instruction necessary to learn.

—SUSAN FROELICH, *Clinton Elementary School*

MIDDLE SCHOOL: GRADES 6–8 When I teach my students a new skill, it is important that I stay close to them while they are working. This way if they need my assistance, I am there to help them master the new skill with some guidance. This practice works especially well when we are working on multistep projects.

—CASEY MAASS, *Edison Middle School*

HIGH SCHOOL: GRADES 9–12 Advanced art students and independent-study students have always been an active part of my classroom, especially when it comes to helping other students maximize their zone of proximal development (and grow in their own skills as artists as well). In my ceramics class, for example, I have several advanced students—who have especially strong knowledge and skills on the ceramic wheel—help my first-year students, who are attempting to work on the wheel for the first time. This additional assistance from the advanced students allows me to help other students who need further instruction.

—DENNIS PETERSON, *Deer River High School*

We have discussed a number of ideas about both Piaget's and Vygotsky's theories and how the theories can be applied to children's education. To reflect on how you might apply their theories to your own classroom, complete Self-Assessment 2.1.

Evaluating Vygotsky's Theory How does Vygotsky's theory compare with Piaget's? 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.

Thinking Back/Thinking Forward

Collaborative learning and cognitive apprenticeships reflect Vygotsky's social constructivist approach. Chapter 10, p. 336

social constructivist approach Emphasizes the social contexts of learning and that knowledge is mutually built and constructed; Vygotsky's theory exemplifies this approach.

SELF-ASSESSMENT 2.1

Applying Piaget and Vygotsky in My Classroom

The grade level at which I plan to teach is ____________________

PIAGET

The Piagetian stage of the majority of children in my classroom will likely be ______________________________

The Piagetian concepts that should help me the most in understanding and teaching children at this grade level are

Concept	Example

VYGOTSKY

The concepts in Vygotsky's theory that should help me the most in understanding and teaching children at this grade level are

Concept	Example

TEACHING CONNECTIONS: Best Practices

Strategies for Applying Vygotsky's Theory to Children's Education

Vygotsky's theory has been embraced by many teachers and has been successfully applied to education. Here are some ways Vygotsky's theory can be incorporated in classrooms:

1. *Assess the child's ZPD.* Like Piaget, Vygotsky did not think that formal, standardized tests are the best way to assess children's learning. Rather, Vygotsky argued that assessment should focus on determining the child's ZPD. The skilled helper presents the child with tasks of varying difficulty to determine the best level at which to begin instruction.

2. *Use the child's ZPD in teaching.* Teaching should begin toward the zone's upper limit, so that the child can reach the goal with help and move to a higher level of skill and knowledge. Offer just enough assistance. You might ask, "What can I do to help you?" Or simply observe the child's intentions and attempts and provide support when needed. When the child hesitates, offer encouragement. And encourage the child to practice the skill. You may watch and appreciate the child's practice or offer support when the child forgets what to do. In Through the Eyes of Teachers, you can read about John Mahoney's teaching practices that reflect Vygotsky's emphasis on the importance of the ZPD. In contrast to in-class work, homework should be aimed at the zone's lower limit so that the child will be capable of completing it. Keeping instruction in the ZPD is likely to require differentiation as children's zones of proximal development are not uniform.

THROUGH THE EYES OF TEACHERS

Using Dialogue and Reframing Concepts to Find the Zone of Proximal Development

John Mahoney teaches mathematics at a high school in Washington, D.C. In Mahoney's view, guiding students' success in math is both collaborative and individual. He encourages dialogue about math during which he reframes concepts

TEACHING CONNECTIONS: Best Practices

Strategies for Applying Vygotsky's Theory to Children's Education

that help students subsequently solve problems on their own. Mahoney also never gives students the answers to math problems. As one student commented, "He's going to make you think." His tests always include a problem that students have not seen but have enough knowledge to figure out the problem's solution. (Source: Wong Briggs, 2005.)

John Mahoney, teaching math.

3. *Use more-skilled peers as teachers.* Remember that it is not just adults that are important in helping children learn. Children also benefit from the support and guidance of more-skilled children (Gredler, 2009). For example, pair a child who is just beginning to read with one who is a more advanced reader. It is also desirable to use cross-age tutoring.

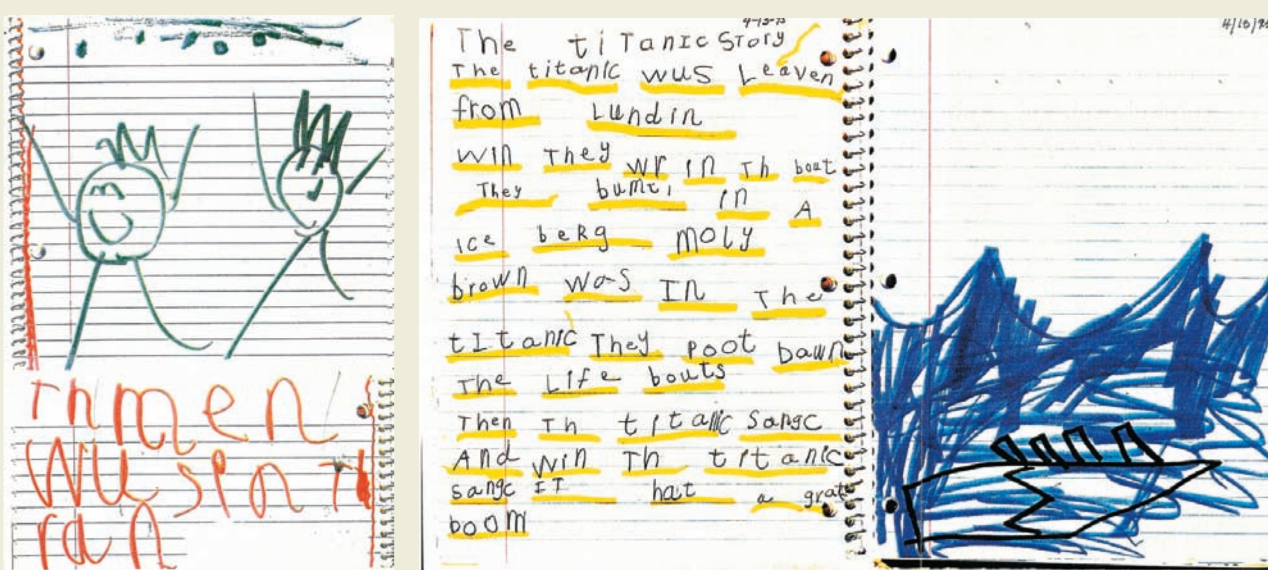
4. *Monitor and encourage children's use of private speech.* Be aware of the developmental change from externally talking to oneself when solving a problem during the preschool years to privately talking to oneself in the early elementary school years. In the elementary school years, encourage children to internalize and self-regulate their talk to themselves.

5. *Place instruction in a meaningful context.* Educators today are moving away from abstract presentations of material, instead providing students with opportunities to experience learning in real-world settings. For example, instead of just memorizing math formulas, students work on math problems with real-world implications.

6. *Transform the classroom with Vygotskian ideas.* Tools of the Mind is a curriculum that is grounded in Vygotsky's (1962) theory with special attention given to cultural tools and developing self-regulation, the ZPD, scaffolding, private speech, shared activity, and play as important activity (Hyson, Copple, & Jones, 2006). Figure 2.16 illustrates how scaffolding was used in Tools of the Mind to improve a young child's writing skills. The Tools of the Mind curriculum was created by Elena Bodrova and Deborah Leong (2007) and has been implemented in more than 200 classrooms. Most of the children in the Tools of the Mind programs are at risk because of their living circumstances, which in many instances involve poverty and other difficult conditions such as being homeless and having parents with drug problems.

One study assessed the effects of the Tools of the Mind curriculum on at-risk preschool children (Diamond & others, 2007). The results indicated that the Tools of the Mind curriculum improved the self-regulatory and cognitive control skills (such as resisting distractions and temptations) of the at-risk children. Other research on the Tools of the Mind curriculum also has found that it improves young children's cognitive skills (Saifer, 2007).

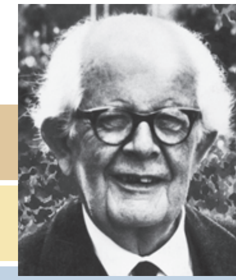
RESEARCH



(a) Five-year-old Aaron's independent journal writing prior to the scaffolded writing technique.

(b) Aaron's journal two months after using the scaffolded writing technique.

FIGURE 2.16 WRITING PROGRESS OF A 5-YEAR-OLD BOY OVER TWO MONTHS USING THE SCAFFOLDING WRITING PROCESS IN TOOLS OF THE MIND



	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 **2.17** COMPARISON OF VYGOTSKY'S AND PIAGET'S THEORIES

In moving from Piaget to Vygotsky, the conceptual shift is from the individual to collaboration, social interaction, and sociocultural activity (Gauvain & Parke, 2010). The endpoint of cognitive development for Piaget is formal operational thought. For Vygotsky, the endpoint can differ, depending on which skills are considered to be the most important in a particular culture (Daniels, 2011). For Piaget, children construct knowledge by transforming, organizing, and reorganizing previous knowledge. For Vygotsky, children construct knowledge through social interaction. 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 (Rogoff & others, 2007). In both Piaget's and Vygotsky's theories, teachers serve as facilitators and guides, rather than as directors and molders of learning. Figure 2.17 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, 2008). Another criticism focuses on Vygotsky not adequately describing how changes in socioemotional capabilities contribute to cognitive development (Gauvain, 2008). Yet another charge 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 children might become lazy and expect help when they might have done something on their own.

What are some contributions and criticisms of Vygotsky's theory?

In our coverage of cognitive development, we have focused on the views of two giants in the field: Piaget and Vygotsky. However, information processing also has emerged as an important perspective in understanding children's cognitive development (Martinez, 2010). It emphasizes how information enters the mind, how it is stored and transformed, and how it is retrieved to perform mental activities such as problem solving and reasoning. It also focuses on how automatically and quickly children process information. The subject of information processing is covered extensively in Chapters 8 and 9.

Review, Reflect, and Practice

2 Discuss the development of the brain and compare the cognitive developmental theories of Jean Piaget and Lev Vygotsky.

REVIEW

- How does the brain develop, and what implications does this development have for children's education?
- What four main ideas did Piaget use to describe cognitive processes? What stages did he identify in children's cognitive development? What are some criticisms of his view?
- What is the nature of Vygotsky's theory? How can Vygotsky's theory be applied to education and his theory compared to Piaget's? What is a criticism of Vygotsky's theory?

REFLECT

- Do you consider yourself to be a formal operational thinker? Do you still sometimes feel like a concrete operational thinker? Give examples.

PRAXIS™ PRACTICE

1. Sander is a 16-year-old boy who takes many risks, such as driving fast and drinking while driving. Recent research on the brain indicates that a likely reason for this risk-taking behavior is that Sander's
   a. hippocampus is damaged.
   b. prefrontal cortex is still developing.
   c. brain lateralization is incomplete.
   d. myelination is complete.
2. Mrs. Gonzales teaches first grade. Which of her following strategies would Piaget most likely endorse?
   a. demonstrating how to perform a math operation and having students imitate her
   b. creating flash cards to teach vocabulary
   c. using a standardized test to assess students' reading skills
   d. designing contexts that promote student's thinking and discovery
3. Mr. Gould's fourth-grade students are learning about the relations among percentages, decimals, and fractions. He distributes an assignment requiring students to convert fractions to decimals and then to percentages. Christopher can do this assignment without help from Mr. Gould or his classmates. What would Vygotsky say about this task for Christopher?
   a. This task is appropriate for Christopher because it is within his zone of proximal development.
   b. This task is inappropriate for Christopher because it is above his zone of proximal development.
   c. This task is inappropriate for Christopher because it is below his zone of proximal development.
   d. This task is inappropriate for Christopher because it is within his zone of proximal development.

Please see the answer key at the end of the book.

3 LANGUAGE DEVELOPMENT

What Is Language? | Biological and Environmental Influences | Language Development

Think how important language is in children's everyday lives. They need language to speak with others, listen to others, read, and write. Their language enables them to describe past events in detail and to plan for the future. Language lets us pass down information from one generation to the next and create a rich cultural heritage.

WHAT IS LANGUAGE?

Language is a form of communication—whether spoken, written, or signed—that is based on a system of symbols. Language consists of the words used by a community (vocabulary) and the rules for varying and combining them (grammar and syntax).

All human languages have some common characteristics (Berko Gleason, 2009). These include infinite generativity and organizational rules. *Infinite generativity* is the ability to produce an endless number of meaningful sentences using a finite set of words and rules.

When we say "rules," we mean that language is orderly and that rules describe the way language works (Berko Gleason & Ratner, 2009). Language involves five systems of rules: phonology, morphology, syntax, semantics, and pragmatics.

Phonology

Every language is made up of basic sounds. **Phonology** is the sound system of a language, including the sounds used and how they may be combined (Stoel-Gammon & Sosa, 2010). For example, English has the sounds *sp, ba,* and *ar,* but the sound sequences *zx* and *qp* do not occur.

A *phoneme* is the basic unit of sound in a language; it is the smallest unit of sound that affects meaning. A good example of a phoneme in English is /k/, the sound represented by the letter *k* in the word *ski* and the letter *c* in the word *cat.* The /k/ sound is slightly different in these two words, and in some languages such as Arabic these two sounds are separate phonemes.

Morphology

The **morphology** of a language refers to the units of meaning involved in word formation. A *morpheme* is a minimal unit of meaning; it is a word or a part of a word that cannot be broken into smaller meaningful parts. Every word in the English language is made up of one or more morphemes. Some words consist of a single morpheme (for example, *help*), whereas others are made up of more than one morpheme (for example, *helper,* which has two morphemes, *help* + *er,* with the morpheme *-er* meaning "one who"—in this case "one who helps"). Thus, not all morphemes are words by themselves; for example, *pre-, -tion,* and *-ing* are morphemes.

Just as the rules that govern phonology describe the sound sequences that can occur in a language, the rules of morphology describe the way meaningful units (morphemes) can be combined in words (Tager-Flusberg & Zukowski, 2009). Morphemes have many jobs in grammar, such as marking tense (for example, *she walks* versus *she walked*) and number (*she walks* versus *they walk*).

Syntax

The way words are combined to form acceptable phrases and sentences is their **syntax** (Naigles & Swensen, 2010). If someone says to you, "Bob slugged Tom" or "Bob was slugged by Tom," you know who did the slugging and who was slugged in each case because you have a syntactic understanding of these sentence structures. You also understand that the sentence "You didn't stay, did you?" is a grammatical sentence but that "You didn't stay, didn't you?" is unacceptable and ambiguous.

language A form of communication, whether spoken, written, or signed, that is based on a system of symbols.

phonology A language's sound system.

morphology Refers to the units of meaning involved in word formation.

syntax The ways that words must be combined to form acceptable phrases and sentences.

Semantics The term **semantics** refers to the meaning of words and sentences. Every word has a set of semantic features, or required attributes related to meaning (Diesendruck, 2010). *Girl* and *women,* for example, share many semantic features, but they differ semantically in regard to age.

Words have semantic restrictions on how they can be used in sentences (Li, 2009). The sentence, *The bicycle talked the boy into buying a candy bar,* is syntactically correct but semantically incorrect. The sentence violates our semantic knowledge that bicycles don't talk.

Pragmatics A final set of language rules involves **pragmatics,** the appropriate use of language in different contexts. Pragmatics covers a lot of territory. When you take turns speaking in a discussion, you are demonstrating knowledge of pragmatics (Siegal & Surian, 2010). You also apply the pragmatics of English when you use polite language in appropriate situations (for example, when talking to a teacher) or tell stories that are interesting.

Pragmatic rules can be complex, and they differ from one culture to another (Bryant, 2009). If you were to study the Japanese language, you would come face-to-face with countless pragmatic rules about conversing with individuals of various social levels and various relationships to you.

BIOLOGICAL AND ENVIRONMENTAL INFLUENCES

Famous linguist Noam Chomsky (1957) argued that humans are prewired to learn language at a certain time and in a certain way. Some language scholars view the remarkable similarities in how children acquire language all over the world despite the vast variation in language input they receive as strong evidence that language has a biological basis.

Despite the influence of biology, children clearly do not learn language in a social vacuum (Gathercole & Hoff, 2010). Children are neither exclusively biological linguists nor exclusively social architects of language (Evans, 2009; Shatz, 2010). No matter how long you converse with a dog, it won't learn to talk, because it doesn't have the human child's biological capacity for language. Unfortunately, though, some children fail to develop good language skills even in the presence of very good role models and interaction. An interactionist view emphasizes the contributions of both biology and experience in language development. That is, children are biologically prepared to learn language as they and their caregivers interact.

In or out of school, encouragement of language development, not drill and practice, is the key (Sachs, 2009). Language development is not simply a matter of being rewarded for saying things correctly and imitating a speaker. Children benefit when their parents and teachers actively engage them in conversation, ask them questions, and emphasize interactive rather than directive language.

Both biological and environmental influences play important roles in children's language development.

LANGUAGE DEVELOPMENT

What are some of the key developmental milestones in language development? We will examine these milestones in infancy, early childhood, middle and late childhood, and adolescence.

DEVELOPMENT

Infancy Language acquisition advances past a number of milestones in infancy (Sachs, 2009). Because the main focus of this text is on children and adolescents

semantics The meaning of words and sentences.

pragmatics The appropriate use of language in different contexts.

rather than infants, we will describe only some of the many language milestones in infancy. Babbling occurs in the middle of the first year, and infants usually utter their first word at about 10 to 13 months. By 18 to 24 months, infants usually have begun to string two words together. In this two-word stage, they quickly grasp the importance of language in communication, creating phrases such as "Book there," "My candy," "Mama walk," and "Give Papa."

Early Childhood As children leave the two-word stage, they move rather quickly into three-, four-, and five-word combinations. The transition from simple sentences expressing a single proposition to complex sentences begins between 2 and 3 years of age and continues into the elementary school years (Bloom, 1998).

Rule Systems of Language Let's explore the changes in the five rules systems we described earlier—phonology, morphology, syntax, semantics, and pragmatics—during early childhood. In terms of phonology, most preschool children gradually become sensitive to the sounds of spoken words (Stoel-Gammon & Sosa, 2010). They notice rhymes, enjoy poems, make up silly names for things by substituting one sound for another (such as *bubblegum, bubblebum, bubbleyum*), and clap along with each syllable in a phrase.

RESEARCH

As they move beyond two-word utterances, there is clear evidence that children know morphological rules. Children begin using the plural and possessive forms of nouns (*dogs* and *dog's*); putting appropriate endings on verbs (*-s* when the subject is third-person singular, *-ed* for the past tense, and *-ing* for the present progressive tense); and using prepositions (*in* and *on*), articles (*a* and *the*), and various forms of the verb *to be* ("I *was going* to the store"). In fact, they *overgeneralize* these rules, applying them to words that do not follow the rules. For example, a preschool child might say "foots" instead of "feet" or "goed" instead of "went."

Children's understanding of morphological rules was the subject of a classic experiment by children's language researcher Jean Berko (1958). Berko presented preschool and first-grade children with cards like the one shown in Figure 2.18. Children were asked to look at the card while the experimenter read the words on it aloud. Then the children were asked to supply the missing word. This might sound easy, but Berko was interested not just in the children's ability to recall the right word but also in their ability to say it "correctly" with the ending that was dictated by morphological rules. *Wugs* is the correct response for the card in Figure 2.18. Although the children were not perfectly accurate, they were much better than chance would dictate. Moreover, they demonstrated their knowledge of morphological rules not only with the plural forms of nouns ("There are two wugs") but also with the possessive forms of nouns and with the third-person singular and past-tense forms of verbs. Berko's study demonstrated not only that the children relied on rules, but also that they had *abstracted* the rules from what they had heard and could apply them to novel situations.

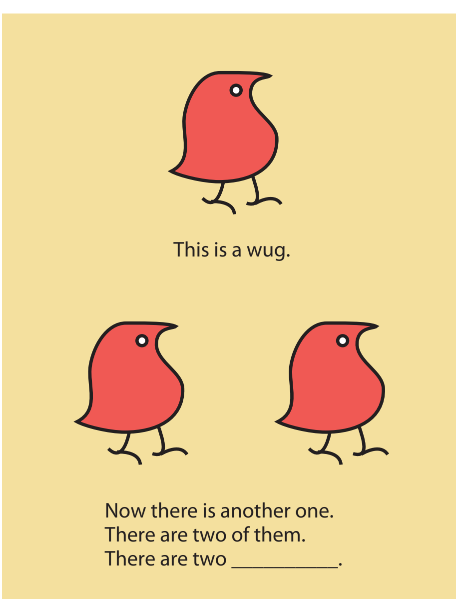


FIGURE 2.18 STIMULI IN BERKO'S STUDY OF YOUNG CHILDREN'S UNDERSTANDING OF MORPHOLOGICAL RULES

In Jean Berko's (1958) study, young children were presented cards such as this one with a "wug" on it. Then the children were asked to supply the missing word and say it correctly. "Wugs" is the correct response here.

Preschool children also learn and apply rules of syntax (Lidz, 2010). After advancing beyond two-word utterances, the child shows a growing mastery of complex rules for how words should be ordered. Consider *wh-* questions, such as "Where is Daddy going?" or "What is that boy doing?" To ask these questions properly, the child must know two important differences between *wh-* questions and affirmative statements (for instance, "Daddy is going to work" and "That boy is waiting on the school bus"). First, a *wh-* word must be added at the beginning of the sentence. Second, the auxiliary verb must be inverted—that is, exchanged with the subject of the sentence. Young children learn quite early where to put the *wh-* word, but they take much longer to learn the auxiliary-inversion rule. Thus, preschool children might ask, "Where Daddy is going?" and "What that boy is doing?"

The speaking vocabulary of a 6-year-old child ranges from 8,000 to 14,000 words. Assuming that word learning began when the child was 12 months old, this translates into a rate of five to eight new word meanings a day between the ages of 1 and 6.

What are some effective strategies for using technology to support children's vocabulary? Computers, of course, can be used in various strategies. CD-ROMs of stories, such as *Living Books*, can promote children's vocabulary development very effectively, especially when there is an option for students to find the meaning of unfamiliar words. Also, the program called Write: Outloud (2009) can help students build their vocabulary (www.donjohnston.com/products/write_outloud/index.html). Further, using the computer for listening to and watching stories can be part of a student's reading-center rotations, reading assignment, or an option during choice time. Learning new words can be enhanced if teachers plan a way for students to keep track of new words. For example, students can record new words in a portfolio for future reference.

TECHNOLOGY

Teachers also can create listening centers to support vocabulary development. Listening centers should include tape recorders, headphones, audiobooks, and corresponding literature. Audiobooks can be used to supplement printed materials, letting students enjoy the dramatization of stories and piquing their interest. Audiobooks may especially benefit students with special needs.

In addition to the remarkable advances young children make in semantics, substantial changes in pragmatics also occur during early childhood (Siegal & Surian, 2010). A 6-year-old is simply a much better conversationalist than a 2-year-old. What are some of the changes in pragmatics that are made in the preschool years? At about 3 years of age, children improve in their ability to talk about things that are not physically present. That is, they improve their command of the characteristic of language known as *displacement*. Children at this stage become increasingly removed from the "here and now" and are able to talk about things not physically present, as well as things that happened in the past or may happen in the future. Preschoolers can tell you what they want for lunch tomorrow, something that would not have been possible at the two-word stage in infancy. Preschool children also become increasingly able to talk in different ways to different people.

Literacy in Early Childhood The concern about the ability of U.S. children to read and write has led to a careful examination of preschool and kindergarten children's experiences with the hope that a positive orientation toward reading and writing can be developed early in life (Otto, 2010). Indeed, early precursors of literacy and academic success include good language skills, phonological and syntactic knowledge, letter identification, and conceptual knowledge about print and its conventions and functions (Beatty & Pratt, 2011).

Thinking Back/Thinking Forward

Teachers can guide students in adopting a number of cognitive strategies for becoming better readers and writers. Chapter 11, p. 365

What should a literacy program for preschool children include? Instruction should be built on what children already know about oral language, reading, and writing. Parents and teachers also need to provide a supportive environment to help children develop literacy skills (Christie, Enz, & Vukelich, 2011; Tompkins, 2011). A recent study revealed that children's early home environment influenced their early language skills, which in turn predicted their readiness for school (Forget-Dubois & others, 2009). Another recent study found that literacy experiences (such as how often the child was read to), the quality of the mother's engagement with her child (such as attempts to cognitively stimulate the child) and provision of learning materials (such as age-appropriate learning materials and books) were important home literacy experiences in low-income families that were linked to the children's language development in positive ways (Rodriquez & others, 2009). In Chapter 11 we will further discuss many aspects of children's experiences that contribute to their literacy development.

RESEARCH

Middle and Late Childhood Children gain new skills as they enter school that make it possible to learn to read and write. These include increased use of language

What are some effective early literacy experiences that parents can provide young children?

to talk about things that are not physically present, learning what a word is, and learning how to recognize and talk about sounds. They also learn the *alphabetic principle* that the letters of the alphabet represent sounds of the language.

Vocabulary development continues at a breathtaking pace for most children during the elementary school years (Pan & Uccelli, 2009). After five years of word learning, the 6-year-old child does not slow down. According to some estimates, elementary school children in the United States are moving along at the awe-inspiring rate of 22 words a day! The average U.S. 12-year-old has developed a speaking vocabulary of approximately 50,000 words.

During middle and late childhood, changes occur in the way mental vocabulary is organized. When asked to say the first word that comes to mind when they hear a word, preschool children typically provide a word that often follows the word in a sentence. For example, when asked to respond to *dog,* the young child may say "barks," or when asked to respond to the word *eat*, may say "lunch." At about 7 years of age, children begin to respond with a word that is the same part of speech as the stimulus word. For example, a child may now respond to the word *dog* with "cat" or "horse." To *eat,* they now might say "drink." This is evidence that children now have begun to categorize their vocabulary by parts of speech.

The process of categorizing becomes easier as children increase their vocabulary. Children's vocabulary increases from an average of about 14,000 words at age 6 to an average of about 40,000 words by age 11.

Children make similar advances in grammar (Tager-Flusberg & Zukowski, 2009). During the elementary school years, children's improvement in logical reasoning and analytical skills helps them understand such constructions as the appropriate use of comparatives *(shorter, deeper)* and subjectives ("If you were president . . ."). During the elementary school years, children become increasingly able to understand and use complex grammar, such as the following sentence: *The boy who kissed his mother wore a hat.* They also learn to use language in a more connected way, producing connected discourse. They become able to relate sentences to one another to produce descriptions, definitions, and narratives that make sense. Children must be able to do these things orally before they can be expected to deal with them in written assignments. In elementary school, defining words also becomes a regular part of classroom discourse, and children increase their knowledge of syntax as they study and talk about the components of sentences, such as subjects and verbs (Melzi & Ely, 2009).

These advances in vocabulary and grammar during the elementary school years are accompanied by the development of **metalinguistic awareness,** which is knowledge about language, such as knowing what a preposition is or being able to discuss the sounds of a language. Metalinguistic awareness allows children "to think about their language, understand what words are, and even define them" (Berko Gleason, 2009, p. 4). It improves considerably during the elementary school years. Defining words becomes a regular part of classroom discourse, and children increase their knowledge of syntax as they study and talk about the components of sentences such as subjects and verbs (Melzi & Ely, 2009).

During this period, children also make progress in understanding how to use language in culturally appropriate ways—pragmatics. By the time they enter adolescence, most know the rules for the use of language in everyday contexts—that is, what is appropriate and inappropriate to say.

What are some advances in language that children make during middle and late childhood?

Adolescence Language development during adolescence includes increased sophistication in the use of words (Berko Gleason, 2009; Berman, 2010). As they develop abstract thinking, adolescents become much better than children at analyzing the function a word plays in a sentence.

Adolescents also develop more subtle abilities with words (Berman, 2010). They make strides in understanding *metaphor,* which is an implied comparison between unlike things. For example, individuals "draw a line in the sand" to indicate a nonnegotiable position; a political campaign is said to be a "marathon, not a sprint." And adolescents become better able to understand and to use *satire,* which is the use of irony, derision, or wit to expose folly or wickedness. Caricatures are an example of satire. More advanced logical thinking also allows adolescents, from about 15 to 20 years of age, to understand complex literary works.

Most adolescents are also much better writers than children are. They are better at organizing ideas before they write, at distinguishing between general and specific points as they write, at stringing together sentences that make sense, and at organizing their writing into an introduction, body, and concluding remarks.

I recently asked teachers about the strategies they use to expand or advance children's and adolescents' language development in class. Following are their responses:

EARLY CHILDHOOD My preschool students often listen to a piece of music and then describe what they heard in their own words. I use this opportunity to broaden their music vocabulary by expanding on what they've said. For example, a child listening to a recording might say, "I heard a low sound." I then respond by saying, "So what instrument do you think could have made that low *pitch*?"

—CONNIE CHRISTY, *Aynor Elementary School (Preschool Program)*

metalinguistic awareness Knowledge of language.

TEACHING CONNECTIONS: Best Practices
Strategies for Vocabulary Development at Different Developmental Levels

In the discussion of semantic development, we described the impressive gains in vocabulary that many children make as they go through the early childhood, middle and late childhood, and adolescent years. However, there are significant individual variations in children's vocabulary, and a good vocabulary contributes in important ways to school success (Pan & Uccelli, 2009). In addition to ideas described earlier on using technology to improve children's vocabulary, here are other strategies to use in the classroom:

Preschool and Kindergarten

1. *Explain new vocabulary in books that you read to young children.*
2. *Name, label, and describe all of the things in the classroom.*
3. *In everyday conversation with children, introduce and elaborate on words that children are unlikely to know about.* This activity can also be used at higher grade levels.

Elementary, Middle, and High School

1. *If students have severe deficits in vocabulary knowledge, provide intense vocabulary instruction.*
2. *As a rule, don't introduce more than 10 words at a time.*
3. *Give students an opportunity to use words in a variety of contexts.* These contexts might include read-aloud, fill-in-the-blank sentences, and read-and-respond activities (students read short, information articles about a topic that includes targeted vocabulary words and then respond to questions about the articles).
4. *Writing can help students process word meanings actively.* For example, assign students a topic to write about using assigned vocabulary words

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Sources: Curtis & Longo, 2001; U.S. Department of Education, 2006.

DEVELOPMENT

ELEMENTARY SCHOOL: GRADES K–5 I often tell my fifth-grade students rich, vivid stories about my childhood experiences growing up in eastern Oregon. It is during

these teaching moments that my students pay the most attention. I sometimes write these stories on a computer and project them onto a screen in the classroom. Then the students and I discuss the stories and the language used—for example, similes, metaphors, figures of speech. We revise and edit the stories as a group and discuss strengths and weaknesses. The students are then assigned a similar topic to write about. This transfer of knowledge is amazing as the students are entertained, exposed to a new way of writing as it happens—and they see how something can be improved on the spot.

—Craig Jensen, *Cooper Mountain Elementary School*

MIDDLE SCHOOL: GRADES 6–8 During classroom discussions with my seventh-grade students, I intentionally incorporate unfamiliar words that will encourage them

to ask, "What does that mean?" For example, when talking about John D. Rockefeller in class recently, I asked, "How many of you would like to become a philanthropist?" I urge students to use their newly learned word at home and to tell the class how they worked it into a conversation. This is a simple way to make vocabulary fun!

—Mark Fodness, *Bemidji Middle School*

HIGH SCHOOL: GRADES 9–12 My high school students often use slang words that I am unfamiliar with. When this happens, I ask the students what the word

means and politely tell them that I want to expand my vocabulary. This dialogue often results in conversations about more appropriate words that the students can use in the workplace, classroom, or at home (and I learn something too!)

—Sandy Swanson, *Menomonee Falls High School*

Review, Reflect, and Practice

3 Identify the key features of language, biological and environmental influences on language, and the typical growth of the child's language.

REVIEW

- What is language? Describe these five features of spoken language: phonology, morphology, syntax, semantics, and pragmatics.
- What evidence supports the idea that humans are "prewired" for learning language? What evidence supports the importance of environmental factors?
- What milestones does a child go through in the course of learning language, and what are the typical ages of these milestones?

REFLECT

- How have teachers encouraged or discouraged your own mastery of language?
- What experiences have done the most to expand your language skills?

PRAXIS™ PRACTICE

1. Josh has developed a large vocabulary. Which of the following language systems does this reflect?
   a. semantics
   b. pragmatics
   c. syntax
   d. morphology
2. Children raised in isolation from human contact often show extreme, long-lasting language deficits that are rarely entirely overcome by later exposure to language. This evidence supports which aspect of language development?
   a. biological
   b. environmental
   c. interactionist
   d. pragmatic
3. Tamara is discussing the birds she saw flying over her neighborhood. She says, "We saw a flock of gooses." If Tamara's language development is normal for her age, how old is Tamara likely to be?
   a. 2 years old
   b. 4 years old
   c. 6 years old
   d. 8 years old

Please see the answer key at the end of the book.

Connecting with the Classroom: Crack the Case

The Book Report

Mr. Johnson assigned his high school senior American government students to read two books during the semester that had "something, anything to do with government or political systems" and to write a brief report about each of their chosen books.

One student in the class, Cindy, chose to read *1984* and *Animal Farm*, both by George Orwell. Written well before the year 1984, the book *1984* is about what could happen in "the future," given certain earlier political decisions. In essence, the world turns into a terrible place in which "Big Brother" monitors all of one's actions via two-way television-like screens. Infractions of minor rules are punished severely. *Animal Farm* is a brief novel about political systems portrayed as various farm animals such as pigs and dogs. Cindy enjoyed both books and completed them both before midterm. Her reports were insightful, reflecting on the symbolism contained in the novels and the implications for present-day government.

Cindy's friend, Lucy, put off reading her first book until the last minute. She knew Cindy enjoyed reading about government and had finished her reports. Lucy asked Cindy if she knew of a "skinny book" she could read to fulfill the assignment. Cindy gladly shared her copy of *Animal Farm* with her friend, but as Lucy began reading the book she wondered why Cindy had given her this book. It didn't seem to fit the requirements of the assignment at all.

The day before the first reports were due, Mr. Johnson overheard the girls talking. Lucy complained to Cindy, "I don't get it. It's a story about pigs and dogs."

Cindy responded, "They aren't really supposed to be farm animals. It's a story about the promises of communism and what happened in the Soviet Union once the communists took over. It's a great story! Don't you see? The pigs symbolize the communist regime that overthrew the czars during the Russian Revolution. They made all kinds of promises about equality for everyone. The people went along with them because they were sick and tired of the rich and powerful running everything while they starved. Once the czars were eliminated, the communists established a new government but didn't keep any of their promises—they controlled everything. Remember in the book when the pigs moved into the house and started walking on two legs? That's supposed to be like when the communist leaders began acting just like the czars. They even created a secret police force—the dogs in the story. Remember how they bullied the other animals? Just like the secret police in the Soviet Union."

Lucy commented, "I still don't get it. How can a pig or a dog be a communist or a cop? They're just animals."

Cindy looked at her friend, dumbfounded. How could she *not* understand this book? It was so obvious.

1. Drawing on Piaget's theory, explain why Cindy understood the book.
2. Based on Piaget's theory, explain why Lucy didn't understand the book.
3. What could Mr. Johnson do to help Lucy understand?
4. How could Mr. Johnson have presented this assignment differently, so that Lucy did not need to rush through a book?
5. At which of Piaget's stages of cognitive development is Cindy operating?
   a. sensorimotor
   b. preoperational
   c. concrete operational
   d. formal operational
   [Explain your choice.]
6. At which of Piaget's stages of cognitive development is Lucy operating?
   a. sensorimotor
   b. preoperational
   c. concrete operational
   d. formal operational
   [Explain your choice.]

Cognitive and Language Development

1 AN OVERVIEW OF CHILD DEVELOPMENT: Define development and explain the main processes, periods, and issues in development, as well as links between development and education.

Exploring What Development Is

Development is the pattern of biological, cognitive, and socioemotional changes that begins at conception and continues through the life span. Most development involves growth, but it also eventually includes decay (dying). The more you learn about children's development, the better you will understand the level at which to appropriately teach them. Childhood learning provides a foundation for learning in the adult years.

Processes and Periods

Child development is the product of biological, cognitive, and socioemotional processes, which often are intertwined. Periods of development include infancy, early childhood, middle and late childhood, and adolescence.

Developmental Issues

The main developmental issues are nature and nurture, continuity and discontinuity, and early and later experience. The nature-nurture issue focuses on the extent to which development is mainly influenced by nature (biological influence) or nurture (environmental influence). Although heredity and environment are pervasive influences on development, humans can author a unique developmental path by changing the environment. Some developmentalists describe development as continuous (gradual, cumulative change), others describe it as discontinuous (a sequence of abrupt stages). The early-later experience issue focuses on whether early experiences (especially in infancy) are more important in development than later experiences. Most developmentalists recognize that extreme positions on the nature-nurture, continuity-discontinuity, and early-later experience issues are unwise. Despite this consensus, these issues continue to be debated.

Development and Education

Developmentally appropriate teaching takes place at a level that is neither too difficult and stressful nor too easy and boring for the child's developmental level. Splintered development occurs when there is considerable unevenness in development across domains.

2 COGNITIVE DEVELOPMENT: Discuss the development of the brain and compare the cognitive developmental theories of Jean Piaget and Lev Vygotsky.

The Brain

An especially important part of growth is the development of the brain and nervous system. Myelination involving hand-eye coordination is not complete until about 4 years of age, and myelination involving focusing attention is not finished until about 10. Substantial synaptic pruning of the brain connections takes place, and the adult level of density of synaptic connections is not reached until some point in adolescence. Different regions of the brain grow at different rates. Changes in the brain in middle and late childhood included advances in functioning in the prefrontal cortex, which are reflected in improved attention, reasoning, and cognitive control. During middle and late childhood, less diffusion and more focal activation occurs in the prefrontal cortex, a change that is associated with an increase in cognitive control. Researchers have recently found a developmental disjunction between the early development of the amygdala, which is responsible for emotion, and the later development of the prefrontal cortex, which is responsible for reasoning and thinking. They argue that these changes in the brain may help to explain the risk-taking behavior and lack of mature judgment in adolescents. Changes in the brain during adolescence also involve the thickening of

(continued)

the corpus callosum. Lateralization in some verbal and nonverbal functions occurs, but in many instances functioning is linked to both hemispheres. There is considerable plasticity in the brain, and the quality of learning environments children experience influence the development of their brain. Too often links between neuroscience and education have been overstated. Based on recent research, what we do know indicates that educational experiences throughout childhood and adolescence can influence the brain's development.

Piaget's Theory

Jean Piaget proposed a major theory of children's cognitive development that involves these important processes: schemas, assimilation and accommodation, organization, and equilibration. In his theory, cognitive development unfolds in a sequence of four stages: sensorimotor (birth to about age 2), preoperational (from about ages 2 to 7), concrete operational (from about ages 7 to 11), and formal operational (from about ages 11 to 15). Each stage is a qualitative advance. In the sensorimotor stage, infants construct an understanding of the world by coordinating their sensory experiences with their motor actions. Thought is more symbolic at the preoperational stage, although the child has not yet mastered some important mental operations. Preoperational thought includes symbolic function and intuitive thought substages. Egocentrism and centration are constraints. At the concrete operational stage, children can perform operations, and logical thought replaces intuitive thought when reasoning can be applied to specific or concrete examples. Classification, seriation, and transitivity are important concrete operational skills. At the formal operational stage, thinking is more abstract, idealistic, and logical. Hypothetical-deductive reasoning becomes important. Adolescent egocentrism characterizes many young adolescents. We owe to Piaget a long list of masterful concepts as well as the current vision of the child as an active, constructivist thinker. Criticisms of his view focus on estimates of children's competence, stages, the training of children to reason at a higher cognitive level, and the neo-Piagetian criticism of not being precise enough about how children learn.

Vygotsky's Theory

Lev Vygotsky proposed another major theory of cognitive development. Vygotsky's view emphasizes that cognitive skills need to be interpreted developmentally, are mediated by language, and have their origins in social relations and culture. Zone of proximal development (ZPD) is Vygotsky's term for the range of tasks that are too difficult for children to master alone but that can be learned with the guidance and assistance of adults and more-skilled children. Scaffolding is an important concept in Vygotsky's theory. He also argued that language plays a key role in guiding cognition. Applications of Vygotsky's ideas to education include using the child's ZPD and scaffolding, using more-skilled peers as teachers, monitoring and encouraging children's use of private speech, and accurately assessing the ZPD. These practices can transform the classroom and establish a meaningful context for instruction. Like Piaget, Vygotsky emphasized that children actively construct their understanding of the world. Unlike Piaget, he did not propose stages of cognitive development, and he emphasized that children construct knowledge through social interaction. In Vygotsky's theory, children depend on tools provided by the culture, which determines which skills they will develop. Some critics say that Vygotsky overemphasized the role of language in thinking.

3 LANGUAGE DEVELOPMENT: Identify the key features of language, biological and environmental influences on language, and the typical growth of the child's language.

What Is Language?

Language is a form of communication, whether spoken, written, or signed, that is based on a system of symbols. Human languages are infinitely generative. All human languages also have organizational rules of phonology, morphology, syntax, semantics, and pragmatics. Phonology is the sound system of a language; morphology refers to the units of meaning involved in word formation; syntax involves the ways that words must be combined to form acceptable phrases and sentences; semantics refers to the meaning of words and sentences; and pragmatics describes the appropriate use of language in different contexts.

Biological and Environmental Influences

Children are biologically prepared to learn language as they and their caregivers interact. Some language scholars argue that the strongest evidence for the biological basis of language

Language Development

is that children all over the world reach language milestones at about the same age despite vast differences in their environmental experiences. However, children do not learn language in a social vacuum. Children benefit when parents and teachers actively engage them in conversation, ask them questions, and talk with, not just to, them. In sum, biology and experience interact to produce language development.

Language acquisition advances through stages. Babbling occurs at about 3 to 6 months, the first word at 10 to 13 months, and two-word utterances at 18 to 24 months. As children move beyond two-word utterances, they can demonstrate that they know some morphological rules, as documented in Jean Berko's study. Children also make advances in phonology, syntax, semantics, and pragmatics in early childhood. Young children's early literacy experiences enhance the likelihood children will have the language skills necessary to benefit from schooling. Vocabulary development increases dramatically during the elementary school years, and by the end of elementary school most children can apply appropriate rules of grammar. Metalinguistic awareness also advances in the elementary school years. In adolescence, language changes include more effective use of words; improvements in the ability to understand metaphor, satire, and adult literary works; and writing.

KEY TERMS

development 29
nature-nurture issue 32
continuity-discontinuity issue 32
early-later experience issue 32
splintered development 33
myelination 35
corpus callosum 36
prefrontal cortex 36
amygdala 36
lateralization 37
schemas 39
assimilation 40
accommodation 40
organization 40
equilibration 40
sensorimotor stage 41
preoperational stage 41
symbolic function substage 41
intuitive thought substage 42
centration 42
conservation 42
concrete operational stage 44
seriation 45
transitivity 45
formal operational stage 45
hypothetical-deductive reasoning 47
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zone of proximal development (ZPD) 50
scaffolding 52
social constructivist approach 53
language 58
phonology 58
morphology 58
syntax 58
semantics 59
pragmatics 59
metalinguistic awareness 63

PORTFOLIO ACTIVITIES

Now that you have a good understanding of this chapter, complete these exercises to expand your thinking.

Independent Reflection

1. Select the general age of the child you expect to teach one day. Make a list of that child's characteristic ways of thinking according to Piaget's theory of cognitive development. List other related characteristics of the child based on your own childhood. Then make a second list of your own current ways of thinking. Compare the lists. In what important cognitive ways do you and the child differ? What adjustments in thinking will you need to make when you set out to communicate with the child? Summarize your thoughts in a brief essay.
2. How might thinking in formal operational ways rather than concrete operational ways help students develop better study skills?
3. What is the most useful idea related to children's language development that you read about in this chapter? Write the idea down in your portfolio and explain how you will implement this idea in your classroom.

Research/Field Experience

4. Find an education article in a magazine or on the Internet that promotes "left-brained" and "right-brained" activities for learning. In a brief report, criticize the article based on what you read in this chapter about neuroscience and brain education.

Go to the Online Learning Center for downloadable portfolio templates.

STUDY, PRACTICE, AND SUCCEED

Visit www.mhhe.com/santrockep5e to review the chapter with self-grading quizzes and self-assessments, to apply the chapter material to two more Crack the Case studies, and for suggested activities to develop your teaching portfolio.