A father encourages his child's curiosity and delight in discovery. With the sensitive support of caring adults, infants' and toddlers' cognition and language develop rapidly.

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When Caitlin, Grace, and Timmy, each nearly 18 months old, gathered at Ginette’s child-care home, the playroom was alive with activity. Grace dropped shapes through holes in a plastic box that Ginette held and adjusted so the harder ones would fall smoothly into place. Once a few shapes were inside, Grace grabbed the box and shook it, squealing with delight as the lid fell open and the shapes scattered around her. The clatter attracted Timmy, who picked up a shape, carried it to the railing at the top of the basement steps, and dropped it overboard, then followed with a teddy bear, a ball, his shoe, and a spoon.

As the toddlers experimented, I could see the beginnings of spoken language—a whole new way of influencing the world. “All gone baw!” Caitlin exclaimed as Timmy tossed the bright red ball down the basement steps. Later that day, Grace revealed the beginnings of make-believe. “Night-night,” she said, putting her head down and closing her eyes.

Over the first two years, the small, reflexive newborn baby becomes a self-assertive, purposeful being who solves simple problems and starts to master the most amazing human ability: language. Parents wonder, How does all this happen so quickly? This question has also captivated researchers, yielding a wealth of findings along with vigorous debate over how to explain the astonishing pace of infant and toddler cognition.

In this chapter, we take up three perspectives on early cognitive development: Piaget’s cognitive-developmental theory, information processing, and Vygotsky’s sociocultural theory. We also consider the usefulness of tests that measure infants’ and toddlers’ intellectual progress. Finally, we look at the beginnings of language. We will see how toddlers’ first words build on early cognitive achievements and how, very soon, new words and expressions greatly increase the speed and flexibility of thinking.

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**Piaget’s Cognitive-Developmental Theory**

Swiss theorist Jean Piaget inspired a vision of children as busy, motivated explorers whose thinking develops as they act directly on the environment. According to Piaget, all aspects of cognition develop in an integrated fashion, changing in a similar way at about the same time as children move through four stages between infancy and adolescence.

Piaget’s first stage, the sensorimotor stage, spans the first two years of life. Piaget believed that infants and toddlers “think” with their eyes, ears, hands, and other sensorimotor equipment. They cannot yet carry out many activities inside their heads. But by the end of toddlerhood, children can solve practical, everyday problems and represent their experiences in speech, gesture, and play.

**Piaget’s Ideas About Cognitive Change**

According to Piaget, specific psychological structures—organized ways of making sense of experience called schemes—change with age. At first, schemes are sensorimotor action patterns. For example, at 6 months, Timmy dropped objects in a fairly rigid way, simply letting go of a rattle and watching with interest. By 18 months, his “dropping scheme” had become deliberate and creative. In tossing objects down the basement stairs, he threw some in the air, bounced others off walls, released some gently and others forcefully. Soon, instead of just acting on objects, he will show evidence of thinking before he acts. For Piaget, this change marks the transition from sensorimotor to preoperational thought.

In Piaget’s theory, two processes, adaptation and organization, account for changes in schemes. **Adaptation.** The next time you have a chance, notice how infants and toddlers tirelessly repeat actions that lead to interesting effects. Adaptation involves building schemes through direct interaction with the environment. It consists of two complementary activities, assimilation and accommodation. During assimilation, we use our current schemes to interpret the external world. For example, when Timmy dropped objects, he was assimilating them to his senso-
The Sensorimotor Stage

The difference between the newborn baby and the 2-year-old child is so vast that Piaget divided the sensorimotor stage into six substages, summarized in Table 5.1. Piaget based this sequence on a very small sample: observations of his son and two daughters as he presented them with everyday problems (such as hidden objects) that helped reveal their understanding of the world.

According to Piaget, at birth infants know so little that they cannot explore purposefully. The circular reaction provides a special means of adapting their first schemes. It involves stumbling onto a new experience caused by the baby's own motor activity. The reaction is “circular” because, as the infant tries to repeat the event again and again, a sensorimotor response that first occurred by chance strengthens into a new scheme. Consider Caitlin, who at age 2 months accidentally made a smacking noise after a feeding. Intrigued, she tried to repeat it until she became expert at smacking her lips. Infants’ difficulty inhibiting new and interesting behaviors may underlie the circular reaction. This immaturity in inhibition seems to be adaptive, helping to ensure that new skills will not be interrupted before they strengthen (Carey & Markman, 1999). Piaget considered revisions in the circular reaction so important that, as Table 5.1 shows, he named the sensorimotor substages after them.

Repeating Chance Behaviors. In Substage 1, babies suck, grasp, and look in much the same way, no matter what experiences they encounter. Around 1 month, as they enter Substage 2, infants start to gain voluntary control over their actions through the primary circular reaction, by repeating chance behaviors largely motivated by basic needs. This leads to some simple motor habits, such as sucking their fist or thumb. Babies also begin to vary their behavior in response to environmental demands. For example, they open their mouths differently for a nipple than for a spoon. And they start to anticipate events. When hungry, 3-month-old Timmy would stop

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**TABLE 5.1** Summary of Piaget’s Sensorimotor Stage

<table>
<thead>
<tr>
<th>SENSORIMOTOR SUBSTAGE</th>
<th>TYPICAL ADAPTIVE BEHAVIORS</th>
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<tbody>
<tr>
<td>1. Reflexive schemes (birth–1 month)</td>
<td>Newborn reflexes (see Chapter 3, pages 82–83)</td>
</tr>
<tr>
<td>2. Primary circular reactions (1–4 months)</td>
<td>Simple motor habits centered around the infant’s own body; limited anticipation of events</td>
</tr>
<tr>
<td>3. Secondary circular reactions (4–8 months)</td>
<td>Actions aimed at repeating interesting effects in the surrounding world; imitation of familiar behaviors</td>
</tr>
<tr>
<td>4. Coordination of secondary circular reactions (8–12 months)</td>
<td>Intentional, or goal-directed, behavior; ability to find a hidden object in the first location in which it is hidden (object permanence); improved anticipation of events; imitation of behaviors slightly different from those the infant usually performs</td>
</tr>
<tr>
<td>5. Tertiary circular reactions (12–18 months)</td>
<td>Exploration of the properties of objects by acting on them in novel ways; imitation of novel behaviors; ability to search in several locations for a hidden object (accurate A–B search)</td>
</tr>
<tr>
<td>6. Mental representation (18 months–2 years)</td>
<td>Internal depictions of objects and events, as indicated by sudden solutions to problems; ability to find an object that has been moved while out of sight (invisible displacement); deferred imitation; and make-believe play</td>
</tr>
</tbody>
</table>
Infants in Substage 4, who can better anticipate events, sometimes use their capacity for intentional behavior to try to change those events. At 10 months, Timmy crawled after Vanessa when she put on her coat, whimpering to keep her from leaving. Also, babies can now imitate behaviors slightly different from those they usually perform. After watching someone else, they try to stir with a spoon or push a toy car (Piaget, 1945/1951).

In Substage 5, from 12 to 18 months, the tertiary circular reaction, in which toddlers repeat behaviors with variation, emerges. Recall how Timmy dropped objects over the basement steps, trying first this action, then that, then another. This deliberately exploratory approach makes 12- to 18-month-olds better problem solvers. According to Piaget, this capacity to experiment leads toddlers to look for a hidden toy in several locations, displaying an accurate A–B search. Their more flexible action patterns also permit them to imitate many more behaviors.

### Mental Representation

Substage 6 brings the ability to create mental representations—internal depictions of information that the mind can manipulate. Our most powerful mental representations are of two kinds: (1) images, or mental pictures of objects, people, and spaces; and (2) concepts, or categories in which similar objects or events are grouped together. We use a mental image to retrace our steps when we've misplaced something or to imitate another's behavior long after observing it. By thinking in concepts and labeling them (for example, “ball” for all rounded, movable objects used in play), we can organize our diverse experiences into more manageable units.

Representation enables older toddlers to solve advanced object permanence problems involving invisible displacement—finding a toy moved while out of sight, such as into a small box.
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while under a cover. It permits deferred imitation—the ability to remember and copy the behavior of models who are not present. And it makes possible make-believe play, in which children act out everyday and imaginary activities. As the sensorimotor stage draws to a close, mental symbols have become major instruments of thinking.

Follow-Up Research on Infant Cognitive Development

Many studies suggest that infants display a wide array of understandings earlier than Piaget believed. Recall the operant conditioning research reviewed in Chapter 4, in which newborns sucked vigorously on a nipple to gain access to interesting sights and sounds. This behavior, which closely resembles Piaget's secondary circular reaction, shows that infants explore and control the external world long before 4 to 8 months. In fact, they do so as soon as they are born.

To discover what infants know about hidden objects and other aspects of physical reality, researchers often use the violation-of-expectation method. They may habituate babies to a physical event (expose them to the event until their looking declines) to familiarize them with a situation in which their knowledge will be tested. Or they may simply show babies an expected event (one that follows physical laws) and an unexpected event (a variation of the first event that violates physical laws). Heightened attention to the unexpected event suggests that the infant is “surprised” by a deviation from physical reality and, therefore, is aware of that aspect of the physical world.

The violation-of-expectation method is controversial. Some researchers believe that it indicates limited awareness of physical events—not the full-blown, conscious understanding that was Piaget's focus in requiring infants to act on their surroundings, as in searching for hidden objects (Campos et al., 2008; Munakata, 2001). Others maintain that the method reveals only babies’ perceptual preference for novelty, not their knowledge of the physical world (Bremner, 2010; Cohen, 2010; Kagan, 2008b). Let's examine this debate in light of recent evidence.

Object Permanence. In a series of studies using the violation-of-expectation method, Renée Baillargeon and her collaborators claimed to have found evidence for object permanence in the first few months of life. Figure 5.1 explains and illustrates one of these studies (Aguiar & Baillargeon, 2002; Baillargeon & DeVos, 1991).

Additional violation-of-expectation studies yielded similar results, suggesting that infants look longer at a wide variety of unexpected events involving hidden objects (Wang, Baillargeon, & Paterson, 2005). And another type of looking behavior also suggests that young infants are aware that objects persist when out of view. Four- and 5-month-olds will track a ball’s path of movement as it disappears and reappears from behind a barrier,
even gazing ahead to where they expect it to emerge (Bertenthal, Longo, & Kenny, 2007; Rosander & von Hofsten, 2004). With age, babies are more likely to fixate on the predicted place of the ball’s reappearance and wait for it—evidence of an increasingly secure grasp of object permanence.

Once 8- to 12-month-olds search for hidden objects, they make the A-not-B search error. Some research suggests that after finding the object several times at A, they do not attend closely when it is hidden at B (Ruffman & Langman, 2002). A more comprehensive explanation is that a dynamic system of factors—having built a habit of reaching toward A, continuing to look at A, having the hiding place at B appear similar to the one at A, and maintaining a constant body posture—increases the chances that the baby will make the A-not-B search error. Disrupting any one of these factors increases 10-month-olds’ accurate searching at B (Thelen et al., 2001). In addition, older infants are still perfecting reaching and grasping (see Chapter 4) (Berger, 2010). If these motor skills are challenging, babies have little attention left to focus on inhibiting their habitual reach toward A.

**LOOK AND LISTEN**

Using an attractive toy and cloth, try several object-hiding tasks with 8- to 14-month-olds. Is their searching behavior consistent with research findings? ●

In sum, babies’ understanding of object permanence becomes increasingly complex with age (Cohen & Cashon, 2006; Moore & Meltzoff, 2008). Success at object search tasks coincides with rapid development of the frontal lobes of the cerebral cortex (Bell, 1998). Also crucial are a wide variety of experiences perceiving, acting on, and remembering objects.

**Mental Representation.** In Piaget’s theory, before about 18 months of age, infants are unable to mentally represent experience. Yet 8- to 10-month-olds’ ability to recall the location of hidden objects after delays of more than a minute, and 14-month-olds’ recall after delays of a day or more, indicate that babies construct mental representations of objects and their whereabouts (McDonough, 1999; Moore & Meltzoff, 2004). And in studies of deferred imitation and problem solving, representational thought is evident even earlier.

**Deferred and Inferred Imitation.** Piaget studied deferred imitation by noting when his three children demonstrated it in their everyday behavior. But laboratory research suggests that it is present at 6 weeks of age! Infants who watched an unfamiliar adult’s facial expression imitated it when exposed to the same adult the next day (Meltzoff & Moore, 1994). As motor capacities improve, infants copy actions with objects. In one study, an adult showed 6- and 9-month-olds a novel series of actions with a puppet: taking its glove off, shaking the glove to ring a bell inside, and replacing the glove. When tested a day later, infants who had seen the novel actions were far more likely to display them (see Figure 5.2) (Barr, Marrott, & Rovee-Collier, 2003).

Between 12 and 18 months, toddlers use deferred imitation skillfully to enrich their range of sensorimotor schemes. They retain modeled behaviors for at least several months, copy the actions of peers as well as adults, and imitate across a change in context—for example, enact at home a behavior seen at child care (Klein & Meltzoff, 1999; Meltzoff & Williamson, 2010). The ability to recall modeled behaviors in the order they occurred—evident as early as 6 months—also strengthens (Bauer, 2006; Rovee-Collier & Cuevas, 2009). And when toddlers imitate in correct sequence, they remember more behaviors (Knopf, Kraus, & Kressley-Mba, 2006).

Toddlers even imitate rationally, by inferring others’ intentions! Fourteen-month-olds are more likely to imitate purposeful than accidental behaviors (Carpenter, Akhtar, & Tomasello, 1998). And they adapt their imitative acts to a model’s goals. If 12-month-olds see an adult perform an unusual action for fun (make a toy dog enter a miniature house by jumping through the chimney, even though its door is wide open), they copy the behavior. But if the adult engages in the odd behavior because she must (she makes the dog go through the chimney only after

---

**FIGURE 5.2 Testing infants for deferred imitation.** After researchers performed a novel series of actions with a puppet, this 6-month-old imitated the actions a day later—at left, removing the glove; at right, shaking the glove to ring a bell inside. With age, gains in recall are evident in deferred imitation of others’ behaviors over longer delays.
finding the door is locked), 12-month-olds typically imitate the more efficient action (putting the dog through the door) (Schwier et al., 2006).

Around 18 months, toddlers can imitate actions an adult tries to produce, even if these are not fully realized (Olineck & Poulin-Dubois, 2007, 2009). On one occasion, Ginette attempted to pour some raisins into a bag but missed, spilling them. A moment later, Grace began dropping the raisins into the bag, indicating that she had inferred Ginette’s goal.

**Problem Solving.** As Piaget indicated, around 7 to 8 months, infants develop intentional means–end action sequences, which they use to solve simple problems, such as pulling on a cloth to obtain a toy resting on its far end (Willatts, 1999). Soon after, infants’ representational skills permit more effective problem solving than Piaget’s theory suggests.

By 10 to 12 months, infants can solve problems by analogy—apply a solution strategy from one problem to other relevant problems. In one study, 12-month-olds who were repeatedly presented with a spoon in the same orientation (handle to one side) readily adapted their motor actions when the spoon was presented with the handle to the other side, successfully transporting food to their mouths (McCarty & Keen, 2005). These findings reveal that at the end of the first year, infants have some ability to move beyond trial-and-error experimentation, represent a solution mentally, and use it in a new context.

**Symbolic Understanding.** One of the most momentous early attainments is the realization that words can be used to cue mental images of things not physically present—a symbolic capacity called displaced reference that emerges around the first birthday. It greatly expands toddlers’ capacity to learn about the world through communicating with others and acquiring new knowledge (Ganea, Pickard, & DeLoache, 2008). They point to, name, and talk about pictures, and they can apply something learned from a book with realistic-looking pictures to real objects, and vice versa.

How do infants and toddlers interpret another ever-present, pictorial medium—video? Turn to the Social Issues: Education box on page 124 to find out.

**Evaluation of the Sensorimotor Stage**

Table 5.2 summarizes the remarkable cognitive attainments we have just considered. **TAKE A MOMENT...** Compare this table with Piaget’s description of the sensorimotor substages in

<table>
<thead>
<tr>
<th>AGE</th>
<th>COGNITIVE ATTAINMENTS</th>
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<tbody>
<tr>
<td>Birth–1 month</td>
<td>Secondary circular reactions using limited motor skills, such as sucking a nipple to gain access to interesting sights and sounds</td>
</tr>
<tr>
<td>1–4 months</td>
<td>Awareness of object permanence, object solidity, and gravity, as suggested by violation-of-expectation findings; deferred imitation of an adult’s facial expression over a short delay (one day)</td>
</tr>
<tr>
<td>4–8 months</td>
<td>Improved knowledge of object properties and basic numerical knowledge, as suggested by violation-of-expectation findings; deferred imitation of an adult’s novel actions on objects over a short delay (one to three days)</td>
</tr>
<tr>
<td>8–12 months</td>
<td>Ability to search for a hidden object when covered by a cloth; ability to solve simple problems by analogy to a previous problem</td>
</tr>
<tr>
<td>12–18 months</td>
<td>Ability to search in several locations for a hidden object, when a hand deposits it under a cloth, and when it is moved from one location to another (accurate A–B search); deferred imitation of an adult’s novel actions on objects after long delays (at least several months) and across a change in situation (from child care to home); rational imitation, inferring the model’s intentions; displaced reference of words</td>
</tr>
<tr>
<td>18 months–2 years</td>
<td>Ability to find an object moved while out of sight (invisible displacement); deferred imitation of actions an adult tries to produce, even if these are not fully realized; deferred imitation of everyday behaviors in make-believe play; beginning awareness of pictures and video as symbols of reality</td>
</tr>
</tbody>
</table>

**TAKE A MOMENT...** Which of the capacities listed in the table indicate that mental representation emerges earlier than Piaget believed?
Social Issues: Education

Baby Learning from TV and Video: The Video Deficit Effect

Children first become TV and video viewers in early infancy, as they are exposed to programs watched by parents and older siblings or to shows aimed at baby viewers, such as the Baby Einstein products. About 40 percent of U.S. 3-month-olds watch regularly, a figure that rises to 90 percent at age 2, a period during which average viewing time increases from just under an hour to 1½ hours a day (Zimmerman, Christakis, & Meltzoff, 2007). Although parents assume that babies learn from TV and videos, research indicates that they cannot take full advantage of them.

Initially, infants respond to videos of people as if viewing people directly—smiling, moving their arms and legs, and (by 6 months) imitating actions of a televised adult. But they confuse the images with the real thing (Barr, Muentener, & Garcia, 2007; Marian, Neisser, & Rochat, 1996). When shown videos of attractive toys, 9-month-olds manually explored the screen. By 19 months, touching had declined in favor of pointing at the images (Pierroutsakos & Troseth, 2003). Nevertheless, toddlers continue to have difficulty applying what they see on video to real situations.

In a series of studies, some 2-year-olds watched through a window while a live adult hid an object in an adjoining room, while others watched the same event on a video screen. Children in the direct viewing condition retrieved the toy easily; those in the video condition had difficulty (Troseth, 2003). This video deficit effect—poorer performance after a video than a live demonstration—has also been found for 2-year-olds’ deferred imitation, word learning, and means—end problem solving (Decampo, 2003; Hayne, Herbert, & Simcock, 2003; Krcmar, Grela, & Linn, 2007).

Toddlers seem to discount information on video as relevant to their everyday experiences because people do not look at and converse with them directly or establish a shared focus on objects, as their caregivers do. In one study, researchers gave some 2-year-olds an interactive video experience (using a two-way, closed-circuit video system). An adult on video interacted with the child for five minutes—calling the child by name, talking about the child’s siblings and pets, waiting for the child to respond, and playing interactive games (Troseth, Saylor, & Archer, 2006). Compared with 2-year-olds who viewed the same adult in a noninteractive video, those in the interactive condition were far more likely to use a verbal cue from a person on video to retrieve a toy.

Around age 2½, the video deficit effect declines. Before this age, the American Academy of Pediatrics (2001) recommends against mass media exposure. In support of this advice, amount of TV viewing is negatively related to 8- to 18-month-olds’ language progress (Tanimura et al., 2004; Zimmerman, Christakis, & Meltzoff, 2007). And 1- to 3-year-old heavy viewers tend to have attention, memory, and reading difficulties in the early school years (Christakis et al., 2004; Zimmerman & Christakis, 2005). When toddlers do watch TV and video, it is likely to work best as a teaching tool when it is rich in social cues—close-ups of characters who look directly at the camera, address questions to viewers, and pause to invite their response.

Piaget assumed led to those understandings. How can we account for babies’ amazing cognitive accomplishments?

Alternative Explanations. Unlike Piaget, who thought young babies constructed all mental representations out of sensorimotor activity, most researchers now believe that infants have some built-in cognitive equipment for making sense of experience. But intense disagreement exists over the extent of this initial understanding. Researchers who lack confidence in the violation-of-expectation method argue that babies’ cognitive starting point is limited (Campos et al., 2008; Cohen, 2010; Cohen & Cashon, 2006; Kagan, 2008b). For example, some believe that newborns begin life with a set of biases.
for attending to certain information and with general-purpose learning procedures, such as powerful techniques for analyzing complex perceptual information. Together, these capacities enable infants to construct a wide variety of schemes (Bahrick, 2010; Quinn, 2008; Rakison, 2010).

Others, convinced by violation-of-expectation findings, believe that infants start out with impressive understandings. According to this core knowledge perspective, babies are born with a set of innate knowledge systems, or core domains of thought. Each of these prewired understandings permits a ready grasp of new, related information and therefore supports early, rapid development (Leslie, 2004; Spelke, 2004; Spelke & Kinzler, 2007). Core knowledge theorists argue that infants could not make sense of the complex stimulation around them without having been genetically “set up” in the course of evolution to comprehend its crucial aspects.

Researchers have conducted many studies of infants’ physical knowledge, including object permanence, object solidity (that one object cannot move through another), and gravity (that an object will fall without support). Violation-of-expectation findings suggest that in the first few months, infants have some awareness of all these basic object properties and quickly build on this knowledge (Baillargeon, 2004; Hespos & Baillargeon, 2008; Luo & Baillargeon, 2005; Spelke, 2000). Core knowledge theorists also assume that an inherited foundation of linguistic knowledge enables swift language acquisition in early childhood—a possibility we will consider later in this chapter. Furthermore, these theorists argue, infants’ early orientation toward people initiates rapid development of psychological knowledge—in particular, understanding of mental states, such as intentions, emotions, desires, and beliefs.

Research even suggests that infants have basic numerical knowledge. In the best-known study, 5-month-olds saw a screen raised to hide a single toy animal and then watched a hand place a second toy behind the screen. Finally the screen was removed to reveal either one or two toys. Infants looked longer at the unexpected, one-toy display, indicating that they kept track of the two objects and were able to add one object to another (Wynn, Bloom, & Chiang, 2002). Findings like these suggest that babies can discriminate quantities up to three and use that knowledge to perform simple arithmetic—both addition and subtraction (Kobayashi et al., 2004; Kobayashi, Hiraki, & Hasegawa, 2005).

Additional evidence suggests that 6-month-olds can distinguish among large sets of items, as long as the difference between those sets is very great—at least a factor of two. For example, they can tell the difference between 8 and 16 dots but not between 6 and 12 (Lipton & Spelke, 2004; Xu, Spelke, & Goddard, 2005). As a result, some researchers believe that infants can represent approximate large-number values, in addition to making small-number discriminations.

But babies’ numerical capacities are controversial—not evident in all studies (Langer, Gillette, & Arriaga, 2003; Wakeley, Rivera, & Langer, 2000). These researchers point out that claims for infants’ knowledge of number concepts are surprising, in view of other research indicating that before 14 to 16 months, toddlers have difficulty making less-than and greater-than comparisons between small sets. And not until the preschool years do children add and subtract small sets correctly.

The core knowledge perspective, while emphasizing native endowment, acknowledges that experience is essential for children to extend this initial knowledge. But so far, it has said little about which experiences are most important in each core domain of thought and how those experiences advance children’s thinking. Despite these limitations, core knowledge research has sharpened the field’s focus on specifying the starting point of human cognition and carefully tracking the changes that build on it.

Piaget’s Legacy. Current research on infant cognition yields broad agreement on two issues. First, many cognitive changes of infancy are not abrupt and stagelike but gradual and continuous (Bjorklund, 2012; Courage & Howe, 2002). Second, rather than developing together, various aspects of infant cognition change unevenly because of the challenges posed by different types of tasks and infants’ varying experience with them. These ideas serve as the basis for another major approach to cognitive development—information processing.

Before turning to this alternative point of view, let’s recognize Piaget’s enormous contributions. Piaget’s work inspired a wealth of research on infant cognition, including studies that challenged his theory. His observations also have been of great practical value. Teachers and caregivers continue to look to the sensorimotor stage for guidelines on how to create developmentally appropriate environments for infants and toddlers.
**Information Processing**

Recall from Chapter 1 that the information-processing researchers are not satisfied with general concepts, such as assimilation and accommodation, to describe how children think. Instead, they want to know exactly what individuals of different ages do when faced with a task or problem (Birney & Sternberg, 2011; Miller, 2009).

**A General Model of Information Processing**

Most information-processing researchers assume that we hold information in three parts of the mental system for processing: the sensory register, the short-term memory store, and the long-term memory store (see Figure 5.3). As information flows through each, we can use mental strategies to operate on and transform it, increasing the chances that we will retain information, use it efficiently, and think flexibly, adapting the information to changing circumstances. To understand this more clearly, let’s look at each component of the mental system.

First, information enters the sensory register, where sights and sounds are represented directly and stored briefly. **Take a Moment...** Look around you, and then close your eyes. An image of what you saw persists for a few seconds, but then it decays unless you use mental strategies to preserve it. For example, by attending to some information more carefully than to other information, you increase the chances that it will transfer to the next step of the information-processing system.

In the second part of the mind, the short-term memory store, we retain attended-to information briefly so we can actively “work” on it to reach our goals. One way of looking at the short-term store is in terms of its **basic capacity**, often referred to as **short-term memory**: how many pieces of information can be held at once for a few seconds. But most researchers endorse a contemporary view of the short-term store, which offers a more meaningful indicator of its capacity, called **working memory**—the number of items that can be briefly held in mind while also engaging in some effort to monitor or manipulate those items. Working memory can be thought of as a “mental workspace.” From childhood on, researchers assess its capacity by presenting individuals with lists of items (such as numerical digits or short sentences) and asking them to “work” on the items (for example, repeat the digits backward or remember the final word of each sentence in correct order).

The sensory register can take in a wide panorama of information. Short-term and working memory are far more restricted, though their capacity increases steadily from early childhood to early adulthood—on a verbatim digit-span task tapping short-term memory, from about 2 to 7 items; and on working-memory tasks, from about 2 to 5 items (Cowan & Alloway, 2009). Still, individual differences are evident at all ages. By engaging in a variety of basic cognitive procedures, such as focusing attention on relevant items and repeating (rehearsing) them rapidly, we increase the chances that information will be retained and accessible to ongoing thinking.

To manage the cognitive system’s activities, the central **executive** directs the flow of information, implementing the basic procedures just mentioned and also engaging in more sophisticated activities that enable complex, flexible thinking. For example, the central executive coordinates incoming information with information already in the system, and it selects, applies, and monitors strategies that facilitate memory storage, comprehension, reasoning, and problem solving (Pressley & Hilden, 2006). The central executive is the conscious, reflective part of our mental system. It ensures that we think purposefully, to attain our goals.

The more effectively the central executive joins with working memory to process information, the better learned cognitive activities will be and the more **automatically** we can apply them. Consider the richness of your thinking while you automatically drive a car. **Automatic processes** are so well-learned that they require no space in working memory and, therefore, permit us to focus on other information while performing them. Furthermore, the more effectively we process information in working memory, the more likely it will transfer to the third, and largest, storage area—**long-term memory**, our permanent knowledge base, which is unlimited. In fact, we store so much in long-term memory that **retrieval**—getting information back from the system—can be problematic. To aid retrieval, we apply strategies, just as we do in working memory. Information in long-term memory is categorized by its contents, much like a library shelving system that enables us to retrieve items by following the same network of associations used to store them.

Information-processing research indicates that several aspects of the cognitive system improve during childhood and adolescence: (1) the **basic capacity** of its stores, especially work-
CHAPTER 5 Cognitive Development in Infancy and Toddlerhood

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ing memory; (2) the speed with which information is worked on; and (3) the functioning of the central executive. Together, these changes make possible more complex forms of thinking with age (Case, 1998; Kail, 2003).

Gains in working-memory capacity are due in part to brain development, but greater processing speed also contributes. Fast, fluent thinking frees working-memory resources to support storage and manipulation of additional information. Furthermore, researchers have become increasingly interested in studying the development of executive function—the diverse cognitive operations and strategies that enable us to achieve our goals in cognitively challenging situations (Welsh, Friedman, & Spieker, 2008). These include controlling attention, suppressing impulses, coordinating information in working memory, and flexibly directing and monitoring thought and behavior. As we will see, gains in working memory capacity and aspects of executive function are under way in the first two years.

Attention

Recall from Chapter 4 that around 2 to 3 months of age, infants explore objects and patterns more thoroughly. Besides attending to more aspects of the environment, infants gradually take in information more quickly. Preterm and newborn babies require a long time—about 3 to 4 minutes—to habituate and recover to novel visual stimuli. But by 4 or 5 months, they need as little as 5 to 10 seconds to take in a complex visual stimulus and recognize it as different from a previous one (Rose, Feldman, & Jankowski, 2001; Slater et al., 1996).

Over the first year, infants attend to novel and eye-catching events. In the second year, as toddlers become increasingly capable of intentional behavior (refer back to Piaget's Substage 4), attraction to novelty declines (but does not disappear) and sustained attention improves. A toddler who engages even in simple goal-directed behavior, such as stacking blocks or putting them in a container, must sustain attention to reach the goal (Ruff & Capozzoli, 2003). As plans and activities gradually become more complex, the duration of attention increases.

Memory

Operant conditioning and habituation provide windows into early memory. Both methods show that retention of visual events increases dramatically over infancy and toddlerhood.

Using operant conditioning, researchers study infant memory by teaching 2- to 6-month-olds to move a mobile by kicking a foot tied to it with a long cord. Two-month-olds remember how to activate the mobile for 1 to 2 days after training, and 3-month-olds for one week. By 6 months, memory increases to two weeks (Rovee-Collier, 1999; Rovee-Collier & Bhatt, 1993). Around the middle of the first year, babies can manipulate switches or buttons to control stimulation. When 6- to 18-month-olds pressed a lever to make a toy train move around a track, duration of memory continued to increase with age; 13 weeks after training, 18-month-olds still remembered how to press the lever (Hartshorn et al., 1998).

Even after babies forget an operant response, they need only a brief prompt—an adult who shakes the mobile—to reinstate
the memory (Hildreth & Rovee-Collier, 2002). And when 6-month-olds are given a chance to reactivate the response themselves for just a couple of minutes, their memory not only returns but extends dramatically, to about 17 weeks (Hildreth, Sweeney, & Rovee-Collier, 2003). Perhaps permitting the baby to generate the previously learned behavior strengthens memory because it reexposes the child to more aspects of the original learning situation.

Habituation studies show that infants learn and retain a wide variety of information just by watching objects and events, sometimes for much longer time spans than in operant conditioning studies. Babies are especially attentive to the movements of objects and people. In one investigation, 5½-month-olds remembered a woman’s captivating action (such as blowing bubbles or brushing hair) seven weeks later, as indicated by a familiarity preference (see page 104 in Chapter 4) (Bahrick, Gogate, & Ruiz, 2002). The babies were so attentive to the woman’s action that they did not remember her face, even when tested 1 minute later for a novelty preference.

So far, we have discussed only recognition—noticing when a stimulus is identical or similar to one previously experienced. It is the simplest form of memory: All babies have to do is indicate (by kicking or looking) that a new stimulus is identical or similar to a previous one. Recall is more challenging because it involves remembering something not present. But by the second half of the first year, infants are capable of recall, as indicated by their ability to find hidden objects and engage in deferred imitation. Recall, too, improves steadily with age.

Long-term recall depends on connections among multiple regions of the cerebral cortex, especially with the prefrontal cortex. During infancy and toddlerhood, these neural circuits develop rapidly (Nelson, Thomas, & de Haan, 2006). Yet a puzzling finding is that older children and adults no longer recall their earliest experiences! See the Biology and Environment box on the following page for a discussion of infantile amnesia.

**Categorization**

Categorization—grouping similar objects and events into a single representation—helps infants make sense of experience. It reduces the enormous amount of new information infants encounter so they can learn and remember (Rakison, 2010).

Creative variations of operant conditioning research with mobiles have been used to investigate infant categorization. One such study, of 3-month-olds, is described and illustrated in Figure 5.4. Similar investigations reveal that in the first few months, babies categorize stimuli on the basis of shape, size, and other physical properties (Wasserman & Rovee-Collier, 2001). By 6 months of age, they can categorize on the basis of two correlated features—for example, the shape and color of an alphabet letter (Bhatt et al., 2004). This ability to categorize using clusters of features prepares babies for acquiring many complex everyday categories.

Habituation has also been used to study infant categorization. Researchers show babies a series of pictures belonging to one category and then see whether they recover to (look longer at) a picture that is not a member of the category. Findings reveal that in the second half of the first year, infants group objects into an impressive array of categories—food items, furniture, land animals, air animals, sea animals, plants, vehicles, and spatial location (“above” and “below,” “on” and “in”) (Bornstein, Arterberry, & Mash, 2010; Casasola, Cohen, & Chiarello, 2003; Oakes, Coppage, & Dingel, 1997). Besides organizing the physical world, infants of this age categorize their emotional and social worlds. They sort people and their voices by gender and age, have begun to distinguish emotional expressions, and separate people’s natural actions (walking) from other motions (see Chapter 4, page 112). Babies’ earliest categories are based on similar overall appearance or prominent object part: legs for animals, wheels for vehicles. By the second half of the first year, more categories appear to be based on subtle sets of features (Mandler, 2004; Quinn, 2008). Older infants can even make categorical distinctions when the perceptual contrast between two categories is minimal (birds versus airplanes). Toddlers begin to categorize flexibly: When 14-month-olds are given four balls and four blocks, some made of soft rubber and some of rigid plastic, their sequence of object touching reveals
Infantile Amnesia

If infants and toddlers recall many aspects of their everyday lives, how do we explain infantile amnesia—that most of us cannot retrieve events that happened to us before age 3? The reason cannot be merely the passage of time because we can recall many personally meaningful one-time events from both the recent and the distant past: the day a sibling was born or a move to a new house—recollections known as autobiographical memory.

Several accounts of infantile amnesia exist. One theory credits brain development, suggesting that vital changes in the prefrontal cortex pave the way for an explicit memory system—one in which children remember deliberately rather than implicitly, without conscious awareness (Nelson, 1995). But mounting evidence indicates that even young infants engage in conscious recall (Bauer, 2006; Rovee-Collier & Cuevas, 2009). Their memory processing is not fundamentally different from that of children and adults.

Another conjecture is that older children and adults often use verbal means for storing information, whereas infants’ and toddlers’ memory processing is largely nonverbal—an incompatibility that may prevent long-term retention of early experiences. To test this idea, researchers sent two adults to the homes of 2- to 4-year-olds with an unusual toy that the children were likely to remember: The Magic Shrinking Machine, shown in Figure 5.5. One adult showed the child how, after inserting an object in an opening on top of the machine and turning a crank that activated flashing lights and musical sounds, the child could retrieve a smaller, identical object (discretely dropped down a chute by the second adult) from behind a door on the front of the machine.

A day later, the researchers tested the children to see how well they recalled the event. Their nonverbal memory—based on acting out the “shrinking” event and recognizing the “shrunk” objects in photos—was excellent. But even when they had the vocabulary, children younger than age 3 had trouble describing features of the “shrinking” experience. Verbal recall increased sharply between ages 3 and 4—the period during which children “scramble over the amnesia barrier” (Simcock & Hayne, 2003, p. 813). In a second study, preschoolers could not translate their nonverbal memory for the game into language 6 months to 1 year later, when their language had improved dramatically. Their verbal reports were “frozen in time,” reflecting their limited language skill at the age they played the game (Simcock & Hayne, 2002).

These findings help us reconcile infants’ and toddlers’ remarkable memory skills with infantile amnesia. During the first few years, children rely heavily on nonverbal memory techniques, such as visual images and motor actions. Only after age 3 do they often represent events verbally and participate in elaborate conversations with adults about them. As children encode autobiographical events in verbal form, they use language-based cues to retrieve them, increasing the accessibility of these memories at later ages (Peterson, Warren, & Short, 2011).

Other findings indicate that the advent of a clear self-image contributes to the end of infantile amnesia (Howe, Courage, & Rooksby, 2009). Toddlers who were advanced in development of a sense of self demonstrated better verbal memories a year later while conversing about past events with their mothers (Harley & Reese, 1999).

Very likely, both neurobiological change and social experience contribute to the decline of infantile amnesia. Brain development and adult–child interaction may jointly foster self-awareness, language, and improved memory, which enable children to talk with adults about significant past experiences (Bauer, 2007). As a result, preschoolers begin to construct a long-lasting autobiographical narrative of their lives and enter into the history of their family and community.
that after classifying by shape, they can switch to classifying by material (soft versus hard) (Ellis & Oakes, 2006).

Young toddlers’ play behaviors reveal that they know certain actions (drinking) are appropriate only for animals, not inanimate objects (Mandler & McDonough, 1998). By the end of the second year, understanding of the animate–inanimate distinction expands. Nonlinear motions are typical of animates (a person or a dog jumping), linear motions of inanimates (a car or a table pushed along a surface). At 22 months, toddlers imitate a nonlinear motion only with toys in the animate category (a cat but not a bed) (Rakison, 2005, 2006). They seem to realize that whereas animates are self-propelled and therefore have varied paths of movement, inanimates move only when acted on, in restricted ways.

Researchers disagree on how toddlers gradually shift from categorizing on the basis of prominent perceptual features (things with flapping wings and feathers belong to one category; things with rigid wings and a smooth surface to another) to categorizing on a conceptual basis, grouping objects by their common function or behavior (birds versus airplanes, dogs versus cats) (Oakes et al., 2009; Rakison & Lupyan, 2008). But all acknowledge that exploration of objects and expanding knowledge of the world contribute. In addition, adult labeling (“Look at the car!” “Do you see the car?”) calls babies’ attention to commonalities among objects, fostering categorization as early as 3 to 4 months of age (Ferry, Hespos, & Waxman, 2010). Toddlers’ vocabulary growth, in turn, fosters categorization (Cohen & Brunt, 2009).

### Evaluation of Information-Processing Findings

The information-processing perspective underscores the continuity of human thinking from infancy into adult life. Infants and toddlers think in ways that are remarkably similar to adults’ thinking, though their mental processing is far from proficient. And their capacity to recall events and to categorize stimuli attests, once again, to their ability to mentally represent their experiences.

Information-processing research has contributed greatly to our view of infants and toddlers as sophisticated cognitive beings. But its central strength—analyzing cognition into its components, such as perception, attention, memory, and categorization—is also its greatest drawback: It has had difficulty putting these components back together into a broad, comprehensive theory.

One approach to overcoming this weakness has been to combine Piaget’s theory with the information-processing approach, an effort we will explore in Chapter 9. A more recent trend has been the application of a dynamic systems view. Researchers analyze each cognitive attainment to see how it results from a complex system of prior accomplishments and the child’s current goals (Spencer & Perone, 2008; Tellen & Smith, 2006). Once these ideas are fully tested, they may move the field closer to a more powerful view of how the minds of infants and children develop.

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The Social Context of Early Cognitive Development

Recall the description at the beginning of this chapter of Grace dropping shapes into a container. Notice that she learns about the toy with Ginette’s support. According to Vygotsky’s sociocultural theory, complex mental activities have their origins in social interaction (Vygotsky, 2003; Rogoff, 2003). Through joint activities with more mature members of their society, children master activities and think in ways that have meaning in their culture.

A special Vygotskian concept explains how this happens. The **zone of proximal (or potential) development** refers to a range of tasks too difficult for the child to do alone but possible with the help of more skilled partners. To understand this idea, think about how a sensitive adult (such as Ginette) introduces a child to a new activity. The adult picks a task that the child can master but that is challenging enough that the child cannot do it by herself. As the adult guides and supports, the child joins in the interaction and picks up mental strategies. As her competence increases, the adult steps back, permitting the child to take more responsibility for the task.

A study by Barbara Rogoff and her collaborators (1984) illustrates this process. Placing a jack-in-the-box nearby, the researchers watched how several adults played with Rogoff’s son and daughter over the first two years. In the early months, the adults tried to focus the baby’s attention by working the toy and, as the bunny popped out, saying something like “My, what happened?” By the end of the first year, when the baby’s cognitive...
Cultural Influences

Social Origins of Make-Believe Play

One of the activities my husband, Ken, used to do with our two sons when they were young was to bake pineapple upside-down cake, a favorite treat. One Sunday afternoon as 4-year-old David stirred the batter, Ken poured some into a small bowl for 21-month-old Peter and handed him a spoon.

“Here’s how you do it, Petey,” instructed David, with a superior air. Peter watched as David stirred, then tried to copy his motion. When it was time to pour the batter, Ken helped Peter hold and tip the small bowl.

“Time to bake it,” said Ken. “Bake it, bake it,” repeated Peter, watching Ken slip the pan into the oven.

Several hours later, we observed one of Peter’s earliest instances of make-believe play. He got his pail from the sandbox and, after filling it with a handful of sand, carried it into the kitchen and put it down on the floor in front of the oven. “Bake it, bake it,” Peter called to Ken. Together, father and son placed the pretend cake in the oven.

Vygotsky believed that society provides children with opportunities to represent culturally meaningful activities in play. Make-believe, he claimed, is first learned under the guidance of experts (Berk, Mann, & Ogan, 2006). In the example just described, Peter extended his capacity to represent daily events when Ken drew him into the baking task and helped him act it out in play.

Current evidence supports the idea that early make-believe is the combined result of children’s readiness to engage in it and social experiences that promote it. In a study of U.S. middle-SES toddlers, 75 to 80 percent of make-believe involved mother-child interaction (Haight & Miller, 1993). At 12 months, almost all play episodes were initiated by mothers, but by the end of the second year, half of pretend episodes were initiated by each. During make-believe, mothers offer toddlers a rich array of cues that they are pretending—looking and smiling at the child more, making more exaggerated movements, and using more “we” talk (acknowledging that pretending is a joint endeavor) than they do during the same real-life event (Lillard, 2007). When adults participate, toddlers’ make-believe is more elaborate (Keren et al., 2005). And the more parents pretend with their toddlers, the more time their children devote to make-believe.

But in some cultures, mothers offer toddlers a rich array of cues that they are pretending—looking and smiling at the child more, making more exaggerated movements, and using more “we” talk (acknowledging that pretending is a joint endeavor) than they do during the same real-life event (Lillard, 2007). When adults participate, toddlers’ make-believe is more elaborate (Keren et al., 2005). And the more parents pretend with their toddlers, the more time their children devote to make-believe.

As early as the first year, cultural variations in social experiences affect mental strategies. In the jack-in-the-box example, adults and children focused their attention on a single activity—a strategy common in Western middle-SES infant and toddler play. In contrast, Guatemalan Mayan babies often attend to several events at once. For example, one 12-month-old skillfully put objects in a jar while watching a passing truck and blowing into a toy whistle (Chavajay & Rogoff, 1999). Processing several competing events simultaneously may be vital in cultures where children largely learn through keen observation of others’ ongoing activities. Children of Guatemalan Mayan, Mexican, and Native-American parents without extensive education continue to display this style of attention well into middle childhood (Correa-Chavez, Rogoff, & Mejia-Arauz, 2005).

Earlier we saw how infants and toddlers create new schemes by acting on the physical world (Piaget) and how certain skills become better developed as children represent their experiences more efficiently and meaningfully (information processing). Vygotsky adds a third dimension to our understanding by emphasizing that many aspects of cognitive development are socially mediated. The Cultural Influences box above presents additional evidence for this idea, and we will see even more in the next section.
Because of Grace’s deprived early environment, Kevin and Monica had a psychologist give her one of many tests available for assessing mental development in infants and toddlers. Worried about Timmy’s progress, Vanessa also arranged for him to be tested. At age 22 months, he spoke only a handful of words, played in a less mature way than Caitlin and Grace, and seemed restless and overactive.

The cognitive theories we have just discussed try to explain the process of development—how children’s thinking changes. Mental tests, in contrast, focus on cognitive products. Their goal is to measure behaviors that reflect development and to arrive at scores that predict future performance, such as later intelligence and school achievement.

Infant and Toddler Intelligence Tests

Accurately measuring infants’ intelligence is a challenge because babies cannot answer questions or follow directions. As a result, most infant tests emphasize perceptual and motor responses. But new tests are being developed that also tap early language, cognition, and social behavior. One commonly used test, the Bayley Scales of Infant and Toddler Development, is suitable for children between 1 month and 3½ years. The most recent edition, the Bayley-III, has three main subtests: (1) the Cognitive Scale, which includes such items as attention to familiar and unfamiliar objects, looking for a fallen object, and pretend play; (2) the Language Scale, which assesses understanding and expression of language—for example, recognition of objects and people, following simple directions, and naming objects and pictures; and (3) the Motor Scale, which includes gross- and fine-motor skills, such as grasping, sitting, stacking blocks, and climbing stairs (Bayley, 2005).

Two additional Bayley-III scales depend on parental report: (4) the Social-Emotional Scale, which asks caregivers about such behaviors as ease of calming, social responsiveness, and imitation in play; and (5) the Adaptive Behavior Scale, which asks about adaptation to the demands of daily life, including communication, self-control, following rules, and getting along with others.

Computing Intelligence Test Scores. Intelligence tests for infants, children, and adults are scored in much the same way—by computing an intelligence quotient (IQ), which indicates the extent to which the raw score (number of items passed) deviates from the typical performance of same-age individuals. To make this comparison possible, test designers engage in standardization—giving the test to a large, representative sample and using the results as the standard for interpreting scores.

Within the standardization sample, performances at each age level form a normal distribution, in which most scores cluster around the mean, or average, with progressively fewer falling toward the extremes (see Figure 5.6). This bell-shaped distribution results whenever researchers measure individual differences in large samples. When intelligence tests are standardized, the mean IQ is set at 100. An individual’s IQ is higher or lower than 100 by an amount that reflects how much his or her test performance deviates from the standardization-sample mean. In this way, the IQ indicates whether the individual is ahead, behind, or on time (average) in mental development in relation to others of the same age. The IQs of 96 percent of individuals fall between 70 and 130; only a few achieve higher or lower scores.

Predicting Later Performance from Infant Tests. Despite careful construction, most infant tests—including previous editions of the Bayley—predict later intelligence poorly. Infants and toddlers easily become distracted, fatigued, or bored...
during testing, so their scores often do not reflect their true abilities. And infant perceptual and motor items differ from the tasks given to older children, which increasingly emphasize verbal, conceptual, and problem-solving skills. In contrast, the Bayley-III Cognitive and Language Scales, which better dovetail with childhood tests, are good predictors of preschool mental test performance (Albers & Grieve, 2007).

Most infant tests are better at making long-term predictions for extremely low-scoring babies. Today, they are largely used for screening—helping to identify for intervention babies who are likely to have developmental problems.

As an alternative to infant tests, some researchers have turned to information-processing measures, such as habituation, to assess early mental progress. Their findings show that speed of habituation and recovery to novel visual stimuli are among the best available infant predictors of IQ from early childhood through early adulthood (Fagan, Holland, & Wheeler, 2007; Kavšek, 2004; McCall & Carriger, 1993). Habituation and recovery seem to be an especially effective early index of intelligence because they assess memory as well as quickness and flexibility of thinking, which underlie intelligent behavior at all ages (Colombo, 2002; Colombo et al., 2004). The consistency of these findings has prompted designers of the Bayley-III to include items that tap such cognitive skills as habituation, object permanence, and categorization.

Early Environment and Mental Development

In Chapter 2, we indicated that intelligence is a complex blend of hereditary and environmental influences. As we consider evidence on the relationship of environmental factors to infant and toddler mental test scores, you will encounter findings that highlight the role of heredity as well.

Home Environment. The Home Observation for Measurement of the Environment (HOME) is a checklist for gathering information about the quality of children’s home lives through observation and parental interview (Caldwell & Bradley, 1994). Factors measured by HOME during the first three years include an organized, stimulating physical setting and parental affection, involvement, and encouragement. Regardless of SES and ethnicity, each predicts better language and IQ scores in toddlerhood and early childhood (Linver, Martin, & Brooks-Gunn, 2004; Tamis-LeMonda et al., 2004; Tong et al., 2007). The extent to which parents talk to infants and toddlers is particularly important. It contributes strongly to early language progress, which, in turn, predicts intelligence and academic achievement in elementary school (Hart & Risley, 1995).

Yet we must interpret these correlational findings cautiously. In all the studies, children were reared by their biological parents. Parents who are genetically more intelligent may provide better experiences while also giving birth to genetically brighter children, who evoke more stimulation from their parents. Research supports this hypothesis, which refers to gene-environment correlation (see Chapter 2, page 55) (Saudino & Plomin, 1997). But heredity does not account for the entire association between home environment and mental test scores.

Family living conditions—both HOME scores and affluence of the surrounding neighborhood—continue to predict children’s IQ beyond the contribution of parental IQ and education (Chase-Lansdale et al., 1997; Klebanov et al., 1998).

How can the research summarized so far help us understand Vanessa’s concern about Timmy’s development? Ben, the psychologist who tested Timmy, found that he scored only slightly below average. Ben talked with Vanessa about her child-rearing practices and watched her play with Timmy. A single parent who worked long hours, Vanessa had little energy for Timmy at the end of the day. Ben also noticed that Vanessa, anxious about Timmy’s progress, tended to pressure him, dampening his active behavior and bombarding him with directions: “That’s enough ball play. Stack these blocks.”

Ben explained that when parents are intrusive in these ways, infants and toddlers are likely to be distractible, play immaturely, and do poorly on mental tests (Bono & Stifter, 2003; Stilson & Harding, 1997). He coached Vanessa in how to interact sensi-
Applying What We Know

Signs of Developmentally Appropriate Infant and Toddler Child Care

<table>
<thead>
<tr>
<th>Program Characteristics</th>
<th>Signs of Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical setting</td>
<td>Indoor environment is clean, in good repair, well-lighted, well-ventilated, and not overcrowded. Fenced outdoor play space is available.</td>
</tr>
<tr>
<td>Toys and equipment</td>
<td>Play materials are age-appropriate and placed on low shelves within easy reach. Cribs, highchairs, infant seats, and child-sized tables and chairs are available. Outdoor equipment includes riding toys, swings, slide, and sandbox.</td>
</tr>
<tr>
<td>Caregiver–child ratio</td>
<td>In child-care centers, caregiver–child ratio is no greater than 1 to 3 for infants and 1 to 6 for toddlers. Group size (number of children in one room) is no greater than 6 infants with 2 caregivers and 12 toddlers with 2 caregivers. In family child care, caregiver is responsible for no more than 6 children; within this group, no more than 2 are infants and toddlers.</td>
</tr>
<tr>
<td>Daily activities</td>
<td>Daily schedule includes times for active play, quiet play, naps, snacks, and meals. Atmosphere is warm and supportive, and children are never left unsupervised.</td>
</tr>
<tr>
<td>Interactions among adults and children</td>
<td>Caregivers respond promptly to infants' and toddlers' distress; hold, talk to, sing to, and read to them; and interact in a manner that respects each child's interests and tolerance for stimulation. Staffing is consistent, so infants and toddlers can form relationships with particular caregivers.</td>
</tr>
<tr>
<td>Caregiver qualifications</td>
<td>Caregiver has some training in child development, first aid, and safety.</td>
</tr>
<tr>
<td>Relationships with parents</td>
<td>Parents are welcome anytime. Caregivers talk frequently with parents about children's behavior and development.</td>
</tr>
<tr>
<td>Licensing and accreditation</td>
<td>Child-care setting is licensed by the state. In the United States, voluntary accreditation by the National Association for the Education of Young Children (<a href="http://www.naeyc.org/academy">www.naeyc.org/academy</a>), or the National Association for Family Child Care (<a href="http://www.nafcc.org">www.nafcc.org</a>) is evidence of an especially high-quality program.</td>
</tr>
</tbody>
</table>

Sources: Copple & Bredekamp, 2009.

Infant and Toddler Child Care. Today, more than 60 percent of U.S. mothers with a child under age 2 are employed (U.S. Census Bureau, 2013). Child care for infants and toddlers has become common, and its quality—though not as influential as parenting—affects mental development. Infants and young children exposed to poor-quality child care score lower on measures of cognitive and social skills (Belsky et al., 2007b; Hausfather et al., 1997; NICHD Early Child Care Research Network, 2000b, 2001, 2003b, 2006). In contrast, good child care can reduce the negative impact of a stressed, poverty-stricken home life, and it sustains the benefits of growing up in an economically advantaged family (Lamb & Ahnert, 2006; McCartney et al., 2007; NICHD Early Child Care Research Network, 2003b).

Unlike most European countries and Australia and New Zealand, where child care is nationally regulated and funded to ensure its quality, reports on U.S. child care raise serious concerns. Standards are set by the states and vary widely. In studies of quality, only 20 to 25 percent of U.S. child-care centers and family child-care homes provided infants and toddlers with sufficiently positive, stimulating experiences to promote healthy psychological development (NICHD Early Childhood Research Network, 2000a, 2004).

LOOK AND LISTEN

Ask several employed parents of infants or toddlers to describe what they sought in a child-care setting. Are the parents knowledgeable about the ingredients of high-quality care?

U.S. settings providing the very worst care tend to serve middle-SES families. These parents are especially likely to place their children in for-profit centers, where quality tends to be lowest. Low-SES children more often attend publicly subsidized, nonprofit centers, which have smaller group sizes and better teacher–child ratios (Lamb & Ahnert, 2006). Still, child-care quality for low-SES children varies widely. And probably because of greater access to adult stimulation, infants and toddlers in high-quality family child care score higher than those in center care in cognitive and language development (NICHD Early Child Care Research Network, 2000b).

See Applying What We Know above for signs of high-quality care for infants and toddlers, based on standards for...
developmentally appropriate practice. These standards, devised by the U.S. National Association for the Education of Young Children, specify program characteristics that serve young children's developmental and individual needs, based on both current research and consensus among experts.

Good child care is a cost-effective means of protecting children's well-being. And much like the programs we are about to consider, it can serve as effective early intervention for children whose development is at risk.

**Early Intervention for At-Risk Infants and Toddlers**

Children living in poverty are likely to show gradual declines in intelligence test scores and to achieve poorly when they reach school age—problems largely due to stressful home environments that undermine children's ability to learn and increase the likelihood that they will remain poor as adults (McLoyd, Aikens, & Burton, 2006). A variety of intervention programs have been developed to break this tragic cycle of poverty. Although most begin during the preschool years, a few start during infancy and continue through early childhood.

In center-based interventions, children attend an organized child-care or preschool program where they receive educational, nutritional, and health services, and their parents receive child-rearing and other social service supports. In home-based interventions, a skilled adult visits the home and works with parents, teaching them how to stimulate a very young child's development. In most programs of either type, participating children score higher than untreated controls on mental tests by age 2. The earlier intervention begins, the longer it lasts, and the greater its scope and intensity, the better participants' cognitive and academic performance is throughout childhood and adolescence (Brooks-Gunn, 2004; Ramey, Ramey, & Lanzi, 2006).

The Carolina Abecedarian Project illustrates these favorable outcomes. In the 1970s, more than 100 infants from poverty-stricken families, ranging in age from 3 weeks to 3 months, were randomly assigned to either a treatment group or a control group. Treatment infants were enrolled in full-time, year-round child care through the preschool years. There they received stimulation aimed at promoting motor, cognitive, language, and social skills and, after age 3, literacy and math concepts. Special emphasis was placed on rich, responsive adult-child verbal communication. All children received nutrition and health services; the primary difference between treatment and controls was the intensive child-care experience.

As Figure 5.7 shows, treatment children sustained an IQ advantage from 12 months until last tested, at age 21. In addition, throughout their school years, treatment youths achieved considerably higher scores in reading and math. These gains translated into more years of schooling completed, higher rates of college enrollment and employment in skilled jobs, and lower rates of drug use and adolescent parenthood (Campbell et al., 2001, 2002; Campbell & Ramey, 2010).

Recognition of the power of intervening as early as possible led the U.S. Congress to provide limited funding for services directed at infants and toddlers who already have serious developmental problems or who are at risk for problems because of poverty. Early Head Start, begun in 1995, currently has 1,000 sites serving about 100,000 low-income children and their families (Early Head Start National Resource Center, 2013). A recent evaluation, conducted when children reached age 3, showed that intervention led to warmer, more stimulating parenting, a reduction in harsh discipline, gains in cognitive and language development, and lessening of child aggression (Love...
et al., 2005; Love, Chazan-Cohen, & Raikes, 2007; Raikes et al., 2010). The strongest effects occurred at sites mixing center- and home-based services. Though not yet plentiful enough to meet the need, such programs are a promising beginning.

**ASK YOURSELF**

**REVIEW** What probably accounts for the finding that speed of habituation and recovery to novel visual stimuli predicts later IQ better than most infant mental test scores?

**APPLY** Fifteen-month-old Joey scored 115 on an infant and toddler intelligence test. His mother wants to know exactly what this means and what she should do to support his mental development. How would you respond?

**REFLECT** Suppose you were seeking a child-care setting for your baby. What would you want it to be like, and why?

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## Language Development

Improvements in perception and cognition during infancy pave the way for an extraordinary human achievement—language. In Chapter 4, we saw that by the second half of the first year, infants make dramatic progress in distinguishing the basic sounds of their language and in segmenting the flow of speech into word and phrase units. They also start to comprehend some words and, around 12 months of age, say their first word. By age 6, children understand the meaning of about 10,000 words and speak in elaborate sentences.

How do infants and toddlers make such remarkable progress in launching these skills? To address this question, let's examine several prominent theories of language development.

### Theories of Language Development

In the 1950s, researchers did not take seriously the idea that very young children might be able to figure out important properties of language. Children's regular and rapid attainment of language milestones suggested a process largely governed by maturation, inspiring the nativist perspective on language development. In recent years, new evidence has spawned the interactionist perspective, which emphasizes the joint roles of children's inner capacities and communicative experiences.

**The Nativist Perspective.** According to linguist Noam Chomsky's (1957) nativist theory, language is etched into the structure of the brain. Focusing on grammar, Chomsky reasoned that the rules of sentence organization are too complex to be directly taught to or discovered by even a cognitively sophisticated young child. Rather, he proposed that all children have a **language acquisition device (LAD),** an innate system that contains a **universal grammar,** or set of rules common to all languages. It enables children, no matter which language they hear, to understand and speak in a rule-oriented fashion as soon as they pick up enough words.

Are children biologically primed to acquire language? Recall from Chapter 4 that newborn babies are remarkably sensitive to speech sounds. And children everywhere reach major language milestones in a similar sequence. Furthermore, evidence that childhood is a **sensitive period** for language acquisition is consistent with Chomsky's idea of a biologically based language program. Researchers have examined the language competence of deaf adults who acquired their first language—American Sign Language (ASL), a gestural system used by the deaf—at different ages. The later learners, whose parents chose to educate them through speech and lip-reading, did not acquire spoken language because of their profound deafness. Consistent with the sensitive-period notion, those who learned ASL in adolescence or adulthood never became as proficient as those who learned in childhood (Mayberry, 2010; Newport, 1991; Singleton & Newport, 2004).

But challenges to Chomsky's theory suggest that it, too, provides only a partial account of language development. First, researchers have had great difficulty specifying Chomsky's universal grammar. Critics doubt that one set of rules can account for the extraordinary variation in grammatical forms among the world's 5,000 to 8,000 languages (Christiansen & Chater, 2008; Evans & Levinson, 2009). Second, children's progress in mastering many sentence constructions is gradual, with errors along the way, indicating more learning and discovery than Chomsky assumed (Tager-Flusbert & Zukowski, 2009).

**The Interactionist Perspective.** Recent ideas about language development emphasize **interactions** between inner capacities and environmental influences. One type of interactionist theory applies the information-processing perspective to language development. A second type emphasizes social interaction.

Some information-processing theorists assume that children make sense of their complex language environments by applying powerful cognitive capacities of a general kind (Bates, 2004; Munakata, 2006; Saffran, 2009). These theorists note that brain regions housing language also govern similar perceptual and cognitive abilities, such as the capacity to analyze musical and visual patterns (Saygin, Leech, & Dick, 2010).

Other theorists blend this information-processing view with Chomsky's nativist perspective. They argue that infants' capacity to analyze speech and other information is not sufﬁcient to account for mastery of higher-level aspects of language, such as intricate grammatical structures (Aslin & Newport, 2009). They also point out that grammatical competence may depend more on specific brain structures than the other components of language. When 2- to 2½-year-olds and adults listened to short sentences—some grammatically correct, others with phrase-structure violations—both groups showed simi-
larly distinct ERP brain‐wave patterns for each sentence type in the left frontal and temporal lobes of the cerebral cortex (Oberecker & Friederici, 2006; Oberecker, Friedrich, & Friederici, 2005). This suggests that 2‐year‐olds process sentence structures using the same neural system as adults do.

Still other interactionists emphasize that social skills and language experiences are centrally involved in language development. In this social‐interactionist view, an active child strives to communicate, cuing caregivers to provide appropriate language experiences, which help the child relate the content and structure of language to its social meanings (Bohannon & Bonvillian, 2009). Among social interactionists, disagreement continues over whether or not children are equipped with specialized language abilities (Lidz, 2007; Shatz, 2007; Tomasello, 2003, 2006). Never theless, as we chart the course of language development, we will encounter much support for their central premise—that children's social competencies and language experiences greatly affect their progress.

Getting Ready to Talk

Before babies say their first word, they make impressive language progress. They listen attentively to human speech, and they make speechlike sounds. As adults, we can hardly help but respond.

Cooing and Babbling. Around 2 months, babies begin to make vowel‐like noises, called cooing because of their pleasant “oo” quality. Gradually, consonants are added, and around 6 months, babbling appears, in which infants repeat consonant‐vowel combinations in long strings, such as “bababababa” or “nanananana.” Babies everywhere (even those who are deaf) start babbling at about the same age and produce a similar range of early sounds. But for babbling to develop further, infants must be able to hear human speech. In hearing‐impaired babies, these speechlike sounds are greatly delayed. And a deaf infant not exposed to sign language will stop babbling entirely (Oller, 2000).

As infants listen to spoken language, babbling expands to a broader range of sounds. Around 7 months, it starts to include many sounds common in spoken languages (Goldstein & Schwade, 2008). By 10 months, babbling reflects the sound and intonation patterns of children's language community (Boysson‐Bardies & Vihman, 1991).

Deaf infants exposed to sign language from birth and hearing babies of deaf, signing parents produce babblelike hand motions with the rhythmic patterns of natural sign languages (Petitto et al., 2001, 2004; Petitto & Marentette, 1991). This sensitivity to language rhythm—evident in both spoken and signed babbling—supports both discovery and production of meaningful language units.

Becoming a Communicator. At birth, infants are prepared for some aspects of conversational behavior. For example, newborns initiate interaction through eye contact and terminate it by looking away. By 3 to 4 months, infants start to gaze in the same general direction adults are looking—a skill that becomes more accurate at 10 to 11 months, as babies realize that others’ focus offers information about their communicative intentions (Senju, Csiobra, & Johnson, 2008). This joint attention, in which the child attends to the same object or event as the caregiver, contributes greatly to early language development. Infants and toddlers who frequently experience it sustain attention longer, comprehend more language, produce meaningful gestures and words earlier, and show faster vocabulary development (Brooks & Meltzoff, 2008; Flom & Pick, 2003; Silvén, 2001).

Between 4 and 6 months, interactions between caregivers and babies begin to include give‐and‐take, as in pat‐a‐cake and peekaboo games. At first, the parent starts the game and the baby is an amused observer. By 12 months, babies participate actively, practicing the turn‐taking pattern of conversation. Infants’ play maturity and vocalizations during games predict advanced language progress in the second year (Rome‐Flanders & Cronk, 1995).

At the end of the first year, babies use preverbal gestures to direct adults’ attention, to influence their behavior, and to convey helpful information (Tomasello, Carpenter, & Liszkowski, 2007). For example, Caitlin held up a toy to show it and pointed to the cupboard when she wanted a cookie. Carolyn responded to these gestures and also labeled them (“You want a cookie!”). In this way, toddlers learn that using language leads to desired results. Soon they integrate words with gestures, as in pointing...
to a toy while saying “give.” The earlier toddlers form word–gesture combinations, the faster their vocabulary growth, the sooner they produce two-word utterances at the end of the second year, and the more complex their sentences at age 3½ (Özçaliskan & Goldin-Meadow, 2005; Rowe & Goldin-Meadow, 2009).

First Words

In the second half of the first year, infants begin to understand word meanings. First spoken words, around 1 year, build on the sensorimotor foundations Piaget described and on categories children have formed. In a study tracking the first 10 words used by several hundred U.S. and Chinese (both Mandarin- and Cantonese-speaking) babies, important people (“Mama,” “Dada”), common objects (“ball,” “bread”), and sound effects (“woof-woof,” “vroom”) were mentioned most often. Action words (“hit,” “grab,” “hug”) and social routines (“hi,” “bye”), though also appearing in all three groups, were more often produced by Chinese than U.S. babies, and the Chinese babies also named more important people—differences we will consider shortly (Tardif et al., 2008).

When toddlers first learn words, they sometimes apply them too narrowly, an error called underextension. At 16 months, Caitlin used “bear” only to refer to the tattered bear she carried nearly constantly. As vocabulary expands, a more common error is overextension—applying a word to a wider collection of objects and events than is appropriate. For example, Grace used “car” for buses, trains, and trucks. Toddlers’ overextensions reflect their sensitivity to categories (MacWhinney, 2005). They apply a new word to a group of similar experiences, often overextending deliberately because they have difficulty recalling or have not acquired a suitable word.

Overextensions illustrate another important feature of language development: the distinction between language production (the words children use) and language comprehension (the words they understand). At all ages, comprehension develops ahead of production. Still, the two capacities are related. The speed and accuracy of toddlers’ comprehension of spoken language, which increases dramatically over the second year, predicts words understood and produced at age 2 (Fernald, Perfors, & Marchman, 2006). Quick comprehension frees space in working memory for picking up new words and for the more demanding task of using them to communicate.

The Two-Word Utterance Phase

Young toddlers add to their spoken vocabularies at a rate of one to three words per week. Gradually, the number of words learned accelerates. Because gains in word production between 18 and 24 months are so impressive (one or two words per day), many researchers concluded that toddlers undergo a spurt in vocabulary—a transition from a slower to a faster learning phase. But recent evidence indicates that most children show a steady increase in rate of word learning that continues through the preschool years (Ganger & Brent, 2004).

Once toddlers produce 200 to 250 words, they start to combine two words: “Mommy shoe,” “go car,” “more cookie.” These two-word utterances are called telegraphic speech because, like a telegram, they focus on high-content words, omitting smaller, less important ones. Children the world over use them to express an impressive variety of meanings.

Two-word speech consists largely of simple formulas (“more + X,” “eat + X”), with different words inserted in the “X” position. Toddlers rarely make gross grammatical errors, such as saying “chair my” instead of “my chair.” Rather than following grammatical rules, toddlers’ word-order regularities are usually copies of adult word pairings, as when the parents says, “How about more sandwich?” (Tomasello, 2006; Tomasello & Brandt, 2009).

Individual and Cultural Differences

Although children typically produce their first word around their first birthday, the range is large, from 8 to 18 months—variation due to a complex blend of genetic and environmental influences. Earlier we saw that Timmy’s spoken language was delayed, in part because of Vanessa’s tense, directive communication with him. But Timmy is also a boy, and many studies show that girls are slightly ahead of boys in early vocabulary growth (Van Hulle, Goldsmith, & Lemery, 2004). The most common explanation is girls’ faster rate of physical maturation,
believed to promote earlier development of the left cerebral hemisphere.

Temperament matters, too. Shy toddlers often wait until they understand a great deal before trying to speak. Once they do speak, their vocabularies increase rapidly, although they remain slightly behind their agemates (Spere et al., 2004). Temperamentally negative toddlers also acquire language more slowly because their high emotional reactivity diverts them from processing linguistic information (Salley & Dixon, 2007).

The quantity of caregiver–child conversation and richness of adults’ vocabularies also play a strong role (Zimmerman et al., 2009). Commonly used words for objects appear early in toddlers’ speech, and the more often their caregivers use a particular noun, the sooner young children produce it (Goodman, Dale, & Li, 2008). Mothers talk more to toddler-age girls than to boys, and parents converse less often with shy than with sociable children (Leaper, Anderson, & Sanders, 1998; Patterson & Fisher, 2002).

Low-SES children, who receive less verbal stimulation in their homes than higher-SES children, usually have smaller vocabularies (Hoff, 2006). Limited parent–child book reading is a major factor. On average, a middle-SES child is read to for 1,000 hours between 1 and 5 years, a low-SES child for only 25 hours (Neuman, 2003). As a result, low-SES kindergartners have vocabularies only one-fourth as large as those of their higher SES agemates (Lee & Burkam, 2002). And low-income children are also behind in early literacy knowledge and later reading achievement, as we will see in Chapter 7.

Furthermore, 2-year-olds’ spoken vocabularies vary substantially across languages—about 180 to 200 words for children acquiring Swedish, 250 to 300 words for children acquiring English, and 500 words for children acquiring Mandarin Chinese (Bleses et al., 2008; Tardif et al., 2009). In Swedish, a complicated system of speech sounds makes syllable and word boundaries challenging to discriminate and pronounce. In contrast, Mandarin Chinese has many short words with easy-to-pronounce initial consonants. Within Mandarin words, each syllable is given one of four distinct tones, aiding discrimination.

Supporting Early Language Development

Consistent with the interactionist view, a rich social environment builds on young children’s natural readiness to acquire language. Adults in many cultures speak to babies in infant-directed speech (IDS), a form of communication made up of short sentences with high-pitched, exaggerated expression, clear pronunciation, distinct pauses between speech segments, and repetition of new words in a variety of contexts (“See the ball.” “The ball bounced!”) (Fernald et al., 1989; O’Neill et al., 2005). Deaf parents use a similar style of communication when signing to their deaf babies (Masataka, 1996). IDS builds on several communicative strategies we have already considered: joint attention, turn-taking, and caregivers’ sensitivity to toddlers’ preverbal gestures. In this example, Carolyn uses IDS with 18-month-old Caitlin:

Caitlin: “Go car.”
Carolyn: “Yes, time to go in the car. Where’s your jacket?”
Caitlin: [Looks around, walks to the closet.] “Dacket!” [Points to her jacket.]
Carolyn: “There’s that jacket! [She helps Caitlin into the jacket.] Now, say bye-bye to Grace and Timmy.”
Carolyn: “Where’s your bear?”
Caitlin: [Looks around.]
Carolyn: [Pointing.] “See? By the sofa.”

From birth on, infants prefer IDS over other adult talk, and by 5 months they are more emotionally responsive to it (Aslin, Jusczyk, & Pisoni, 1998). Parents constantly fine-tune the length and content of their utterances to fit their children’s needs—adjustments that foster word learning and enable toddlers to join in (Cameron-Faulkner, Lieven, & Tomasello, 2003; Rowe, 2008).

Look and Listen

While observing a parent and toddler playing, describe how the parent adapts his or her language to the child’s needs. Did the parent use IDS? ●

Do social experiences that promote language development remind you of those that strengthen cognitive development in general? IDS and parent–child conversation create a zone of proximal development in which children’s language expands. In the next chapter, we will see that sensitivity to children’s needs and capacities supports their emotional and social development as well.

Ask Yourself

Review Describe evidence that supports the social interactionist perspective on language development.

Apply Fran frequently corrects her 17-month-old son Jeremy’s attempts to talk and—fearing that he won’t use words—refuses to respond to his gestures. How might Fran be contributing to Jeremy’s slow language progress?

Reflect Find an opportunity to speak to an infant or toddler. Did you use IDS? What features of your speech are likely to promote early language development, and why?
Piaget's Cognitive-Developmental Theory (p. 118)

According to Piaget, how do schemes change over the course of development?

- By acting on the environment, children move through four stages in which psychological structures, or schemes, achieve a better fit with external reality.
- Schemes change in two ways: through adaptation, which is made up of two complementary activities—assimilation and accommodation—and through organization.

Describe the major cognitive achievements of the sensorimotor stage.

- In the sensorimotor stage, the circular reaction provides a means of adapting first schemes, and the newborn's reflexes gradually transform into the flexible action patterns of the older infant. Eight- to 12-month-olds develop intentional, or goal-directed, behavior and begin to understand object permanence.
- Between 18 and 24 months, mental representation is evident in mastery of object permanence problems involving invisible displacement, deferred imitation, and make-believe play.
- What does follow-up research reveal about the accuracy of Piaget's sensorimotor stage?
  - Many studies suggest that infants display certain understandings earlier than Piaget believed. Some awareness of object permanence, as revealed by the violation-of-expectation method and object-track monitoring, may be evident in the first few months.
  - Around the first birthday, babies understand displaced reference of words. By the middle of the second year, toddlers treat realistic-looking pictures symbolically; around 2 1/2 years, they grasp the symbolic meaning of video.
  - Today, researchers believe that newborns have more built-in equipment for making sense of their world than Piaget assumed, although they disagree on how much initial understanding infants have. According to the core knowledge perspective, infants are born with core domains of thought that support early, rapid cognitive development. Research suggests that infants have basic physical, linguistic, psychological, and numerical knowledge.
  - Broad agreement exists that many cognitive changes of infancy are continuous rather than stagelike and that various aspects of cognition develop unevenly rather than in an integrated fashion.

Information Processing (p. 126)

Describe the information-processing view of cognitive development.

- Most information-processing researchers assume that we hold information in three parts of the mental system for processing: the sensory register, the short-term memory store, and long-term memory. The central executive joins with working memory—our “mental workspace”—to process information effectively, increasing the chances that it will transfer to our permanent knowledge base. Well-learned automatic processes require no space in working memory, permitting us to focus on other information while performing them.
- Gains in executive function—including attention, impulse control, and coordinating information in working memory—are under way in the first two years.

What changes in attention, memory, and categorization take place during the first two years?

- With age, infants attend to more aspects of the environment and take information in more quickly. In the second year, attention to novelty declines and sustained attention improves.
- Young infants are capable of recognition memory. By the second half of the first year, they also engage in recall.
- Infants group stimuli into increasingly complex categories, and toddlers’ categorization gradually shifts from a perceptual to a conceptual basis. Understanding of the animate–inanimate distinction expands during toddlerhood.

Describe contributions and limitations of the information-processing approach to our understanding of early cognitive development.

- Information-processing findings reveal remarkable similarities between babies’ and adults’ thinking. But information processing has not yet provided a broad, comprehensive theory of children’s thinking.

The Social Context of Early Cognitive Development (p. 130)

How does Vygotsky’s concept of the zone of proximal development expand our understanding of early cognitive development?

- Vygotsky believed that infants master tasks within the zone of proximal development—one step ahead of their current capacities—through the guidance of more skilled partners. As early as the first year, cultural variations in social experiences affect mental strategies.

Individual Differences in Early Mental Development (p. 132)

Describe the mental testing approach and the extent to which infant tests predict later performance.

- The mental testing approach measures intellectual development in an effort to predict future performance. Scores are arrived at by computing an intelligence quotient (IQ), which compares an individual’s test performance with that of a standardization sample of same-age individuals, whose scores form a normal distribution.
- Infant tests consisting largely of perceptual and motor responses predict later intelligence poorly. Speed of habituation and recovery to visual stimuli are better predictors of future performance.
Discuss environmental influences on early mental development and early intervention for at-risk infants and toddlers.

- Research with the Home Observation for Measurement of the Environment (HOME) shows that an organized, stimulating home environment and parental encouragement, involvement, and affection repeatedly predict early mental test scores. Although the HOME–IQ relationship is partly due to heredity, family living conditions also affect mental development.

- Quality of infant and toddler child care has a major impact on mental development. Standards for developmentally appropriate practice specify program characteristics that meet young children’s developmental needs.

Intensive intervention beginning in infancy and extending through early childhood can prevent the gradual declines in intelligence and poor academic performance of many poverty-stricken children.

Language Development (p. 136)

Describe theories of language development, and indicate how much emphasis each places on innate abilities and environmental influences.

- Chomsky’s nativist theory regards children as naturally endowed with a language acquisition device (LAD). Consistent with this perspective, mastery of a complex language system is unique to humans, and childhood is a sensitive period for language acquisition.

- Recent theories view language development as resulting from interactions between inner capacities and environmental influences. Some interactionists apply the information-processing perspective to language development. Others emphasize children’s social skills and language experiences.

Describe major language milestones of the first two years, individual differences, and ways adults can support early language development.

- Infants begin cooing at 2 months and babbling at about 6 months. Around 10 to 11 months, their skill at establishing joint attention improves, and soon they use preverbal gestures. Adults can encourage language progress by responding to infants’ coos and babbles, playing turn-taking games, establishing joint attention and labeling what babies see, and responding verbally to their preverbal gestures.

- Around 12 months, toddlers say their first word. Young children often make errors of underextension and overextension. Once vocabulary reaches 200 to 250 words, two-word utterances called telegraphic speech appear. At all ages, language comprehension is ahead of production.

- Girls show faster language progress than boys. Reserved, cautious toddlers may wait before trying to speak, and temperamentally negative toddlers also acquire language more slowly. Low-SES children, whose homes tend to be less verbally stimulating, typically have smaller vocabularies.

- Adults in many cultures speak to young children in infant-directed speech (IDS), a simplified form of language that is well suited to their learning needs. Parent–toddler conversation is a good predictor of language development and later reading success.

Important Terms and Concepts

accommodation (p. 119)  
adaptation (p. 118)  
assimilation (p. 118)  
autobiographical memory (p. 129)  
automatic processes (p. 127)  
babbling (p. 137)  
central executive (p. 127)  
circular reaction (p. 119)  
cooing (p. 137)  
core knowledge perspective (p. 125)  
deferred imitation (p. 121)  
developmentally appropriate practice (p. 135)  
displaced reference (p. 123)  
executive function (p. 127)  
Home Observation for Measurement of the Environment (HOME) (p. 133)  
infant-directed speech (IDS) (p. 139)  
infantile amnesia (p. 129)  
intelligence quotient (IQ) (p. 132)  
intentional, or goal-directed, behavior (p. 120)  
joint attention (p. 137)  
language acquisition device (LAD) (p. 136)  
long-term memory (p. 127)  
make-believe play (p. 121)  
mental representation (p. 120)  
normal distribution (p. 132)  
object permanence (p. 120)  
orGANIZATION (p. 119)  
overextension (p. 138)  
recall (p. 128)  
recognition (p. 128)  
scheme (p. 118)  
sensorimotor stage (p. 118)  
sensory register (p. 26)  
short-term memory store (p. 126)  
standardization (p. 132)  
telegraphic speech (p. 138)  
underextension (p. 38)  
video deficit effect (p. 124)  
violation-of-expectation method (p. 121)  
working memory (p. 126)  
zone of proximal development (p. 130)