Cognitive Change: Cognitive–Developmental and Sociocultural Approaches

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"There you go, little guy," Mateo’s uncle says, placing a rattle in the infant’s grasp. Six-month-old Mateo shakes the toy and puts it in his mouth, sucking on it. He then removes the rattle from his mouth and gives it a vigorous shake, dropping it to the ground. “Mateo! Where’s your rattle?” asks his mother. “Whenever he drops his toy, he never looks for it,” she explains to his uncle, “not even when it’s his favorite toy.” As Mateo grows older, he will soon begin to show an interest in objects that disappear, like his rattle, and his thinking will become more complex as he progresses through toddlerhood and learns language. These are just the first in a lifetime of changes that will transform how Mateo views his world. How do we explain these cognitive changes? Three major perspectives on cognition address this question in different ways. Cognitive–developmental theories emphasize the structural changes that underlie development and how the content and organization of thinking changes. Sociocultural theories point to the roles of context and our need to communicate in influencing thought. Information processing theories (discussed in Chapter 7) emphasize changes in physical capacities and strategy use as contributors to cognitive change. In this chapter, we examine the cognitive–developmental and sociocultural approaches to cognitive change throughout life.
Ch 6.1 Identify Piaget’s six substages of sensorimotor reasoning and summarize criticism of this perspective on infant and early childhood cognitive development.

The first scientist to systematically examine children's thinking and reasoning, Swiss scholar Jean Piaget (1896–1980), believed that to understand children we must understand how they think because thinking influences all of behavior. Piaget formulated the cognitive development perspective, which views children and adults as active explorers who learn by interacting with the world, building their own understanding of everyday phenomena, and applying it to adapt to the world around them.

**Processes of Development**

According to Piaget (1952), children are active in their own development not simply because they engage other people, but because they engage the world, adapting their ways of thinking in response to their experiences. Through these interactions they organize what they learn to construct and refine their own schemas, or concepts, ideas, and ways of interacting on the world. Our earliest schemas are inborn motor responses, such as the reflex response that causes infants to close their fingers around an object when it touches their palm. As the infant grows and develops, these early motor schemas are transformed into cognitive schemas, or thought. At all ages we rely on our schemas to make sense of the world, but our schemas are constantly adapting and developing in response to our experiences. According to Piaget, cognitive development is the result of two developmental processes: assimilation and accommodation.

**Assimilation** involves integrating a new experience into a preexisting schema. For example, suppose that 1-year-old Kelly uses the schema of “grab and shove into the mouth” to learn. He grabs and shoves his rattle into his mouth, learning about the rattle by using his preexisting schema. When Kelly comes across another object, such as Mommy’s wristwatch, he transfers the schema to it—and assimilates the wristwatch by grabbing it and shoving it into his mouth. He develops an understanding of the new objects through assimilation, by fitting them into his preexisting schema.

Sometimes we encounter experiences or information that do not fit within an existing schema, so we must change the schema, adapting and modifying it in light of the new information. This process is called **accommodation**. For example, suppose Kelly encounters another object, a beach ball. He tries his schema of grab and shove, but the beach ball won’t fit into his mouth; perhaps he cannot even grab it. He must adapt his schema or create a new one in order to incorporate the new information—to learn about the beach ball. Kelly may squeeze and mouth the ball instead, accommodating or changing his schema to interact with the new object.

The processes of assimilation and accommodation are continually occurring and are ways that people adapt to their environment, absorbing the constant flux of information they encounter daily (see Figure 6.1). People—infants, children, and adults—constantly integrate new information into their schemas and continually encounter new information that requires them to modify their schemas. Piaget proposed that people naturally strive for cognitive equilibrium, a balance between the processes of assimilation and accommodation. When assimilation and accommodation are
balanced, individuals are neither incorporating new information into their schemas nor changing their schemas in light of new information; instead, our schemas match the outside world and represent it clearly. But a state of cognitive equilibrium is rare and fleeting. More frequently, people experience a mismatch or disequilibrium between their schemas and the world. For example, when Kelly picks up his mother's wristwatch and tries to learn about it by applying his grab-and-shove schema, he displays cognitive disequilibrium because he has discovered information that is new to him and therefore must be assimilated. Likewise, Kelly also displays cognitive disequilibrium when he must accommodate his schema to learn from a new experience, such as an encounter with a beach ball.

Disequilibrium leads to cognitive growth because of the mismatch between children's schemas and reality. This mismatch leads to confusion and discomfort, which in turn motivate children to modify their cognitive schemas so that their view of the world matches reality. It is through assimilation and accommodation that this modification takes place so that cognitive equilibrium is restored. Children's drive for cognitive equilibrium is the basis for cognitive change, propelling them through the four stages of cognitive development proposed by Piaget (see Table 1.4 in Chapter 1). With each advancing stage, children create and use more sophisticated cognitive schemas, enabling them to think, reason, and understand their world in more complex ways. The earliest schemas emerge during the first stage of cognitive development: the sensorimotor stage.

INFANCY: SENSORIMOTOR REASONING

"Be gentle with Baby Emily," Lila cautions her 22-month-old son, Gabriel. "She's just one week old and very little. You were once little like her." "No," Gabriel giggles: "Big boy!" Gabriel picks up his teddy bear, cradles it like a baby, then holds it to his chest, rubbing its back to imitate what he sees Mommy do with Baby Emily. In less than 2 years, Gabriel has transformed from a tiny infant, like Baby Emily, to a toddler who can imitate what he sees and verbally express his ideas. Like all newborns, Baby Emily is equipped with inborn sensory capacities and preferences that enable her to tune in to the world around her. Baby Emily's abilities to think, reason, problem solve, and interact with objects and people will change dramatically over the next 2 years.

Sensorimotor Substages

During the sensorimotor stage, from birth to about 2 years, infants learn about the world through their senses and motor skills. To think about an object they must act on it by viewing it, listening to it, touching it, smelling it, and tasting it. Piaget (1952) believed that infants are not capable of mental representation—thinking about an object using mental pictures. They also lack the ability to remember and think about objects that are not present. Instead, in order to think about an object, an infant must experience it through both the visual and tactile senses. The sensorimotor period of reasoning, as Piaget conceived of it, progresses through six substages in which cognition develops from reflexes to intentional action, to symbolic representation.

Substage 1: Reflexes (birth to 1 month). In the first substage, newborns use their reflexes, such as the sucking and palmar grasp reflexes, to react to stimuli they experience. During
the first month of life, infants use these reflexes to learn about their world, through the process of assimilation; they apply their sucking schema to assimilate information and learn about their environment. At about 1 month of age, newborns begin to accommodate, or modify, their sucking behaviors to specific objects, sucking differently in response to a bottle verses a pacifier. For example, they may modify their sucking schema when they encounter a pacifier, perhaps sucking less vigorously and without swallowing. During the first month of life, newborns strengthen and modify their original reflexive schemas to explore the world around them.

**Substage 2: Primary Circular Reactions (1 to 4 months).** During the second substage, infants begin to make accidental discoveries. Early cognitive growth in the sensorimotor period comes through engaging in **circular reactions**, the repetition of an action and its response. Infants learn to repeat pleasurable or interesting events that originally occurred by chance. Between 1 and 4 months infants engage in behaviors called **primary circular reactions**, which consist of repeating actions involving the parts of the body that produce pleasurable or interesting results. A primary circular reaction begins by chance or by accident, as the infant produces a pleasurable sensation and learns to repeat the behavior to make the event happen again and experience the pleasurable effect again. For example, an infant flails her arms and accidentally puts her hand in her mouth. She is surprised at the outcome (her hand in her mouth) and tries to make it happen again. Therefore the infant repeats the behavior to experience and explore her body.

**Substage 3: Secondary Circular Reactions (4 to 8 months).** During the third sensorimotor substage, as infants’ awareness extends further, they engage in **secondary circular reactions**, which are repetitions of actions that trigger responses in the external environment, outside of the baby’s body. Now the patterns of repetition are oriented toward making interesting events occur in the infant’s environment. For example, the infant shakes a rattle to hear its noise or kicks his or her legs to move a mobile hanging over the crib. Secondary circular reactions indicate that infants’ attention has expanded to include the environment outside their bodies and that they are beginning to understand that their actions cause results in the external environment. In this way, infants discover new ways of interacting with their environments to continue experiencing sensations and events that they find pleasing.

**Substage 4: Coordination of Secondary Circular Reactions (8 to 12 months).** Unlike primary and secondary circular reactions, which are behaviors that are discovered by accident, the coordination of secondary circular reactions substage represents true means–end behavior and signifies the beginning of intentional behavior. During this substage, infants purposefully coordinate two secondary circular reactions and apply them in new situations to achieve a goal. For example, Piaget described how his son, Laurent, combined the two activities of knocking a barrier out of his way and grasping an object. When Piaget put a pillow in front of a matchbox that Laurent desired, the boy pushed the pillow aside and grabbed the box. In this way, Laurent integrated two secondary circular reactions to achieve a goal. Now planning and goal-directed behavior have emerged.

One of the most important advances during the coordination of secondary circular reactions stage is **object permanence**, the understanding that objects continue to exist outside of sensory awareness (e.g., are no longer visible). According to Piaget, infants
younger than 8 months of age do not yet have object permanence—out of sight is literally out of mind. An infant loses interest and stops reaching for or looking at a small toy after it is covered by a cloth. It is not until 8 to 12 months, during the coordination of secondary circular reactions stage, that object permanence emerges and infants will search for hidden objects. Displaying object permanence is an important cognitive advance because it signifies a capacity for mental representation, or internal thought. The ability to think about an object internally is an important step toward learning language because language uses symbols: Sounds symbolize and stand for objects (e.g., infants must understand that the sound “ball” represents an object, a ball).

**Stage 5: Tertiary Circular Reactions (12 to 18 months).** During the fifth substage, infants begin to experiment with new behaviors to see the results. Piaget described infants as “little scientists” during this period because they move from intentional behavior to systematic exploration. In what Piaget referred to as tertiary circular reactions, infants now engage in mini-experiments: active, purposeful, trial-and-error exploration to search for new discoveries. They vary their actions to see how the changes affect the outcomes. For example, many infants begin to experiment with gravity by dropping objects to the floor while sitting in a high chair. First an infant throws a ball and watches it bounce. Next a piece of paper floats slowly down. Then mommy’s keys clatter down. And so on. This purposeful exploration is how infants search for new discoveries and learn about the world. When presented with a problem, babies in the tertiary circular reactions substage engage in trial-and-error analyses, trying out behaviors until they find the best one to attain their goal.

**Substage 6: Mental Representation (18 to 24 months).** The sixth sensorimotor substage marks a transition between the sensorimotor and preoperational reasoning stages. Between 18 and 24 months of age, infants develop representational thought, the ability to use symbols such as words and mental pictures to represent objects and actions in memory. In developing this ability, infants are freed from immediate experience: They can think about objects that they no longer see directly in front of them and can engage in deferred imitation, imitating actions of an absent model. Now, external physical exploration of the world gives way to internal mental exploration. Children can think through potential solutions and create new solutions to problems without engaging in physical trial and error, but by simply considering the potential solutions and their consequences. Table 6.1 summarizes the substages of sensorimotor reasoning.

**TABLE 6.1 • Substages of Sensorimotor Reasoning**

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<th>SUBSTAGE</th>
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<td>Newborn strengthens and adapts reflexes</td>
<td>Newborn shows a different sucking response to a nipple versus a pacifier</td>
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<td>Primary circular reactions (1–4 months)</td>
<td>Repeats motor actions that produce interesting outcomes that are centered on the body</td>
<td>Infant pats hand against the floor to feel sensation on palm</td>
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<tr>
<td>Secondary circular reactions (4–8 months)</td>
<td>Repeats motor actions that produce interesting outcomes that are directed toward the environment</td>
<td>Infant bats mobile with his arm and watches the mobile move</td>
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Coordination of secondary circular reactions (8–12 months) | Combines secondary circular reactions to achieve goals and solve problems; the beginnings of intentional behavior | Infant uses one hand to lift a bucket covering a ball and the other to grasp the ball. Infant uses both hands to pull a string attached to a ball and eventually reach the ball

Tertiary circular reactions (12–18 months) | Experiments with different actions to achieve the same goal or observe the outcome and make new discoveries | Infant hits a pot with a wooden spoon and listens to the sound, then hits other objects in the kitchen, such as the refrigerator, stove, plates, to hear the sound that the spoon makes against the objects

Mental representation (18–24 months) | Internal mental representation of objects and events; thinking to solve problems rather than relying on trial and error | When confronted with a problem, like a toy that is out of reach on the counter, the infant can consider possible solutions to a problem in his mind, decide on a solution, and implement it

### Evaluating Sensorimotor Reasoning

Piaget’s contributions to our understanding of cognitive development are vast and invaluable. He was the first to ask what develops during childhood and how it occurs. Piaget recognized that motor action and cognition are inextricably linked, a view still accepted by today’s developmental scientists (Adolph & Berger, 2005; Beilin & Fireman, 2000; Woods & Wilcox, 2013).

Piaget’s work has stimulated a great deal of research as developmental scientists have tested his theory. However, measuring the cognitive capabilities of infants and toddlers is very challenging because, unlike older children and adults, babies cannot fill out questionnaires or answer questions orally. Researchers have had to devise methods of measuring observable behavior that can provide clues to what an infant is thinking. For example, researchers measure infants’ looking behavior: What does the infant look at, and for how long? Using such methods, they have found support for some of Piaget’s claims and evidence that challenges others. One of the most contested aspects of Piaget’s theory concerns his assumption that infants are not capable of mental representation until late in the sensorimotor period. A growing body of research conducted with object permanence and imitation tasks suggests otherwise, as described in the following sections.

### Violation-of-Expectation Tasks

Piaget’s method of determining whether an infant understood object permanence relied on the infant’s ability to demonstrate it by uncovering a hidden object. Critics argue that many infants may understand that the object is hidden but lack the motor ability to coordinate their hands to physically demonstrate their understanding. Studying infants’ looking behavior enables researchers to study object permanence in younger infants with undeveloped motor skills because it eliminates the need for infants to use motor activity to demonstrate their cognitive competence.

One such research design uses a violation-of-expectation task, in which a stimulus appears to violate physical laws (Baillargeon, 1994). Specifically, in a violation-of-expectation task an infant is shown two events: one that is labeled expected because it follows physical laws and a second that is called unexpected because it violates physical laws. If the infant looks longer at the unexpected event it suggests that he or she is surprised by it, is aware of physical properties of objects, and can mentally represent them.
In a classic study, developmental researcher Renée Baillargeon (1987) utilized the violation-of-expectation method to study the mental representation capacities of very young infants. Infants were shown a drawbridge that rotated 180 degrees. Then the infants watched as a box was placed behind the drawbridge to impede its movement. Infants watched as either the drawbridge rotated and stopped upon hitting the box or did not stop and appeared to move through the box (an “impossible” event). As shown in Figure 6.2, 4.5-month-old infants looked longer when the drawbridge appeared to move through the box (the “impossible” unexpected event), rather than when it stopped; this motion was “possible” in terms of solidity and object permanence. In the Control Condition, the screen rotations were identical, but no box was presented (such that both motions were equally possible). The results from the test phase are depicted in the right panels of (B). In the Experimental Condition, infants looked longer at the Impossible Test but not the Possible Test. However, in the Control Condition no preference was observed. They looked equally at the full and partial rotation. These results suggest a violation of infants’ expectations regarding object permanence.


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Other researchers counter that these results do not demonstrate object permanence in young infants, but rather illustrate infants’ preference for novelty or for greater movement (Bogatz, Shinskey, & Schilling, 2000). For example, when the study was replicated without the box, 5-month-old infants looked longer at the full rotation, suggesting that infants looked at the unexpected event not because it violated physical laws, but because it represented greater movement (Rivera, Wakely, & Langer, 1999). However, studies that use simpler tasks have shown support for young infants’ competence. At 4 and 5 months, infants will watch a ball roll behind a barrier, gazing to where they expect it to reappear (Bertenthal, Longo, & Kenny, 2007; von Hofsten, Kochukhova, & Rosander, 2007). When 6-month-old infants are shown an object and the lights are then turned off, they will reach in the dark for the object (Goubet & Clifton, 1998; Shinskey & Munakata, 2003).
They will also reach for an object hidden by being immersed in liquid (Shinskey, 2012), suggesting that they maintain a mental representation of the object and therefore have object permanence earlier than Piaget believed.

**A-Not-B Tasks.** Other critics of Piaget's views of infants' capacities for object permanence focus on an error that 8- to 12-month-old infants make, known as the *A-not-B error*. The A-not-B error occurs when infants are able to uncover a toy hidden behind a barrier, yet when they observe the toy moved from behind one barrier (Place A) to another (Place B), they look for the toy in the first place it was hidden, Place A, even after watching the toy be moved to Place B (see Figure 6.3). Piaget believed that the infant incorrectly, but persistently, searches for the object in Place A because he or she lacks object permanence. More recent research shows that infants look at Place B, the correct location, at the same time as they mistakenly reach for Place A (Diamond, 1985), suggesting that they understand the correct location of the object (Place B), but cannot keep themselves from reaching for Place A because of neural and motor immaturity (Diamond, 1991).

Other researchers propose that infants cannot restrain the impulse to repeat a behavior that was previously rewarded (Zelazo, Reznick, & Spinazzola, 1998). When looking time procedures are used to study the A-not-B error (Ahmed & Ruffman, 1998), infants look longer when the impossible illusory event occurs (when the toy is moved from Place A to Place B but is then found at Place A) than when the expected, possible event occurs (when the toy is moved from Place A to Place B and is found at Place B). This suggests that infants have object permanence but their motor skills prohibit them from demonstrating it in A-not-B tasks. One longitudinal study followed infants from 5 to 10 months of age and found that between 5 and 8 months infants showed better performance on an A-not-B looking task rather than a reaching task. Nine- and 10-month old infants performed equally well on A-not-B looking and reaching tasks (Cuevas & Bell, 2010). Age-related changes in performance on A-not-B and other object permanence tasks may be due to maturation of brain circuitry controlling motor skills and inhibition as well as advances in the ability to control attention (Cuevas & Bell, 2010; Marcovitch, Clearfield, Swingler, Calkins, & Bell, 2016; Watanabe, Forssman, Green, Bohlin, & von Hofsten, 2012).

**Deferred-Imitation Tasks.** Another method of studying infants’ capacities for mental representation relies on deferred imitation, the ability to repeat an act performed some time

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**FIGURE 6.3: A-Not-B Error**

The infant continues to look for the ball under place A despite having seen the ball moved to place B.
ago. Piaget (1962) believed that infants under 18 months cannot engage in deferred imitation because they lack mental representation abilities. Yet laboratory research on infant facial imitation has found that 6-week-old infants who watch an unfamiliar adult’s facial expression will imitate it when they see the same adult the next day (Meltzoff & Moore, 1994). Six- and 9-month-old infants also display deferred imitation of unique actions performed with toys, such as taking a puppet’s glove off, shaking it to ring a bell inside, and replacing it, over a 24-hour delay (Barr, Marrott, & Rovee-Collier, 2003).

When infants engage in deferred imitation, they act on the basis of stored representations of actions—memories—that counter Piaget’s beliefs about infants’ capabilities (Jones & Herbert, 2006). Many researchers now suggest that deferred imitation, along with object permanence itself, is better viewed as a continuously developing ability, rather than the stage-like shift in representational capacities that Piaget proposed (Hayne, 2004; Rovee-Collier, Hayne, & Colombo, 2002). For example, a 3-year longitudinal study of infants 12, 18, and 24 months old showed that performance on deferred imitation tasks improved throughout the second year of life (Kolling, Goertz, Stefanie, & Knopf, 2010). Between 12 and 18 months, infants remember modeled behaviors for several months and imitate peers as well as adults (Hayne, Boniface, & Barr, 2000; Klein & Meltzoff, 1999). Increases in imitative capacity are observed with development up to 30 months of age as well as when shorter sequences of action are used, such as a sequence of fewer than eight unique actions (Barr, Dowden, & Hayne, 1996; Herbert & Hayne, 2000; Kressley-Mba, Lurg, & Knopf, 2005). In addition, research following infants from 9 months to 14 months of age suggests that individual differences in imitation are stable; children who show lower levels of imitation at 9 months of age continue to score lower on imitation at 14 months (Heimann & Meltzoff, 1996). These gradual changes suggest that infants and toddlers increase their representational capacities in a continuous developmental progression.

Core Knowledge Perspective as an Alternative Theory

Developmental psychologists generally agree with Piaget’s description of infants as interacting with the world, actively taking in information, and constructing their own thinking. However, most researchers no longer agree with Piaget’s belief that all knowledge begins with sensorimotor activity. Instead, infants are thought to have some innate, or inborn, cognitive capacities. Conservative theorists believe that infants are born with limited learning capacities such as a set of biases that cause them to attend to features of the environment that will help them to learn quickly (Kagan, 2008). Alternatively, the core knowledge perspective explains that infants are born with several innate knowledge systems or core domains of thought that enable early rapid learning and adaptation (Spelke, Lee, & Izard, 2010; Spelke & Kinzler, 2007).

According to core knowledge theorists, infants learn so quickly and encounter such a great amount of sensory information that some prewired evolutionary understanding, including the early ability to learn rules, must be at work (Spelke, 2016; Wang, Zhang, & Baillargeon, 2016). Using the violation-of-expectation method, core knowledge researchers have found that young infants have a grasp of the physical properties of objects, including the knowledge that objects do not disappear out of existence (permanence), they cannot pass through another (solidity), and they will fall without support (gravity; Baillargeon, Li, Gertner, & Wu, 2011). Newborns are sensitive to the physical properties of objects and show preferences for causality, looking longer at stimuli that illustrate physical causality (e.g., Ball A rolling and hitting Ball B and Ball B rolling) than those that do not (e.g., Ball A rolling and Ball B rolling after a delay; Mascalzoni, Regolin, Vallortigara, & Simion, 2013). Infants are also thought to have early knowledge of numbers. Five-month-old infants can discriminate between small and large numbers of items (Cordes & Brannon, 2009; Libertus & Brannon, 2009). Even newborns are sensitive
to large differences in number, distinguishing nine items from three, for example, but newborns show difficulty distinguishing small numbers from each other (two vs. three items; Coubart, Izard, Spelke, Marie, & Streri, 2014). Comparative research has shown that animals display these systems of knowledge early in life and without much experience (Vallortigara, 2012), suggesting that it is possible—and perhaps evolutionarily adaptive—for infants to quickly yet naturally construct an understanding of the world (Xu & Kushnir, 2013).

Much core knowledge research employs the same looking paradigms described earlier, in which infants’ visual preferences are measured as indicators of what they know. Critics argue that it is unclear whether we can interpret infants’ looking in the same way as adults (Kagan, 2008). Such measures demonstrate discrimination—that young infants can tell the difference between stimuli—but perceiving the difference between two stimuli does not necessarily mean that an infant understands how the two stimuli differ (Bremner, Slater, & Johnson, 2015). Others have suggested that infants are not detecting differences in number, but rather differences in area (Mix, Huttenlocher, & Levine, 2002). For example, it may be that the infant differentiates nine items from three not because of the change in number, but simply because nine items take up more space than three. More recent research has shown that 7-month-old infants can differentiate changes in number and area, are more sensitive to changes in number than area, and prefer to look at number changes over area changes (Libertus, Starr, & Brannon, 2014). Infants apply basic inferential mechanisms to quickly yet naturally construct an understanding of the world (Xu & Kushnir, 2013). Research with toddlers has suggested that they can understand, learn, and use causal principles to guide their actions (Walker & Gopnik, 2013).

Overall, Piaget’s theory has had a profound influence on how we view cognitive development. However, infants and toddlers are more cognitively competent than Piaget imagined, showing signs of representational ability and conceptual thought that he believed were not possible (Flavell, 1993). Developmental scientists agree with Piaget that immature forms of cognition give way to more mature forms, that the individual is active in development, and that interaction with the environment is critical for cognitive growth.

Electronic media are an important part of children’s, adolescents’, and adults’ environments. Do infants interact with electronic media? The Applied Developmental Science feature examines whether infants can learn from electronic media.

**EARLY CHILDHOOD: PREOPERATIONAL REASONING**

Four-year-old Timothy stands up on his toes and releases his parachute toy, letting the action figure dangling from a parachute drift a few feet from him and collapse on the floor. “I’m going to go up high and make it faster,” he says, imagining standing on the sofa and making the toy sail far into the clouds. He stands on the sofa and releases the toy, which sails a bit farther this time. “Next time he’ll jump out of the plane even higher!” Timothy thinks, excitedly. His friend Isaiah calls out, “Let’s make him land on the moon! He can meet space people!”

Timothy and Isaiah can plan, think of solutions to problems, and use language to communicate their ideas. They learn through play and by interacting with people and objects around them. From the cognitive-developmental perspective, young children’s thought progresses from the sensory and motor schemes of infancy to more sophisticated representational thought. Preoperational reasoning appears in young children from about ages 2 to 6 and is characterized by a dramatic leap in the use of symbolic thinking that permits young children to use language, interact with others, and play using their own thoughts and imaginations to guide their behavior. It is symbolic thought that enables Timothy and Martin to use language to communicate their thoughts and desires—and it is also what allows them to send their toy on a mission to the moon to visit with pretend space people.
The Media and Baby Geniuses

Most babies watch at least some television or play with electronic devices, such as their parents’ mobile phones and tablets. How might viewing media influence infants’ development?

Nine-month-old Derek sat in his high chair, munching cereal and watching the flickering television screen in front of him. In fact, 90% of parents report that their infants under the age of 2 years watch some form of electronic media, and the programming they watch is often specifically tailored to infants (Brown, 2011).

Infant-directed videos are often advertised as a way to enhance babies’ brain development, intelligence, and early learning as they offer educational content embedded in an engaging video format and focused on themes such as language and general knowledge, including, shape, color, reading, and numbers (Fenstermacher et al., 2010). Most parents believe that age-appropriate videos can have an important positive impact on early child development, providing good entertainment for babies and convenience for parents (Robb, Richert, & Wartella, 2009).

But do baby videos really aid development? Brain-building claims made by baby media manufacturers are not supported by the research literature (Christakis, 2009) and longitudinal studies suggest no evidence of long-term benefits of media use in early childhood (American Academy of Pediatrics Council on Communications and Media, 2016; Courage & Howe, 2010; Ferguson & Donnellan, 2014). One study tested a popular DVD program that claims to help young infants learn to read. Ten- to 18-month-old infants who regularly watched the program for 7 months did not differ from other infants in intelligence, cognitive skills, reading skill, or word knowledge (Neuman, Kaefer, Pinkham, & Strouse, 2014). Other research has demonstrated that infants learn more readily from people than from TV, a finding known as the video deficit effect (Anderson & Pempek, 2005). For example, when 12- to 18-month-old infants watched a bestselling DVD that labels household objects, the infants learned very little from it as compared with what they learned though interaction with parents (DeLoache et al., 2010). Yet the video deficit is reduced when infants’ memory capacities are taken into account, such as by repeating content and adding visual and auditory cues (Barr, 2013). Infants and toddlers may be capable of learning from screen media, depending on the degree to which the media content resembles infants’ and toddlers’ real-life experiences, including the use of simple stories and familiar objects or routines (Linebarger & Vaala, 2010).

Are baby videos harmful? Some studies suggest that exposure to baby media may be associated with deficits and delays in language development (Chonchaiya & Pruksananonda, 2008; Zimmerman, Christakis, & Meltzoff, 2007). The effects of media use vary with its content, quality, and context. For example, one study showed that Hispanic infants and toddlers who viewed more than two hours of television per day showed poor scores on a language measure—but the relationship was true only for infant media; those who viewed adult media showed no difference in language scores (uch, Fisher, Ensari, & Harrington, 2013). It may not be the quantity of television viewing that is related with language outcomes but the quality. Poor quality viewing (e.g., background television, solitary viewing, and earlier age of viewing), is associated with lower vocabulary scores (Hudon, Fennell, & Hoftyzer, 2013). Age certainly matters. For example, one study showed that infants who are 17 months old and older were able to learn words from infant DVDs, as evidenced by looking measures, whereas younger infants did not display this learning (Krcmar, 2014).

Although infant media will not transform ordinary infants into brilliant geniuses, in limited doses it does not seem to cause harm (Neuman et al., 2014). Parents play a role in influencing the effects of educational and interactive baby media on their infants. (American Academy of Pediatrics Council on Communications and Media, 2016). When parents watch videos along with their infants and talk to them about the content, infants spend more time looking at the screen, learn more from the media, and show greater knowledge of language as toddlers (Linebarger & Vaala, 2010). In today’s electronically connected world, it is impossible for most families to prevent infants from coming into contact with screens, whether television, tablet, or mobile phone. Considering that nearly 40% of infants under the age of 2 have viewed a mobile device, it appears that a developmental task for today’s infants and toddlers is to learn how to learn from screens (Wartella & Lauricella, 2012).

What Do You Think?

1. How might you teach infants and toddlers how to learn from screens, such as from televisions, cell phones, and tablets?
2. Imagine that you are a parent. Why might you allow your young child to play with your mobile phone or tablet? In your view, what are some disadvantages of screen use by infants and toddlers?
Characteristics of Preoperational Reasoning

Young children in the preoperational stage show impressive advances in representational thinking, but they are unable to grasp logic and cannot understand complex relationships. For example, a child may not understand that her father was once her grandmother’s little boy. Alternatively, a child may not understand that his brother is also his sister’s brother. Understanding each of these complex relationships requires the use of cognitive operations that are beyond the preoperational child’s capacities. Children who show preoperational reasoning tend to make several common errors, including egocentrism, animism, centration, and irreversibility.

Egocentrism. “See my picture?” Ricardo asks as he holds up a blank sheet of paper. Mr. Seris answers, “You can see your picture, but I can’t. Turn your page around so that I can see your picture. There it is! It’s beautiful,” he proclaims after Ricardo flips the piece of paper, permitting him to see his drawing. Ricardo did not realize that even though he could see his drawing, Mr. Seris could not. Ricardo displays egocentrism, the inability to take another person’s point of view or perspective. The egocentric child views the world from his or her own perspective, assuming that other people share her feelings, knowledge, and even physical view of the world. For example, the egocentric child may present Mommy with her teddy bear when Mommy looks sad, not realizing that although the teddy bear may make her feel better, Mommy has different needs and preferences.

A classic task used to illustrate preoperational children’s egocentrism is the three mountain task. As shown in Figure 6.4, the child sits at a table facing three large mountains. A doll is placed in a chair across the table from the child. The child is asked how the mountains look to the doll. Piaget found that young children in the preoperational stage described the scene from their own perspective rather than the doll’s. They could not complete the task correctly because they could not imagine that someone else could see the world differently. The children exhibited egocentrism; they were not able to take another point of view (the doll’s; Piaget & Inhelder, 1967).

Animism. Egocentric thinking can also take the form of animism, the belief that inanimate objects are alive and have feelings and intentions. “It’s raining because the sun is sad and it is crying,” 3-year-old Melinda explains. Children accept their own explanations for phenomena as they are unable to consider another viewpoint or alternative reason. The 4-year-old child who cries after bumping her head on a table may feel better after...
her mother smacks the table, saying, “Bad table!” In the child's eyes, the table got what it deserved—payback!

**Centration.** Preoperational children exhibit centration, the tendency to focus on one part of a stimulus or situation and exclude all others. For example, a boy may believe that if he wears a dress he will become a girl. He focuses entirely on the appearance (the dress) rather than the other characteristics that make him a boy. Consider a group of children who are lined up according to height. If one child is asked, “Who is the tallest?” he or she will correctly point to the tallest child. Then, if the child is asked, “Who is the oldest?” he or she may point to the tallest child. “Who is the smartest?” Again the child points to the tallest child of the group, demonstrating centration: the child focuses on height to the exclusion of the other attributes.

Centration is illustrated by a classic task that requires the preoperational child to distinguish what something appears to be from what it really is, the **appearance-reality distinction.** In a classic study illustrating this effect, DeVries (1969) presented 3- to 6-year-old children with a cat named Maynard (see Figure 6.5). The children were permitted to pet Maynard. Then, while his head and shoulders were hidden behind a screen (and his back and tail were still visible), a dog mask was placed onto Maynard's head. The children were then asked, “What kind of animal is it now?” “Does it bark or meow?” Three-year-old children, despite Maynard's body and tail being visible during the transformation, replied that he was now a dog. Six-year-old children were able to distinguish Maynard's appearance from reality and explained that he only looked like a dog.

One reason that 3-year-old children fail appearance-reality tasks is because they are not yet capable of effective **dual encoding,** the ability to mentally represent an object in more than one way at a time (Flavell, Green, & Flavell, 1986). For example, young children are not able to understand that a scale model (like a doll house) can be both an object (something to play with) and a symbol (of an actual house; DeLoache, 2000; MacConnell & Daehler, 2004).

**Irreversibility.** “You ruined it!” cried Johnson after his older sister, Monique, placed a triangular block atop the tower of blocks he had just built. “No, I just put a triangle there to show it was the top and finish it,” she explains. “No!” insists Johnson. “OK, I'll take it off,” says Monique. “See? Now it's just how you left it.” “No. It's ruined,” Johnson sighs. Johnson continued to be upset after his sister removed the triangular block, not realizing that by removing the block she has restored the block structure to its original state. Young children's thinking is characterized by **irreversibility,** meaning that they do not understand that reversing a process can often undo it and restore the original state.

Preoperational children's irreversible thinking is illustrated by **conservation** tasks that require them to understand that the quantity of a substance is not transformed by changes in its appearance; that a change in appearance can be reversed. For example, a child is shown two identical glasses. The same amount of liquid is poured into each glass. After the child agrees that the two glasses contain the same amount of water, the liquid from one glass is poured into a taller, narrower glass and the child is asked whether one glass contains more liquid than the other. Young children in the preoperational stage reply that the taller narrower glass contains more liquid.}

**FIGURE 6.5: Appearance vs. Reality: Is It a Cat or Dog?**

Young children did not understand that Maynard the cat remained a cat despite wearing a dog mask and looking like a dog.

contains more liquid. Why? It has a higher liquid level than the shorter, wider glass has. They center on the appearance of the liquid without realizing that the process can be reversed by pouring the liquid back into the shorter, wider glass. They focus on the height of the water, ignoring other aspects such as the change in width, not understanding that it is still the same water.

Figure 6.6 displays additional conservation problems. Characteristics of preoperational children’s reasoning are summarized in Table 6.2.

Evaluating Preoperational Reasoning

Similar to findings that infants are more capable than Piaget envisioned, research with young children has contravened some of Piaget’s conclusions. Just as Piaget’s sensorimotor tasks underestimated infants’ cognitive abilities, his tests of preoperational thinking underestimated young children. Success on Piaget’s tasks appears to depend more on the child’s language abilities than his or her actions. To be successful at the three mountain task, for example, the child must not only understand how the mounds look from the other side of the table, but must be able to communicate that understanding. Appearance–reality tasks require not simply an understanding of dual representation, but the ability to express it. However, if the task is nonverbal, such as requiring reaching for an object rather than talking about it, even 3-year-old children can distinguish appearance from reality, as we will discuss in the following sections (Sapp, Lee, & Muir, 2000).

<table>
<thead>
<tr>
<th>Conservation Task</th>
<th>Original Presentation</th>
<th>Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Are there the same number of pennies in each row?</td>
<td>Now are there the same number of pennies in each row, or does one row have more?</td>
</tr>
<tr>
<td></td>
<td>![Image of pennies]</td>
<td>![Image of pennies]</td>
</tr>
<tr>
<td>Mass</td>
<td>Is there the same amount of clay in each ball?</td>
<td>Now does each piece have the same amount of clay, or does one have more?</td>
</tr>
<tr>
<td></td>
<td>![Image of clay]</td>
<td>![Image of clay]</td>
</tr>
<tr>
<td>Liquid</td>
<td>Is there the same amount of water in each glass?</td>
<td>Now does each glass have the same amount of water, or does one have more?</td>
</tr>
<tr>
<td></td>
<td>![Image of glasses]</td>
<td>![Image of glasses]</td>
</tr>
</tbody>
</table>

FIGURE 6.6: Additional Conservation Problems

TABLE 6.2 • Characteristics of Preoperational Children’s Reasoning

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Egocentrism</td>
<td>The inability to take another person’s point of view or perspective</td>
</tr>
<tr>
<td>Animism</td>
<td>The belief that inanimate objects are alive and have feelings and intentions</td>
</tr>
<tr>
<td>Irreversibility</td>
<td>Failure to understand that reversing a process can often undo a process and restore the original state</td>
</tr>
<tr>
<td>Centration</td>
<td>Tendency to focus attention on one part of a stimulus or situation and exclude all others</td>
</tr>
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</table>
Research Findings on Egocentrism and Animism. Simple tasks demonstrate that young children are less egocentric than Piaget posited. When a 3-year-old child is shown a card that depicts a dog on one side and a cat on another, and the card is held up between the researcher who can see the cat and the child who can see the dog, the child correctly responds that the researcher can see the cat (Flavell, Everett, Croft, & Flavell, 1981). In a variation of the three mountain task, called the doll and police officer task, the child sits in front of a square board that is divided into four sections (Hughes, 1975). A toy police officer is placed at the edge of the board. A doll is placed in one section, moved to another section, and so on. With each move the child is asked whether the police officer can see the doll. Finally another police officer is placed on the board and the child is asked to hide the doll from both police officers. In this task, nearly all children ages 3 ½ to 5 were able to take the police officers’ perspectives and successfully complete the task. By making the task more relevant to children's everyday lives (i.e., hiding), and less difficult, it became clear that young children are less egocentric than Piaget theorized (M. Hughes, 1975; Newcombe & Huttenlocher, 1992).

Likewise, although young children sometimes provide animistic answers to questions, they do not display animism as often as Piaget believed. Three-year-old children do not tend to describe inanimate objects with lifelike qualities, even when the object is a robot that can move (Gelman & Gottfried, 1996; Jipson, Gülgöz, & Gelman, 2016). Three- and 4-year-old children recognize that living things are regulated by their own internal energy but inanimate objects are not (Gottfried & Gelman, 2005). Most 4-year-old children understand that animals grow, and even plants grow, but objects do not (Backschneider, Shatz, & Gelman, 1993). Sometimes, however, young children provide animistic responses. For example, Dolgin and Behrend (1984) found that animistic statements are not due to a belief that all objects are alive but rather that novel objects that seem to move independently are alive. Three-year-old children may display animism when considering trains and airplanes, believing that they are alive because these objects appear to move on their own, like other living things (Gjersoe, Hall, & Hood, 2015; Massey & Gelman, 1988; Poulin-Dublins & Héroux, 1994). Gjersoe et al. (2015) suggest an emotional component to animistic beliefs. They found that 3-year-olds attribute mental stages to toys to which they are emotionally attached, but not to other favorite toys, even those with which they frequently engage in imaginary play. Finally, children show individual differences in their expressions of animism and reasoning about living things and these differences are linked with aspects of cognitive development such as memory, working memory, and inhibition (Zaitchik, Iqbal, & Carey, 2014).

Research Findings on Reversibility and the Appearance–Reality Distinction. Piaget (1970) posited that young children cannot solve or be taught to solve conservation problems because they lack the cognitive operations needed to understand reversibility and that transformations in appearance do not change a given substance. However, research has shown that 4-year-old children can be taught to conserve (Gelman, 1969; Hendler & Weisberg, 1992), suggesting that children's difficulties with reversibility and conservation tasks can be overcome (Gallagher, 2008). In addition, when a conservation of numbers task is scaled down to include only three objects instead of six, even 3-year-olds perform well without training (R. Gelman, 1972).

In the classic appearance–reality task, when 3-year-old children are shown a sponge that looks like a rock, they tend to say that it “really and truly is” a rock (Flavell, Flavell, & Green, 1987; Flavell, Green, & Flavell, 1989). They focus on the most salient feature, its rock-like appearance, displaying centration. However, if the children are told to play a trick on someone (i.e., “let’s pretend that this sponge is a rock and tell Anne that it is a rock when it really is a sponge”) or are asked to choose an object that can be used to clean spilled water, many choose the sponge, illustrating that they can form a dual representation of the sponge as an object that looks like a rock (Rice, Koinis, Sullivan, Tager-Flusberg, & Winner, 1997; Sapp et al., 2000). Research suggests that 3-year-old
children can shift between describing the real and fake or imagined aspects of an object or situation, and can flexibly describe misleading appearances and functions of objects in response to natural conversational prompts, as compared with the more formal language in the typical prompts used in traditional appearance–reality tasks (e.g., “What is it really and truly?”; Deák, 2006; Hansen & Markman, 2005).

Some responses to appearance–reality tasks may reflect how children respond to sequences of questions rather than confusing appearance and reality (Deák, 2006). Some preschoolers will repeat their first answer to every successive question about a topic, making it hard to determine what they understand. These types of errors are related to age: 3-year-old children are especially likely to make such errors, 5-year-olds make few repetitive errors, and 4-year-old children tend to make intermediate errors. This suggests a clear developmental trend in language ability that appears on appearance–reality tests as well as other tests of cognitive ability (Deák, 2006). In sum, preschoolers show an understanding of the appearance–reality distinction and it develops throughout childhood (Woolley & Ghossainy, 2013).

Researchers generally conclude that typical Piagetian tasks emphasize what young children cannot understand more than what they can understand (Beilin, 1992). Traditional appearance–reality tasks require that young children articulate their understanding rather than demonstrate it nonverbally. Often asking different, simplified, questions enables children to demonstrate their understanding (Bullock, 1985; Deák, 2006; Hansen & Markman, 2005; Waxman & Hatch, 1992). Certainly young children are more egocentric and illogical than older, school-aged children, but they are able to demonstrate logical reasoning about simple problems in familiar contexts. Young children can adapt their speech to their listeners: For example, they use simpler language when talking to younger siblings (Gelman & Shatz, 1978), suggesting understanding that their sibling has a different perspective and capacity for language than they do. Young children also quickly develop increasingly sophisticated representational abilities through their symbolic play activities. Pretending that objects and people are something other than what they really are helps young children to develop capacities for dual representation, and they slowly begin to differentiate misleading appearances from reality (Golomb & Galasso, 1995).

Children can also imagine what something looks like and draw a picture to represent that vision. Drawing requires dual representation: the ability for the child to understand that her scratches and squiggles on the page are a picture as well as represent something else—an object, person, or scene. Drawing may seem simple, but it illustrates complex thinking skills.

**Thinking in Context 6.1**

1. Toys offer infants important opportunities to practice and hone their development. Infants play with toys in different ways at different ages. Identify a toy appropriate for an infant in the secondary circular reactions substage (e.g., a loud rattle or jingling set of toy keys). Compare and contrast how infants in the secondary circular reactions substage and infants in the coordination of secondary circular reactions substage might play with the toy. How might infants in the tertiary reactions substage play with it? How might infants’ play align with their developing schemes?

2. Infants around the world delight in playing peekaboo. Compare and contrast how Piaget and core knowledge theorists might account for infants’ attention and interest in the caregiver’s disappearing and reappearing face.

3. Might parent–infant interactions, the home environment, and sociocultural context influence cognitive development? For example, does such influence occur when infants develop object permanence or young children overcome egocentrism? Why or why not?

4. Do you think that young children can be taught to respond correctly to conservation problems? Why or why not? If so, what sort of training might children need?
Infants and young children experience cognitive transformations that change their understanding of the world. Their earliest thinking, limited to the here and now, is transformed by the emergence of mental representation and the corresponding ability to learn language. Similarly, older children and adolescents undergo radical changes in their ability to think and solve problems. These changes are marked by the emergence of logical thinking in middle childhood and abstract reasoning in adolescence.

**Middle Childhood: Concrete Operational Reasoning**

When children enter the **concrete operational stage of reasoning**, at about age 6 or 7, they gain the capacity to use logic to solve problems. School-age children demonstrate a more sophisticated understanding of the physical world around them.

**Characteristics of Concrete Operational Reasoning**

Older children’s newly developed ability for logical thinking enables them to reason about physical quantities and is evident in their skills for conservation and classification. These cognitive capacities, in turn, influence their interests, interactions with others, and how they spend their time.

**Conservation.** As we saw earlier in this chapter, young children typically lack understanding of conservation, as demonstrated in the classic experiment with liquid and two containers of different shapes (see Figure 6.6). In another classic conservation problem, a child is shown two identical balls of clay and watches while the experimenter rolls one ball into a long hotdog shape. When asked which piece contains more clay, a child who reasons at the preoperational stage will say that the hotdog shape contains more clay because it is longer. Eight-year-old Julio, on the other hand, knows that the two shapes contain the same amount of clay. At the concrete operational stage of reasoning, Julio grasps the principle of **object identity**: the understanding that certain characteristics of an object do not change despite superficial changes to the object’s appearance. Julio notices that the ball shape is shorter than the hotdog shape, but it is also thicker. An understanding of **reversibility**—that an object can be returned to its original state, undoing the superficial physical alterations by which it was changed—means Julio realizes that the hotdog-shaped clay can be reformed into its original ball shape.

Most children solve this conservation problem of substance by age 7 or 8. At about age 9 or 10, children also correctly solve conservation of weight tasks (“Which is heavier, the hotdog or the ball?”). Conservation of volume tasks (after placing the hotdog and ball-shaped clay in glasses of liquid: “Which displaces more liquid?”) are solved last, at about age 12. The ability to conserve develops slowly, and children show inconsistencies in their ability to solve different types of conservation problems.

Piaget posited that young school-age children’s thinking is so concrete that principles often seem to be tied to particular situations. In his view, they cannot yet apply their understanding of one type of conservation to another problem, even though the principles underlying all conservation problems are the same. Alternatively, some theorists argue that children’s capacities to solve conservation problems correspond to brain development and advances in information processing abilities (Morra, Gobbo, Marini, & Sheese, 2008).
Children play an active role in their own cognitive development, by interacting with the world. Some educators advocate for brain-based education that capitalizes on children’s natural inclinations towards active learning. Brain-based education views learning as multidimensional, including more than academics. In its simplest sense, brain-based education encourages children to develop all aspects of their brains, tapping physical, musical, creative, cognitive, and other abilities. Given that the brain changes with experience, enriched everyday experiences such as learning a musical instrument, role playing, and expanding vocabulary may alter children’s brains.

Neurological researchers, however, are critical of some popular brain-based educational approaches, such as those that emphasize teaching different parts of the brain separately (Howard-Jones, 2014). For example, a common brain-based education instructional strategy is to teach for the left or right lateralized brain. The “left brain” is said to be the “logical” hemisphere, concerned with language and analysis, while the “right brain” is said to be the “intuitive” hemisphere concerned with spatial patterns and creativity (Sousa, 2001). Brain-based learning theorists may then encourage teachers to teach specific hemispheres during adapted lessons. To teach to the left hemisphere, teachers have students create visual representations of concepts (Sousa, 2001). Brain researchers, however, are sharply critical of left/right brain teaching because, although the brain is lateralized, it functions as a whole (Howard-Jones, 2014). Language and spatial information—and, for that matter, most other abilities—are processed differently but simultaneously by the two hemispheres (Corballis, Lalueza-Fox, Orlando, Enard, & Green, 2014). It is highly improbable, then, that any given lesson, regardless of analytic or spatial type, can stimulate activation of only one hemisphere.

For this reason some experts argue that the leap from neurological research to the classroom is large and not supported. For many researchers, the problem of brain-based education is its reliance on the brain itself and in its oversimplification of complex theories and research. Although we have learned much, brain research is in its infancy. Researchers do not know enough about how the brain functions and learns to draw direct inferences about teaching. For example, MRI research illuminates patterns of brain activity, but researchers do not yet conclusively know what those patterns mean or if those patterns of brain activity have implications for behavior. Applying these findings to inform education is premature. Many researchers, therefore, find it problematic to state that teaching strategies should be derived from brain research—at least not yet.

On the positive side, however, brain-based education emphasizes active learning. Teachers who foster active learning encourage students to become engaged and participate in their own learning, such as being creative in artwork, physical activity, and story making (Bruer, 2008). Active learning is an important educational strategy. Although many developmental researchers argue that the neurological science behind brain-based education is questionable, the active learning practices that comprise many brain-based learning activities advance children’s learning.

**What Do You Think?**

1. Identify an advantage and a disadvantage to brain-based education. In your view, should preschools emphasize teaching specifically to a specific part of the brain, such as the left or right hemisphere?

The earliest type of conservation, numerical conservation, is associated with development of information processing capacities, such as working memory and the ability to control impulses, which permit children to manipulate numerical information to solve problems (Borst, Poirel, Pineau, Cassotti, & Houdé, 2013). As compared with 5-year-olds, 9-year-olds show more activity in parts of the temporal and prefrontal cortex as well as other parts of the brain associated with working memory, inhibitory control, and executive control (Houdé et al., 2011; Poirel et al., 2012). With practice, the cognitive abilities tested in Piagetian tasks become automatic and require less attention and fewer processing resources, enabling children to think in more complex ways (Case, 1998, 1999; Pascual-Leone, 2000).
For example, once a child realizes that the hotdog-shaped clay was once in the shape of a ball, and thereby demonstrates an understanding of conservation of substance, the scheme becomes routine and requires less attention and mental resources than before (Siegler & Richards, 1982). Now the child can consider more challenging conservation problems. Children must practice one form of conservation in order for it to become automatic and free cognitive resources to apply that scheme to other conservation problems.

Classification. What hobbies did you enjoy as a child? Did you build model cars or airplanes? Collect and trade coins, stamps, rocks, or baseball cards? School-age children develop interests and hobbies that require advanced thinking skills, such as the ability to compare multiple items across several dimensions. Classification is the ability to understand hierarchies and to simultaneously consider relations between a general category and more specific subcategories. The classification skills that accompany concrete operational reasoning permit school-age children to categorize or organize objects based on physical dimensions. Several types of classification skills emerge during the concrete operational stage: seriation, transitive influence, and class inclusion. For example, in one classification experiment, a child is shown a bunch of flowers (seven daisies and two roses) and is told that there are nine flowers: seven are called daisies and two are called roses. The child is then asked, “Are there more daisies or flowers?” Preoperational children will answer that there are more daisies, as they do not understand that daisies are a subclass of flowers (Inhelder & Piaget, 1964). By age 5, children have some knowledge of classification hierarchies and may grasp that daisies are flowers, but they still may not fully understand and apply classification hierarchies (Deneault & Ricard, 2006). By about age 8, children can not only classify objects, in this case flowers, but make quantitative judgments and respond that there are more flowers than daisies (Borst et al., 2013).

Children’s ability to perform and interest in hierarchical classification becomes apparent in middle childhood when they begin to collect items and spend hours sorting their collections along various dimensions. For example, one day Susan sorts her rock collection by geographic location (e.g., part of the world in which it is most commonly found), with subcategories based on hardness and color. At other times, Susan organizes her rocks based on other characteristics, such as age, composition, and more.

Seriation is the ability to order objects in a series according to a physical dimension, such as height, weight, or color. For example, ask a child to arrange a handful of sticks in order by length, from shortest to longest. Four- to 5-year-old children can pick out the smallest and largest stick, but they will arrange the others haphazardly. Six- to 7-year-old children, on the other hand, arrange the sticks by picking out the smallest, and next smallest, and so on (Inhelder & Piaget, 1964).

The ability to infer the relationship between two objects by understanding each object’s relationship to a third is called transitive inference. For example, present a child with three sticks: A, B, and C. She is shown that stick A is longer than stick B and stick B is longer than stick C. The concrete operational child does not need to physically compare
sticks A and C to know that stick A is longer than the stick C. She uses the information given about the two sticks to infer their relative lengths (Ameel, Verschueren, & Schaeken, 2007; Wright & Smailes, 2015). Transitive inference emerges earlier than other concrete operational skills. By about 5 years of age, children are able to infer that A is longer than C (Goodwin & Johnson-Laird, 2008).

**Evaluating Concrete Operational Reasoning**

According to Piaget, the cognitive stages of development are universal: All children around the world progress through stages that determine their reasoning and their perspective on the world. Piaget emphasized the universal nature of development and placed less attention on culture and context as influences on development. Today’s researchers, however, find that the cultural context in which children are immersed plays a critical role in development (Goodnow & Lawrence, 2015). Although it is generally accepted that the features and correlates of Piaget’s conception of concrete operational reasoning are universal, cultural factors play a role in the rate of cognitive development (Siegler, 1998). Studies of children in non-Western cultures suggest that they achieve conservation and other concrete operational tasks later than children from Western cultures. When 10- and 11-year-old Canadian Micmac Indian children were tested in English on conservation problems (substance, weight, and volume), they performed worse than 10- to 11-year-old white English-speaking children. But when tested in their native language, by researchers from their own culture, the children performed as well as the English-speaking children (Collette & Van der Linden, 2002). Cultural differences in children’s performance on tasks that measure concrete operational reasoning may be more a result of methodology and how questions are asked rather than children’s abilities (D’Esposito et al., 1995).

Children around the world demonstrate concrete operational reasoning, but experience, specific cultural practices, and education play a role in how it is displayed (Manoach et al., 1997). Children are more likely to display logical reasoning when considering substances with which they are familiar. Mexican children who make pottery understand at an early age that clay remains the same when its shape is changed. They demonstrate conservation of substance earlier than other forms of conservation (Fry & Hale, 1996) and earlier than children who do not make pottery (Hitch, Touse, & Hutton, 2001; Leather & Henry, 1994).

Despite having never attended school and scoring low on measures of mathematics achievement, many 6- to 15-year-old children living in the streets of Brazil demonstrate sophisticated logical and computational reasoning. Why? These children sell items such as fruit and candy to earn their living. In addition to pricing their products competitively, collecting money, making change, and giving discounts, the children must adjust prices daily to account for changes in demand, overhead, and the rate of inflation (Gathercole, Pickering, Ambridge, & Wearing, 2004). Researchers found that the children’s competence in mathematics was influenced by experience, situational demands, and learning from others. Despite this, schooling also matters in promoting cognitive development because children with some schooling were more adept at these tasks than were unschooled children (Siegel, 1994).

Schooling influences the rate at which principles are understood. For example, children who have been in school longer tend to do better on transitive inference tasks than same-age children with less schooling (Artman & Cahan, 1993). Likewise, Zimbabwean...
Children’s Understanding of Illness

School-age children’s emerging capacities for reasoning influence their understanding of a variety of phenomena, including their conceptions of illness (Brodie, 1974). Experts formerly thought that children’s understanding of illness was unsophisticated; for example, they were thought to view illness as being caused by misdeeds, a view referred to as immanent justice (Kister & Patterson, 1980; Myant & Williams, 2005).

As children advance in cognitive maturity from older childhood into adolescence, they develop more advanced conceptions of illness and distinguish specific symptoms and diseases, appreciate psychological, emotional, and social aspects of physical illness, associate illness with germs and infection, and demonstrate an understanding of contagiousness (Brewster, 1982; Kister & Patterson, 1980; Mouratidi, Bonoti, & Leondari, 2016). Older children tend to refer to germs in their explanations of illness, but they tend to view germs as operating in an all-or-nothing fashion such that the presence of germs alone is seen as enough to make a child sick (Raman & Gelman, 2005). It is not until early adolescence or later that they understand the complexity of causal influences and interactions.

Children in Western cultures and adults in non-Western cultures tend to rely on immanent justice and other nonbiological explanations (e.g., magic or fate) for contagious illnesses such as colds, coughs, and stomachaches (Raman & Winer, 2002). However, open-ended interviews require that the child not only understand the phenomenon, but be able to explain it. When researchers use less demanding tasks, such as forced choice (multiple choice) tasks, they find that Chinese and U.S. children as young as 3 years of age have an understanding that illness is not intentional, that some behaviors can prevent illness and others can make it more likely, and that germs or contamination are responsible for the transmission of contagious illnesses (Legare, Wellman, & Gelman, 2009; Raman & Gelman, 2008; Zhu & Liu, 2007).

Overall, school-aged children tend to prefer biological explanations of illness and use immanent justice reasoning only as a fallback position to explain an illness that is not within the range of their personal experience. Cultural influences also shape children’s understanding of illness. For example, one study of 5- to 15-year-old children and adults from Sesotho-speaking South African communities showed that the participants, who were exposed to Western medicine, endorsed biological explanations for illness at high levels, but also often endorsed witchcraft (Legare & Gelman, 2008). Bewitchment explanations were neither the result of ignorance nor replaced by biological explanations. Instead, both natural and supernatural explanations were used to explain the same phenomena and were viewed as complementary. Although specific explanations may vary by culture, the coexistence of biological and supernatural reasoning about causes of illness is not confined to specific cultures. U.S. children and adults retain some supernatural explanations in addition to developing biological explanations (Legare, Evans, Rosengren, & Harris, 2012). Diverse, culturally constructed belief systems about illness co-exist with factual understanding and explanations of illness change with development.

What Do You Think?

1. Does Piaget’s theory adequately explain the changes that occur in children’s understanding of illness? Why or why not?
2. Consider your own views and experience. Do you remember “catching a cold” when you were a child? What did that mean to you?
Fourteen-year-old Eric spends much of his time learning about astronomy. He wonders about the existence of dark matter—cosmological matter that cannot be observed but is inferred by its gravitational pull on objects like planets and even galaxies. Eric reads blogs written by astronomers and has started his own blog where he comments on the best websites for teenagers who are interested in learning about the galaxy. Eric’s newfound ability and interest in considering complex, abstract phenomena illustrates the ways in which adolescents’ thinking departs from children’s.

As compared with childhood, cognitive development during the adolescent period receives much less attention from theorists and researchers, but adolescents show significant advances in their reasoning capacities (Kuhn, 2008). Similar to earlier periods in life, the cognitive–developmental perspective on cognition describes adolescence as a time of transformation in thought.

**Characteristics of Formal Operational Reasoning**

In early adolescence, at about 11 years of age, individuals enter the final stage of Piaget’s scheme of cognitive development: formal operations. **Formal operational reasoning** entails the ability to think abstractly, logically, and systematically (Inhelder & Piaget, 1958; Piaget, 1972). Children in the concrete operational stage reason about things—concepts that exist in reality, such as the problem of how to divide a bowl of pudding into five equal servings. Adolescents in the formal operational stage, however, reason about ideas—possibilities that do not exist in reality and that may have no tangible substance, such as whether it is possible to distribute love equally among several targets (Inhelder & Piaget, 1958; Piaget, 1972). The ability to think about possibilities beyond the here and now permits adolescents to plan for the future, make inferences from available information, and consider ways of solving potential, but not yet real, problems.

Formal operational thought enables adolescents to engage in **hypothetical–deductive reasoning**, or the ability to consider problems, generate and systematically test hypotheses, and draw conclusions. Piaget’s pendulum task (Figure 6.7) tests children’s and adolescents’ abilities to use scientific reasoning to solve a problem with multiple possible solutions (Inhelder & Piaget, 1958). Adolescents display formal operational reasoning when they develop hypotheses and systematically test them. For example, in the pendulum task they change one variable while holding the others constant (e.g., trying each of the lengths of string while keeping the weight, height, and force the same). Concrete operational children, on the other hand, fail to disentangle the variables and do not take into account nontangible variables such as height and force. They do not proceed systematically in a way that permits them to solve the pendulum problem; for example, they might test a short string with a heavy weight, then try a long string with a short weight. Solving the pendulum problem requires the scientific reasoning capacities that come with formal operational reasoning.

Adolescents soon learn that hypothetical thought makes for a much more interesting, but complicated, world. Now they are primed to think about possibility and the possible becomes a reality of its own (Inhelder & Piaget, 1958). However, adolescents can get carried away with their consideration of the possible. When Nadia tries to solve the problem of how to organize her room, she might become paralyzed by all the possibilities—myriad ways of arranging furniture, organizing books, and classifying all the things she owns—rather than simply beginning the task.
Adolescents’ emerging abilities to reason influence how they view the world and themselves. However, abstract thought develops gradually. Teenagers are prone to errors in reasoning and lapses in judgment, as evidenced by the emergence of adolescent egocentrism. Adolescents’ new cognitive abilities draw them to consider the intangible, such as ideas and possibilities. At the same time, they undergo physical changes and psychological changes that lead them to direct their new abstract abilities toward themselves. Adolescents are naturally self-conscious. As 14-year-old Mayla’s mother explains, “She’s always in her head but also outside, paying attention to her clothes and the smallest details of her appearance, as if anyone would notice anyway.” Adolescents are egocentric. They have difficulty with perspective-taking, specifically with separating their own and others’ perspectives (Inhelder & Piaget, 1958). Researcher David Elkind proposed that adolescent egocentrism is manifested in two phenomena: the imaginary audience and the personal fable (Elkind & Bowen, 1979).

Adolescents’ preoccupation with themselves also leads them to believe that they are special, unique, and invulnerable—a perspective known as the personal fable (Elkind & Bowen, 1979). A sense of self-importance underlies the personal fable belief that they will be admired, achieve fame, and be remembered. Many adolescents perceive their own experiences as unique. They believe that their emotions, the highs of happiness and depths of despair that they feel, are different and more intense than other people’s emotions and that others simply do not understand. The invulnerability aspect of the personal fable, coupled with brain development that predisposes adolescents to seek risks, makes adolescents more likely to engage in risky activities, such as drug use, delinquency, and unsafe sex; they believe that they, unlike other teens, are invulnerable to the negative consequences of such behaviors (Alberts et al., 2007; Greene & Krcmar, 2000). Specifically, research with 6th- through 12th-graders suggests that the invulnerability aspect of the personal fable is associated with engaging in risky activities while the sense of personal uniqueness is associated with depression and suicidal ideation (Aalsma, Lapsley, & Flannery, 2006).

Both the imaginary audience and personal fable are thought to increase in early adolescence, peak in middle adolescence, and decline in late adolescence (Alberts et al., 2007; Elkind & Bowen, 1979; Lapsley, Jackson, Rice, & Shadid, 1988), but some research suggests that adolescent egocentrism may persist into late adolescence and beyond (Schwartz, Maynard, & Uzelac, 2008). Even adults are susceptible to these lapses in perspective. In studies many instances adolescents may be less likely to see themselves as invincible than are adults. Studies in which adolescents and adults evaluate the possible consequences of various behaviors, adolescents perceive more risks inherent to health behaviors and activities, such as substance use and risky driving, for example, than do adults (Fischhoff, 2008; Millstein & Halpern-Felsher, 2002). Perhaps adolescent egocentrism, specifically the personal fable, may not be a feature unique to adolescence.

What Do You Think?

1. Do you remember experiencing the imaginary audience or personal fable? Provide an example of the imaginary audience and personal fable from your own experience or create hypothetical examples.

2. Do you think adolescent egocentrism disappears? If so, what factors might contribute to the fall of adolescent egocentrism? If not, why?
Evaluating Formal Operational Reasoning

An assumption of Piaget’s cognitive–developmental theory is that development is a universal process, yet the reality is that people vary in their cognitive development. Although adults are presumably capable of abstract reasoning, many of them fail hypothetical-deductive tasks (Kuhn, Langer, Kohlberg, & Haan, 1977). Does this mean they cannot think abstractly? In response to research findings suggesting variability in formal operational reasoning, Piaget (1972) explained that opportunities to use formal operational reasoning influence its development. In contrast to his position on earlier stage structures, Piaget argued that formal operations structures may vary by content area. Individuals reason at the most advanced levels when considering material with which they have the greatest experience. For example, completing college courses in math and science is associated with gains in propositional thought, while courses in social science are associated with advances in statistical reasoning skills (Lehman & Nisbett, 1990; Lehman, Lempert, & Nisbett, 1988). In one study in the early 1990s, adolescents from 10 to 15 years of age performed better on Piagetian tasks, such as the pendulum task, than adolescents had done more than two decades before. The researchers attributed the difference to the fact that (in France, where the studies were done) secondary education was less common in the earlier decades, therefore adolescents had fewer opportunities to practice the reasoning measured by Piagetian tasks (Flieller, 1999).

The appearance of formal operational reasoning is not consistent across people or across intellectual domains, but instead varies with situation, task, experience, context, and motivation (Kuhn, 2008; Labouvie-Vief, 2015a; Piaget, 1972). Moreover, many theorists explain that formal operational reasoning does not suddenly appear in early adolescence. Instead, cognitive change occurs gradually from childhood on, with gains in knowledge, experience, and information processing capacity (Keating, 2004; Kuhn & Franklin, 2006; Moshman, 2005). Finally, many developmental scientists believe that cognitive development continues throughout adulthood, as we discuss later in this chapter.

Thinking in Context 6.2

1. Cognitive changes influence children’s interests and how they spend their time. Consider your own childhood interests. How did they change in late childhood and into adolescence? How might your shifting and intensifying interests reflect cognitive development?

2. Do you think that most young adolescents show formal operational reasoning? Give examples to support your answer.

3. The cognitive development perspective has been criticized for downplaying the role of context in cognitive development. Identify contextual factors that might influence the path of cognitive development. Consider it from a bioecological perspective. What factors at the micro, meso, exo, and macrosystem levels might influence cognitive change in childhood and adolescence?

VYGOTSKY’S SOCIOCULTURAL PERSPECTIVE

LO: 6.3 Summarize Vygotsky’s sociocultural perspective and how it is manifested in scaffolding, the zone of proximal development, and cultural tools.

While Piaget searched for universal patterns, Russian psychologist Lev Vygotsky emphasized the influence of culture on children’s thinking. Specifically, he proposed that cognitive development is influenced by differences in the ways particular cultures and societies approach problems. Although Vygotsky wrote at the same time as Piaget, his writings remained relatively unknown for decades. For political reasons his work was banned in his
country, the Soviet Union, and English translations of his writing did not become available until the 1980s. Vygotsky’s sociocultural perspective asserts that we are embedded in a context that shapes how we think and who we become. Much of children’s learning comes not from working alone, but from collaborating with others.

**SCAFFOLDING AND GUIDED PARTICIPATION**

According to the sociocultural perspective, children’s social experiences teach them how to think. Children interact with more skilled partners who serve as models and provide instruction. Over time, children internalize the instruction, making it part of their skill set, and they thereby master tasks. For example, children of the Zinacantec Maya of Chiapas, Mexico, learn by actively participating in informal tasks such as making tortillas and weaving (Maynard, 2002, 2004). Children learn by working alongside more experienced partners who provide assistance when needed (Rogoff, 1998; Rogoff, Mosier, Mistry, & Göncü, 1993). Older and more skilled members of society stimulate children’s cognitive development by presenting new challenges and guiding or assisting them with particularly difficult tasks. Parents and child care providers often provide this informal instruction, but anyone who is more skilled at a given task, including older siblings and peers, can promote children’s cognitive development (Maynard, 2002; Rogoff, 1990).

In this way, children learn through guided participation (also known as an apprenticeship in thinking), a form of sensitive teaching in which the partner is attuned to the needs of the child and helps him or her to accomplish more than the child could do alone (Rogoff, 1990). As novices, children learn from more skilled, or expert, partners by observing them and asking questions. In this way children are apprentices, learning how others approach problems. The expert partner provides scaffolding that permits the child to bridge the gap between his or her current competence level and the task at hand. For example, consider a child working on a jigsaw puzzle. She is stumped, unable to complete it on her own. Suppose a more skilled partner, such as an adult, sibling, or another child who has more experience with puzzles, provides a little bit of assistance, a scaffold. The expert partner might point to an empty space on the puzzle and encourage the child to find a piece that fits that spot. If the child remains stumped, the partner might point out a piece or rotate it to help the child see the relationship. The expert partner acts to motivate the child and provide support to help the child finish the puzzle, emphasizing that they are working together. The child novice and expert partner interact to accomplish the goal and the expert adjusts his or her responses to meet the needs of the child.

With time, the child internalizes the scaffolding lesson and learns to accomplish the task on her own. In this way cognitive development and learning occurs as the child actively internalizes elements of context, such as interactions with more skilled people (Fernyhough, 2008). Scaffolding occurs in formal educational settings, but also informally, any time a partner adjusts his or her interactional style to fit the needs of a child and help the child to complete a task that he or she could not complete alone.

The quality of scaffolding influences children’s development. In one study of preschool teachers and children, the degree to which the adult matched the child’s needs for help in playing predicted more autonomous play on the part of children over a 6-month period (Trawick-Smith & Dziurgot, 2011). Adults may intentionally encourage and support children’s

**PHOTO 6.8**: Scaffolding and Guided Participation
Pura helps her grandmother grind corn for tortillas.
learning (Zuckerman, 2007). For example, one study of parents and young children visiting a science museum found that when parents provided specific guidance in considering a conservation of volume problem, such as discussing the size of the containers, asking “how” and “why” questions, and talking about simple math, children were more likely to give correct responses to scientific reasoning problems, including those involving conservation (Vandermaas-Peeler, Massey, & Kendall, 2016).

Scaffolding also occurs informally. Mothers vary their scaffolding behaviors in response to children’s attempts at tasks. For example, they spontaneously use different behaviors depending on the child’s attention skills, using more verbal engagement, strategic questions, verbal hints, and verbal prompts when children show difficulty paying attention during a task (Robinson, Burns, & Davis, 2009). Moreover, maternal reading, scaffolding, and verbal guidance are associated with 2- to 4-year-olds’ capacities for cognitive control and planning (Bibok, Carpendale, & Müller, 2009; Hughes & Ensor, 2009; Moriguchi, 2014). In this way, learning is a social activity, and children can learn from many social partners, including peers. Collaboration with more skilled peers improves performance on cognitive tasks such as card sorting tasks, Piagetian tasks, planning, and academic tasks (Ellis & Gauvain, 1992; Sills, Rowse, & Emerson, 2016). Social interaction may have varying effects on learning depending on social factors. For example, in a problem-solving task, child dyads who were not friends spent more time determining the division of labor and angling for control than completing the task (Azmitia & Perlmutter, 1989). Children’s ability to learn from peer interactions may, therefore, depend on their peer relationships.

**ZONE OF PROXIMAL DEVELOPMENT**

As Vygotsky explained, “What the child can do in cooperation today, he can do alone tomorrow” (1962, p. 104). Effective scaffolding works within the zone of proximal development, the gap between the child’s competence level—what he can do alone—and what he can do with assistance. The upper limit of this zone is what the child can accomplish with a skilled partner. Over time, the child internalizes the scaffolding, the skill becomes within his range of competence, and his zone of proximal development shifts. Adults tend to naturally provide children with instruction within the zone of proximal development (Conner, Knight, & Cross, 1997; Rogoff, 1998). For example, adults reading a book to a child tend to point to items, label and describe characters’ emotional states, explain, ask questions, listen, and respond sensitively, helping the child understand challenging material that is just beyond what the child can understand on his or her own (Adrián, Clemente, & Villanueva, 2007; Danis, Bernard, & Leproux, 2000; Silva, Strasser, & Cain, 2014). Adults learn as they participate in the child’s zone of proximal development and they modify their behaviors (Ferholt & Lecusay, 2010). For example, mothers may observe that the timing of their suggestions and feedback helps children attend and switch tasks appropriately (Bibok et al., 2009).

Effective teachers take advantage of the social nature of learning by assigning children tasks that they can accomplish with some assistance, providing just enough help so that students learn to complete the tasks independently, and creating learning environments that stimulate children to complete more challenging tasks on their own (Wass & Golding, 2014).

**CULTURAL TOOLS**

Mental activity is influenced by cultural tools that are passed on to members of the culture (Robbins, 2005; Vygotsky, 1978). Cultural tools include physical items such as computers, pencils, and paper, but also ways of thinking about phenomena, including how to approach math and scientific problems. Children learn how to use the tools of their culture by interacting with skilled partners who provide scaffolding within the zone of
proximal development. For example, suppose a child wanted to bake cookies for the first time. Rather than send the child into the kitchen alone, we would probably accompany the child and provide the tools needed to accomplish the task, such as the ingredients, a rolling pin to roll the dough, cookie cutters, and a baking sheet. We would probably show the child how to use each tool, such as how to roll out the dough, and watch as he or she does it, scaffolding his or her learning. With interaction and experience, the child adopts and internalizes the tools and knowledge, becoming able to use them independently.

Vygotsky argued that in this way, culturally valued ways of thinking and problem solving get passed on to children. Spoken language is an important tool of thought, as we will discuss in Chapter 7, as are writing, numeracy, and problem-solving techniques.

The contextual nature of learning is illustrated by a study of two generations of Zinacantec Mayan children, one generation studied in 1969 and 1970, and a second generation in 1991 and 1993 (Greenfield, Maynard, & Childs, 2003). In the intervening two decades, the community, located in Chiapas, Mexico, was involved in a transition from an economy based primarily on subsistence and agriculture to an economy based primarily on money and commerce. Researchers examined the number and quality of weaving apprenticeships as well as visual representation ability. They concluded that the processes of learning and cognition changed over this period, trending toward greater emphasis on independent cultural learning, abstract thinking, and creativity, and away from scaffolding, simple representation of tasks, and imitation strategies (Greenfield et al., 2003). Changes in cultural apprenticeships were associated with shifts in the process of child cognition. The contexts in which we are embedded are always changing and evolving, as are our ways of thinking.

**EVALUATING VYGOTSKY’S SOCIOCULTURAL PERSPECTIVE**

Although relatively unknown until recent decades, Vygotsky’s ideas about the sociocultural nature of cognitive development have influenced prominent theories of development, such as Bronfenbrenner’s (1979) bioecological theory. They have been applied in educational settings, supporting the use of assisted discovery, guiding children’s learning, and cooperative learning with peers.

Similar to Piaget’s theory, Vygotsky’s theory has been criticized for a lack of precision. The mechanisms or processes underlying the social transmission of thought are not described (Ellis & Gauvain, 1992; Gönçü & Gauvain, 2012). Moreover, constructs such as the zone of proximal development are not easily testable (Wertsch, 1998). In addition, underlying cognitive capacities, such as attention and memory, are not addressed. It is understandable, however, that Vygotsky’s theory is incomplete, as he died of tuberculosis at the age of 37. We can only speculate about how his ideas might have evolved over a longer lifetime. Nevertheless, Vygotsky provided a new framework for understanding development as a process of transmitting culturally valued tools that influence how we look at the world, think, and approach problems.
Thinking in Context 6.3

1. Contrast Vygotsky and Piaget’s perspectives on cognitive development.

2. What cultural tools have you adopted? How have interactions with others influenced your cognitive development?

3. How might Vygotsky’s ideas be applied to children’s learning at home and in the classroom? Give some examples.

Cognitive Development in Adulthood

LO: 6.4 Explain postformal reasoning and how it compares with cognitive affective complexity.

For Alexander, a college junior majoring in biology, weighing hypotheses on evolutionary theory is easy. As he sees it, there is one account that is clearly more rational and supported by data than the others. However, like most young adults, Alexander finds personal decisions much more difficult because many are vague and have multiple options with both costs and benefits. As teenagers mature into adults, their thinking becomes increasingly flexible and practical. Adults come to expect uncertainty and ambiguity, and to recognize that everyday problems are influenced by emotion and experience rather than pure reasoning. Researchers who study adult cognition often focus on epistemic cognition—the ways in which individuals understand the nature of knowledge and how they arrive at ideas, beliefs, and conclusions.

Postformal Reasoning and Reflective Judgment

Many researchers who adopt Piaget’s perspective on cognitive development agree that formal operations, Piaget’s final stage of cognitive development, does not adequately describe adult cognition. Instead, adults develop a more advanced form of thinking known as postformal reasoning, which integrates abstract reasoning with practical considerations (Sinnott, 1998). Young adults who demonstrate postformal reasoning recognize that most problems have multiple causes and solutions, that some solutions are better choices than others, and that all problems involve uncertainty.

With maturation, young people become more likely to compare their reasoning process and justifications with others. When their justifications fall short, adults seek a more adequate explanation and adjust their thinking accordingly. People’s understanding of the nature of knowledge advances along a predictable path in young adulthood, especially among college students (King & Kitchener, 1994; Magolda, 2002; Perry, 1970).

When they enter college, young people tend to view knowledge as a set of facts that hold true across people and contexts (King & Kitchener, 2004; Perry, 1970). They view learning as a matter of acquiring and assessing facts. Beginning college students tend to display dualistic thinking: polar reasoning in which knowledge and accounts of phenomena are viewed as either right or wrong, with no in between. They tend to have difficulty grasping that several contradictory arguments can each have supporting evidence. The entering college student may sit through class lectures, wondering, “Which theory is right?” and become frustrated when the professor explains that multiple theories each have various strengths and weaknesses.

With experience in college, such as exposure to multiple viewpoints, multiple arguments, and their inherent contradictions, students become aware of the diversity of viewpoints that exist in every area study. Their thinking becomes more flexible and they relinquish the belief in absolute knowledge that characterizes dualistic thinking (Baxter Magolda, 2004). Instead they move toward relativistic thinking, in which...
most knowledge is viewed as relative, dependent on the situation and thinker (King & Kitchener, 2004; Perry, 1970). Relativistic thinkers recognize that beliefs are subjective, that there are multiple perspectives on a given issue, and that all perspectives are defensible (Magolda, 2002; Sinnott, 1998). Often students become overwhelmed by relativism and conclude that most topics are simply a matter of opinion and perspective and all views are valid. For example, they may conclude that all solutions to a problem are correct as it all depends on a person’s perspective. A more mature thinker, however, begins to acknowledge the multiple options yet carefully evaluate them to choose the most adequate solution.

As shown in Table 6.3, the most mature type of reasoning entails **reflective judgment**: reasoning that synthesizes contradictions among perspectives (King & Kitchener, 2004; Perry, 1970). While a relativistic thinker may approach a problem such as deciding which theory is most adequate or which short story is best by explaining that it is simply a matter of opinion and it “depends on the person,” the individual who displays reflective judgment recognizes that options and opinions can be evaluated—and generates criteria to do so (Sinnott, 2003). Although reasoning tends to advance throughout the college years, ultimately few adults demonstrate reflective judgment (Perry, 1970).

Development beyond formal operations is dependent on experience and the ability to reflect one’s thought process (known as metacognition, discussed in Chapter 7). Exposure to situations and reasoning that challenges students’ knowledge and belief systems, coupled with more explicit, powerful, and effective cognitive abilities, permits individuals to consider the adequacy of their own thought and reasoning processes and modify them as needed (Kuhn, 2000). Advancement to postformal reasoning is associated with contextual factors; specifically, it is associated with exposure to realistic but ambiguous problems and supportive guidance, such as that which is often a part of college education in Western cultures (King & Kitchener, 2002; Zeidler, Sadler, Applebaum, & Callahan, 2009).

### Table 6.3 • Postformal Reasoning

<table>
<thead>
<tr>
<th>UNDERSTANDING OF KNOWLEDGE</th>
<th>EXAMPLES FROM INTERVIEWS WITH YOUNG ADULTS</th>
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<tbody>
<tr>
<td><strong>Dualistic thinking</strong></td>
<td>Knowledge is a collection of facts, and a given idea is either right or wrong.</td>
</tr>
<tr>
<td><strong>Relativistic thinking</strong></td>
<td>Knowledge is relative, dependent on the situation and thinker, and a matter of opinion and perspective.</td>
</tr>
<tr>
<td><strong>Reflective judgment</strong></td>
<td>Knowledge is a synthesis of contradictory information and perspectives whose evidence can be evaluated according to certain criteria.</td>
</tr>
</tbody>
</table>
Yet postformal reasoning is not universal across cultures. For example, Chinese college students generally do not display the typical advancement from dualism to relativism to reflective judgment (Zhang, 2004; Zhang & Watkins, 2001). When compared with their U.S. counterparts, Chinese students tend to lack opportunities for making their own choices and decisions in many areas such as curricula, career choices, academic majors, and residential arrangements (Zhang, 1999). Experience in decision making matters. Some theorists argue that even in Western cultures, the most advanced level of postformal reasoning (commitment within relativism) may come only with graduate study and wrestling with challenging philosophical and practical problems (King & Kitchener, 2004).

Regardless of education, culture, or age, social interaction is a critical influence on the development of postformal cognition (Kuhn, 2008). Social interaction entails discussing multiple perspectives and solutions to a problem as well as encouraging individuals to consider others’ perspectives, evaluate their own reasoning, and perhaps advance to more sophisticated forms of reasoning. People’s reasoning advances throughout adulthood; however, reasoning and decision-making are not simply cognitive endeavors but are influenced by emotion.

### Pragmatic Thought and Cognitive-Emotional Complexity

Development in adulthood entails changes in abstract reasoning and also an extension of reflective judgment, which permits the acceptance of inconsistency and ambiguity, to pragmatic thought emphasizing the use of logic to address everyday problems (Labouvie-Vief, 1980, 2006, 2015b). Managing various roles and tackling the problems of everyday life requires thinking that is adaptive and accepting of contradiction. For example, adults must come to terms with their relative power across various contexts: At home they have autonomy and are able to carve out their own niche, whereas at work they must follow the directions of their employer. Coordinating dynamic roles as spouse, parent, friend, employee, and manager requires flexibility.

However, reasoning in everyday situations is not simply a matter of logic; it is fused with emotion. Over the course of adulthood, individuals become better at understanding and regulating their emotions, which influences their reasoning in everyday situations (Blanchard-Fields, 2007; Mather, 2012; Watson & Blanchard-Fields, 1998). In turn, advancing cognitive capacities transform how adults experience and understand emotion, so that it becomes integrated with cognition. For example, in dealing with complex hypothetical interpersonal problems, young and middle-aged adults prefer problem-focused strategies that directly address the problem, whereas older adults prefer to combine problem-focused with emotion-focused strategies that emphasize regulating their affective reactions (Watson & Blanchard-Fields 1998).

Successfully coordinating emotion and cognition improves people’s capacity to adapt to the complexities adult life and the inherent balancing of many roles and obligations (Labouvie-Vief, 2006). This capacity to be aware of emotions, integrate positive and negative feelings about an issue, and regulate intense emotions to make logical decisions about complicated issues is known as cognitive-affective complexity (Labouvie-Vief, 2003, 2015a; Mikels et al., 2010). Cognitive-affective complexity increases from early adulthood through late middle adulthood (Labouvie-Vief et al., 2010). With gains in cognitive-affective complexity, adults better understand others, including their perspectives, feelings, and motivations. This, in turn, helps them to participate in social interactions, become more tolerant of other viewpoints, and solve day-to-day problems. As adults progress through older adulthood, however, cognitive-affective complexity declines, and they tend to prefer solutions that emphasize emotional regulation over problem-focused solutions. Some researchers attribute this shift toward maintaining positive emotions over affective complexity to neurological and cognitive changes (Labouvie-Vief et al., 2010), yet others argue that it serves a coping function to
preserve a positive sense of self and relationships (Carstensen & Mikels, 2005; Reed & Carstensen, 2012; see Chapter 10).

**EVALUATING COGNITIVE–DEVELOPMENTAL APPROACHES TO ADULT DEVELOPMENT**

Similar to research on the development of formal operations, advances in postformal reasoning and cognitive–affective complexity vary among individuals. Adults are more likely than adolescents to demonstrate postformal reasoning, but not all adults reach the most advanced levels of reasoning (Commons & Richards, 2002; Sinnott, 2003). In fact, most do not. People seem to show more mature reasoning when considering material and problems with which they have the greatest experience.

As with findings with younger ages, the ways in which researchers ask questions influences individuals’ responses and, ultimately, what is concluded about cognition (Ojalehto & Medin, 2015). For example, researchers have learned that more complex responses are yielded when they ask participants to consider systems of causation using prompts such as “how are x and y related to each other and to the larger system?” as compared with prompts that encourage reasoning about individual causal links (“does x cause y?”). This work has shown that there is cultural variation in reasoning about causal events (Ojalehto & Medin, 2015). Westerners tend to explain events using a single or a few direct causes. In contrast, people from East Asian cultures tend to explain events as caused by multiple factors that interact, creating a ripple effect whereby one event holds many complex consequences that may not be easily anticipated (Maddux & Yuki, 2006). This reasoning is conceptually similar to the interacting systems posited by Bronfenbrenner (see Chapter 1). Other research has shown that a multifactor interactive view of causality is present among people of many non-Western cultural communities. For example, Indigenous Itza’ Maya and Native American Menominee people tend to emphasize complex interactions across many entities, such as animal and spiritual entities; contexts, such as habitats; and time frames (Atran & Medin, 2008; Unsworth et al., 2012).

Likewise, cognitive–affective complexity relies on advances in emotional awareness and regulation (Labouvie-Vief, 2003). The ability to coordinate sophisticated emotions and cognitions vary with situations, tasks, contexts, and motivations (Kuhn, 2008; Labouvie-Vief, 2015a; Piaget, 1972). Furthermore, advanced forms of pragmatic reasoning likely do not suddenly appear; rather, they emerge with gains in knowledge, experience, and information-processing capacity (Keating, 2004; Kuhn & Franklin, 2006; Moshman, 2005).

Although cognitive development perspectives offer rich descriptions of how people of various ages think, especially describing what reasoning looks like across development, critics have argued that they provide little explanation of just how these changes occur (Brainerd et al., 1978; Halford, 1989). That is, what causes cognitive change? Most current research on cognitive change across the lifespan examines the changes that occur in information processing capacities, such as advances in attention, memory, and problem solving—topics we discuss in Chapter 7.

**Thinking in Context 6.4**

1. What evidence, if any, do you see that most young adolescents show formal operational reasoning? Give examples to support your answer.

2. Can you identify examples of postformal reasoning in your own thinking? What are some challenges of evaluating one’s own thinking?

3. What kinds of experiences foster the development of postformal reasoning? In your view, is higher education necessary to develop the capacity for postformal reasoning? Why or why not?
Seven-year old Megan sets the large pitcher of lemonade on the table, the essential component to her lemonade stand. Her father explains, “To make money you need to make sure that you spend less on lemonade and cups than you earn.” Showing Megan the price of the lemonade mix and cups and the number of servings each jar of lemonade mix makes, he explains that she will make enough money to stay in business if she sells each cup of lemonade for 50 cents. “Don’t overfill each cup. See this line?” Megan’s father asks, pointing to a line near the top of the cup. “Pour lemonade up to this line.” Nodding, Megan excitedly answers, “OK!”

Megan is pleasantly surprised to see that her lemonade stand is popular with the neighborhood kids and adults. So much so that she runs out of cups. Racing into her house, Megan asks her mother for more cups. “These are all we have left,” she answers, handing Megan a package of cups. Megan notices that the new cups are a little bit larger than her first set of cups. As she pours lemonade into the new cups, Megan remembers her father’s warning that if she wants to make enough money to stay in business she shouldn’t overfill cups. She carefully adjusts the amounts, pouring a little bit less into each cup.

At the end of the week Megan happily counts her earnings. Her father reminds her to put aside money to buy more supplies. “How much money do you think we need to buy more lemonade and cups?” he asks. “I don’t know,” Megan answers. “Well let’s see,” he responds. “The lemonade powder cost $2 and you needed two jars. How much is that?” “Four!” “How much were the cups? Look at the price sticker.” “One dollar, but we need two, right?” “Yes, so how much are the cups?” “Two dollars.” “So how much will our supplies cost?” Megan looks unsure. “How much is the lemonade? How much are the cups? Put those numbers together.” “Six!” “Exactly. Now, how much money did you make?” “Thirteen dollars.” “And how much will you have left after buying supplies? It’s how much money you made, take away what you spend on supplies” “Seven?” “Yes, you earned seven dollars!”

Now 20 years old, Megan fondly looks back on her lemonade-selling days. “I wish everything were that easy. Simple problems and simple answers. It’s not like that anymore.” Megan sometimes finds her college classes challenging: “There are so many theories and every theory sounds good and makes sense. I think it’s just a matter of opinion because every theory explains stuff just as well as the others.” Megan’s older sister responds, “Not so fast. Not all theories are equally good. It might look that way at first, but if you look a little deeper you’ll see that some have more support to back them up than others. Which theory to choose is not really an opinion; it’s a judgment based on weighing the evidence.” Megan retorts, “You just overthink everything because you’re in graduate school.”

1. At what Piagetian stage does 7-year-old Megan reason? Explain the evidence for your answer.
2. What role does Megan’s father play in her cognitive advances? Describe his actions from Vygotsky’s perspective.
3. What advances in reasoning do 20-year-old Megan and her older sister demonstrate? How do you know? Cite some examples from their conversation.
3. Might parent–infant interactions, the home environment, and sociocultural context influence cognitive development? For example,

THINKING IN CONTEXT

1. Toys offer infants important opportunities to practice and hone their development. Infants play with toys in different ways at different ages. Identify a toy appropriate for an infant in the secondary circular reactions stage (e.g., a loud rattle or jingling set of toy keys). Compare and contrast how infants in the secondary circular reactions stage play and infants in the coordination of secondary circular reactions stage might play with the toy. How might infants in the tertiary reactions stage play with it? How might infants’ play align with their developing schemes?

2. Infants around the world delight in playing peekaboo. Compare and contrast how Piaget and core knowledge theorists might account for infants’ attention and interest in the caregiver’s disappearing and reappearing face.

3. Might parent-infant interactions, the home environment, and sociocultural context influence cognitive development? For example,

THINKING IN CONTEXT

1. Cognitive changes influence children’s interests and how they spend their time. Consider your own childhood interests. How did they change in late childhood and into adolescence? How might your shifting and intensifying interests reflect cognitive development?

2. Do you think that most young adolescents show formal operational reasoning? Give examples to support your answer.

3. The cognitive development perspective has been criticized for downplaying the role of context in cognitive development. Identify contextual factors that might influence the path of cognitive development. Consider it from a bioecological perspective. What factors at the micro, meso, exo, and macrosystem levels might influence cognitive change in childhood and adolescence?
6.3 Summarize Vygotsky’s sociocultural perspective and how it is manifested in scaffolding, the zone of proximal development, and cultural tools.

SUMMARY

Vygotsky posited that differences in the ways particular cultures and societies approach problems influence cognitive development. According to Vygotsky’s sociocultural theory, we are embedded in a context that shapes how we think and who we become, and learning occurs through collaborating with others. Children learn through guided participation and scaffolding. Over time, children internalize the instruction, making it part of their skill set, and they thereby master tasks. Effective scaffolding works within the zone of proximal development. Vygotsky posed that mental activity is influenced by cultural tools that are passed on to its members.

KEY WORDS

sociocultural perspective
guided participation
scaffolding
zone of proximal development

THINKING IN CONTEXT

1. Contrast Vygotsky and Piaget’s perspectives on cognitive development.
2. What cultural tools have you adopted? How have interactions with others influenced your cognitive development?
3. How might Vygotsky’s ideas be applied to children’s learning at home and in the classroom? Give some examples.

6.4 Explain postformal reasoning and how it compares with cognitive–affective complexity.

SUMMARY

People’s understanding of the nature of knowledge advances along a predictable path in adulthood, from dualistic thinking to relativistic thinking, to reflective judgment. Development beyond formal operations is dependent on metacognition and experience. The ability to accept inconsistency and ambiguity, characteristic of reflective judgment, permits advances in pragmatic thought. Successfully coordinating emotion and cognition improves people’s capacity to adapt to the complexities adult life. Advances in reasoning during the adult years entails making gains in cognitive–affective complexity.

KEY WORDS

epistemic cognition
postformal reasoning
dualistic thinking
relativistic thinking
reflective judgment
pragmatic thought
cognitive–affective complexity

THINKING IN CONTEXT

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