Development Through the Lifespan, 6/e

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chapter 5

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.

Cognitive Development in Infancy and Toddlerhood

chapter outline

When Caitlin, Grace, and Timmy gathered at Ginette's child-care home, the playroom was alive with activity. The three spirited explorers, each nearly 18 months old, were bent on discovery. 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. Meanwhile, Caitlin pulled open a drawer, unloaded a set of wooden bowls, stacked them in a pile, knocked it over, and then banged two bowls together.

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. "Bye-bye," Grace chimed in, waving as the ball disappeared from sight. Later that day, Grace revealed the beginnings of make-believe. "Night-night," she said, putting her head down and closing her eyes, ever so pleased that she could decide for herself when and where to go to bed.

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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 their thinking. Throughout development, cognition and language mutually support each other.

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. Influenced by his background in biology, Piaget believed that the child's mind forms and modifies psychological structures so they achieve a better fit with external reality. Recall from Chapter 1 that in Piaget's theory, children move through four stages between infancy and adolescence. During these stages, all aspects of cognition develop in an integrated fashion, changing in a similar way at about the same time.

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. To appreciate Piaget's view of how these vast changes take place, let's consider some important concepts.

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 or teething ring 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.

TAKE A MOMENT... 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 sensorimotor "dropping scheme." In **accommodation,** we create new schemes or adjust old ones after noticing that our current ways of thinking do not capture the environment completely. When Timmy dropped objects in different ways, he modified his dropping scheme to take account of the varied properties of objects.

According to Piaget, the balance between assimilation and accommodation varies over time. When children are not changing much, they assimilate more than they accommodate—a steady, comfortable state that Piaget called cognitive *equilibrium*. During rapid cognitive change, however, children are in a state of *disequilibrium,* or cognitive discomfort. Realizing that new information does not match their current schemes, they shift from assimilation toward accommodation. After modifying their schemes, they move back toward assimilation, exercising their newly changed structures until they are ready to be modified again.

In Piaget's theory, first schemes are sensorimotor action patterns. As this 11-month-old repeatedly experiments with her dropping scheme, her dropping behavior becomes more deliberate and varied.

Each time this back-and-forth movement between equilibrium and disequilibrium occurs, more effective schemes are produced. Because the times of greatest accommodation are the earliest ones, the sensorimotor stage is Piaget's most complex period of development.

Organization.

Schemes also change through **organization,** a process that takes place internally, apart from direct contact with the environment. Once children form new schemes, they rearrange them, linking them with other schemes to create a strongly interconnected cognitive system. For example, eventually Timmy will relate "dropping" to "throwing" and to his developing understanding of "nearness" and "farness." According to Piaget, schemes truly reach equilibrium when they become part of a broad network of structures that can be jointly applied to the surrounding world (Piaget, 1936/1952).

In the following sections, we will first describe infant development as Piaget saw it, noting research that supports his observations. Then we will consider evidence demonstrating that, in some ways, babies' cognitive competence is more advanced than Piaget believed.

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 his own three children—a very small sample. He observed his son and two daughters carefully and also 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. Finding the sound intriguing, she tried to repeat it until she became quite expert at smacking her lips.

The circular reaction initially centers on the infant's own body but later turns outward, toward manipulation of objects. In the second year, it becomes experimental and creative, aimed at producing novel outcomes. 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.

This 3-month-old tries to repeat a newly discovered action—sucking her toes—in a primary circular reaction that helps her gain voluntary control over her behavior.

Repeating Chance Behaviors. Piaget saw newborn reflexes as the building blocks of sensorimotor intelligence. In Substage 1, babies suck, grasp, and look in much the same way, no matter what experiences they encounter. In one amusing example, Carolyn described how 2-week-old Caitlin lay on the bed next to her sleeping father. Suddenly, he awoke with a start. Caitlin had latched on and begun to suck on his back!

Around 1 month, as babies enter Substage 2, they 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 in this substage 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 crying as soon as Vanessa entered the room—a signal that feeding time was near.

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

SENSORIMOTOR SUBSTAGE	TYPICAL ADAPTIVE BEHAVIORS
1. Reflexive schemes (birth–1 month)	Newborn reflexes (see Chapter 3, page 107)
2. Primary circular reactions (1–4 months)	Simple motor habits centered around the infant's own body; limited anticipation of events
3. Secondary circular reactions (4–8 months)	Actions aimed at repeating interesting effects in the surrounding world; imitation of familiar behaviors
4. Coordination of secondary circular reactions (8–12 months)	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
5. Tertiary circular reactions (12–18 months)	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)
6. Mental representation (18 months–2 years)	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

During Substage 3, from 4 to 8 months, infants sit up and reach for and manipulate objects. These motor achievements strengthen the *secondary circular reaction,* through which babies try to repeat interesting events in the surrounding environment that are caused by their own actions. For example, 4-month-old Caitlin accidentally knocked a toy hung in front of her, producing a fascinating swinging motion. Over the next three days, Caitlin tried to repeat this effect, gradually forming a new "hitting" scheme. Improved control over their own behavior permits infants to imitate others' behavior more effectively. However, they usually cannot adapt flexibly and quickly enough to imitate novel behaviors. Therefore, although they enjoy watching an adult demonstrate a game of pat-a-cake, they are not yet able to participate.

Intentional Behavior. In Substage 4, 8- to 12-month-olds combine schemes into new, more complex action sequences. As a result, actions that lead to new schemes no longer have a hit-or-miss quality—*accidentally* bringing the thumb to the mouth or *happening* to hit the toy. Instead, 8- to 12-month-olds can engage in **intentional,** or **goal-directed, behavior,** coordinating schemes deliberately to solve simple problems. Consider Piaget's famous object-hiding task, in which he shows the baby an attractive toy and then hides it behind his hand or under a cover. Infants of this substage can find the object by coordinating two schemes—"pushing" aside the obstacle and "grasping" the toy. Piaget regarded these *means–end action sequences* as the foundation for all problem solving.

Retrieving hidden objects reveals that infants have begun to master **object permanence,** the understanding that objects continue to exist when out of sight. But this awareness is not yet complete. Babies still make the *A-not-B search error:* If they reach several times for an object at a first hiding place (A), then see it moved to a second (B), they still search for it in the first hiding place (A). Consequently, Piaget concluded, they do not have a clear image of the object as persisting when hidden from view.

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, push a toy car, or drop raisins into a cup (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. For example, Grace figured out how to fit a shape through a hole in a container by turning and twisting it until it fell through and how to use a stick to get toys that were out of reach. According to Piaget, this capacity to experiment leads to a more advanced understanding of object permanence. Toddlers 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—stacking blocks, scribbling on paper, and making funny faces.

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 become more efficient thinkers, organizing our diverse experiences into meaningful, manageable, and memorable units.

Piaget noted that 18- to 24-month-olds arrive at solutions suddenly rather than through trial-and-error behavior. In doing so, they seem to experiment with actions inside their heads—evidence that they can mentally represent their experiences. For example, at 19 months, Grace—after bumping her new push toy against a wall—paused for a moment as if to "think," then immediately turned the toy in a new direction.

Representation also 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 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.

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To find the toy hidden under the cloth, a 10-month-old engages in intentional, goal-directed behavior—the basis for all problem solving.

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, 2008). Let's examine this debate in light of recent evidence.

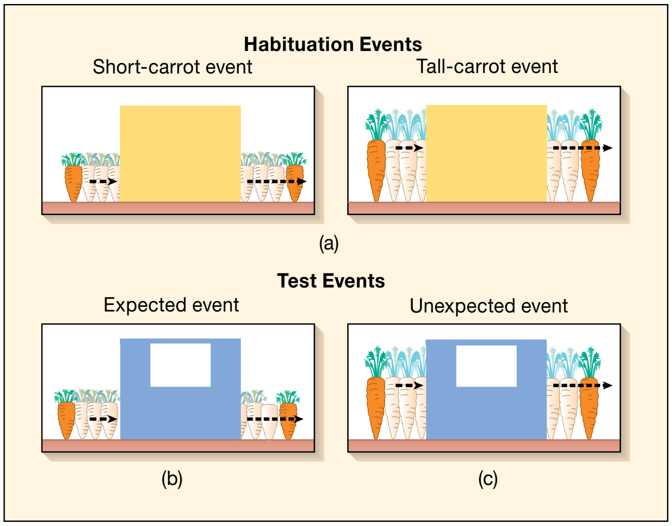

FIGURE 5.1 Testing young infants for understanding of object permanence using the violation-of-expectation method. (a) First, infants were habituated to two events: a short carrot and a tall carrot moving behind a yellow screen, on alternate trials. Next, the researchers presented two test events. The color of the screen was changed to help infants notice its window. (b) In the *expected event,* the carrot shorter than the window's lower edge moved behind the blue screen and reappeared on the other side. (c) In the *unexpected event,* the carrot taller than the window's lower edge moved behind the screen and did not appear in the window, but then emerged intact on the other side. Infants as young as 2½ to 3½ months looked longer at the *unexpected event,* suggesting that they had some understanding of object permanence. (Adapted from R. Baillargeon & J. DeVos, 1991, "Object Permanence in Young Infants: Further Evidence," *Child Development, 62,* p. 1230. © 1991, John Wiley and Sons. Adapted with permission of John Wiley and Sons.)

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 illustrates one of these studies (Aguiar & Baillargeon, 2002; Baillargeon & DeVos, 1991). After habituating to a short and a tall carrot moving behind a screen, infants were given two test events: (1) an *expected event,* in which the short carrot moved behind a screen, could not be seen in its window, and reappeared on the other side; and (2) an *unexpected event,* in which the tall carrot moved behind a screen, could not be seen in its window (although it was taller than the window's lower edge), and reappeared. Infants as young as 2½ to 3½ months looked longer at the unexpected event, suggesting that they had some awareness that an object moved behind a screen would continue to exist.

Additional violation-of-expectation studies yielded similar results, suggesting that infants look longer at a wide variety of unexpected events involving hidden objects (Newcombe, Sluzenski, & Huttenlocher, 2005; Wang, Baillargeon, & Paterson, 2005). Still, several researchers using similar procedures failed to confirm Baillargeon's findings (Cohen & Marks, 2002; Schöner & Thelen, 2006; Sirois & Jackson, 2012). And, as previously noted, critics question what babies' looking preferences tell us about what they actually understand.

But another type of looking behavior 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.

In related research, 6-month-olds' ERP brain-wave activity was recorded as the babies watched two events on a computer screen. In one event, a black square moved until it covered an object, then moved away to reveal the object (object permanence). In the other, as a black square began to move across an object, the object disintegrated (object disappearance) (Kaufman, Csibra, & Johnson, 2005). Only while watching the first event did the infants show a particular brain-wave pattern in the right temporal lobe—the same pattern adults exhibit when told to sustain a mental image of an object.

If young infants do have some notion of object permanence, how do we explain Piaget's finding that even babies capable of reaching do not try to search for hidden objects before 8 months of age? Consistent with Piaget's theory, searching for hidden objects is a true cognitive advance because infants solve some object-hiding tasks before others: Ten-month-olds search for an object placed on a table and covered by a cloth before they search for an object that a hand deposits under a cloth (Moore & Meltzoff, 1999). In the second, more difficult task, infants seem to expect the object to reappear in the hand from which it initially disappeared. When the hand emerges without the object, they conclude that there is no other place the object could be. Not until 14 months can most babies infer that the hand deposited the object under the cloth.

Once 8- to 12-month-olds search for hidden objects, they make the A-not-B search error. Some research suggests that they search at A (where they found the object previously) instead of B (its most recent location) because they have trouble inhibiting a previously rewarded response (Diamond, Cruttenden, & Neiderman, 1994). Another possibility is 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 complex, 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 3) (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, mastery of object permanence is a gradual achievement. Babies' understanding becomes increasingly complex with age: They must distinguish the object from the barrier concealing it, keep track of the object's whereabouts, and use this knowledge to obtain the object (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 imitation by noting when his three children demonstrated it in their everyday behavior. Under these conditions, a great deal must be known about the infant's daily life to be sure that deferred imitation—which requires infants to represent a model's past behavior—has occurred.

Laboratory research suggests that deferred imitation 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 imitate them (see Figure 5.2). And when researchers paired a second, motionless puppet with the first puppet a day before the demonstration, 6-month-olds generalized the novel actions to this new, very different-looking puppet (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 over the second year (Bauer, 2006; Rovee-Collier & Cuevas, 2009). And when toddlers imitate in correct sequence, they remember more behaviors (Knopf, Kraus, & Kressley-Mba, 2006).

Through deferred imitation, toddlers greatly expand their sensorimotor schemes. While imitating, this 2-year-old encounters a problem faced by all cookie bakers at one time or another.

COURTESY OF CAROLYN ROVEE-COLLIER

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.

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 first trying to use the door and finding it locked), 12-month-olds typically imitate the more efficient action (putting the dog through the door) (Schwier et al., 2006).

Between 14 and 18 months, toddlers become increasingly adept at imitating actions an adult *tries* to produce, even if these are not fully realized (Bellagamba, Camaioni, & Colonnesi, 2006; Olineck & Poulin-Dubois, 2007, 2009). On one occasion, Ginette attempted to pour some raisins into a bag but missed, spilling them onto the counter. 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, babies were given three similar problems, each requiring them to overcome a barrier, grasp a string, and pull it to get an attractive toy. The problems differed in many aspects of their superficial features—texture and color of the string, barrier, and floor mat and type of toy (horse, doll, or car). For the first problem, the parent demonstrated the solution and encouraged the infant to imitate. Babies obtained the toy more readily with each additional problem (Chen, Sanchez, & Campbell, 1997). Similarly, 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 most of the time (McCarty & Keen, 2005).

These findings reveal that at the end of the first year, infants form flexible mental representations of how to use tools to get objects. They have some ability to move beyond trial-and-error experimentation, represent a solution mentally, and use it in new contexts.

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. Observations of 12-month-olds reveal that they respond to the label of an absent toy by looking at and gesturing toward the spot where it usually rests (Saylor, 2004). As memory and vocabulary improve, skill at displaced reference expands.

But at first, toddlers have difficulty using language to acquire new information about an absent object—an ability that is essential to learn from symbols. In one study, an adult taught 19- and 22-month-olds a name for a stuffed animal—"Lucy" for a frog. Then, with the frog out of sight, the toddler was told that some water had spilled, so "Lucy's all wet!" Finally, the adult showed the toddler three stuffed animals—a wet frog, a dry frog, and a pig—and said, "Get Lucy!" (Ganea et al., 2007). Although all the children remembered that Lucy was a frog, only the 22-month-olds identified the wet frog as Lucy. This capacity to use language as a flexible symbolic tool—to modify and enrich existing mental representations—improves gradually into the preschool years.

Awareness of the symbolic function of pictures also emerges in the second year. Even newborns perceive a relation between a picture and its referent, as indicated by their preference for looking at a photo of their mother's face (see page 145 in Chapter 4). At the same time, infants do not treat pictures as symbols.

Rather, they touch, rub, and pat a color photo of an object, or pick it up and manipulate it. These behaviors, which reveal confusion about the picture's true nature, decline after 9 months, becoming rare around 18 months (DeLoache et al., 1988; DeLoache & Ganea, 2009).

As long as pictures strongly resemble real objects, by the middle of the second year toddlers treat them symbolically. After hearing a novel label ("blicket") applied to a color photo of an unfamiliar object, most 15- to 24-month-olds—when presented with both the real object and its picture and asked to indicate the "blicket"—gave a symbolic response. They selected either the real object or both the object and its picture, not the picture alone (Ganea et al., 2009). Around this time, toddlers increasingly use pictures as vehicles for communicating with others and acquiring new knowledge (Ganea, Bloom 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.

But even after coming to appreciate the symbolic nature of pictures, young children have difficulty grasping the distinction between some pictures (such as line drawings) and their referents, as we will see in Chapter 8. How do infants and toddlers interpret another ever-present, pictorial medium—video? Turn to the Social Issues: Education box on the following page 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 5.1 on page 153. You will see that infants anticipate events, actively search for hidden objects, master the A–B object search, flexibly vary their sensorimotor schemes, engage in make-believe play, and treat pictures and video images symbolically within Piaget's time frame. Yet other capacities—including secondary circular reactions, understanding of object properties, first signs of object permanence, deferred imitation, problem solving by analogy, and displaced reference of words—emerge earlier than Piaget expected. These findings show that the cognitive attainments of infancy do not develop together in the neat, stepwise fashion that Piaget assumed.

Recent research raises questions about Piaget's view of how infant development takes place. Consistent with Piaget's ideas, sensorimotor action helps infants construct some forms of knowledge. For example, in Chapter 4, we saw that crawling enhances depth perception and ability to find hidden objects, and handling objects fosters awareness of object properties. Yet we have also seen that infants comprehend a great deal before they are capable of the motor behaviors that 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. As we have seen, much evidence on young infants' cognition rests on the violation-of-expectation method. Researchers who lack confidence in this method argue that babies' cognitive starting point is limited (Campos et al., 2008; Cohen, 2010; Cohen & Cashon, 2006; Kagan, 2008). 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; Huttenlocher, 2002; Quinn, 2008; Rakison, 2010).

TABLE 5.2 **Some Cognitive Attainments of Infancy and Toddlerhood**

AGE	COGNITIVE ATTAINMENTS
Birth–1 month	Secondary circular reactions using limited motor skills, such as sucking a nipple to gain access to interesting sights and sounds
1–4 months	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)
4–8 months	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)
8–12 months	Ability to search for a hidden object when covered by a cloth; ability to solve simple problems by analogy to a previous problem
12–18 months	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
18 months–2 years	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

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 viewers not yet out of diapers, 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, as they do with pictures. By 19 months, touching and grabbing 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; Troseth & DeLoache, 1998). 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 (Deocampo, 2003; Hayne, Herbert, & Simcock, 2003; Krcmar, Grela, & Linn, 2007).

One explanation is that 2-year-olds typically do not view a video character as offering socially relevant information. After an adult on video announced where she hid a toy, few 2-year-olds searched (Schmidt, Crawley-Davis, & Anderson, 2007). In contrast, when the adult uttered the same words while standing in front of the child, 2-year-olds promptly retrieved the object.

This baby thinks the child she sees on the TV screen is real. Not until she is about 2½ will she understand how onscreen images relate to real people and objects.

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. Repetition of video programs also helps children over age 2 make sense of video content.

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 (Carey & Markman, 1999; 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, which we will address further in Chapter 6.

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. If infants kept track of the two objects (requiring them to add one object to another), then they should look longer at the unexpected, one-toy display—which is what they did (see Figure 5.3) (Wynn, Bloom, & Chiang, 2002). These findings and those of similar investigations suggest that babies can discriminate quantities up to three and use that knowledge to perform simple arithmetic—both addition and subtraction (in which two objects are covered and one object is removed) (Kobayashi et al., 2004; Kobayashi, Hiraki, & Hasegawa, 2005; Wynn, Bloom, & Chiang, 2002).

Did this toddler learn to build a block tower by repeatedly acting on objects, as Piaget assumed? Or did he begin life with innate knowledge that helps him understand objects and their relationships quickly, with little hands-on exploration?

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 the small-number discriminations evident in Figure 5.3.

But like other violation-of-expectation results, babies' numerical capacities are controversial. In experiments similar to those just described, looking preferences were inconsistent

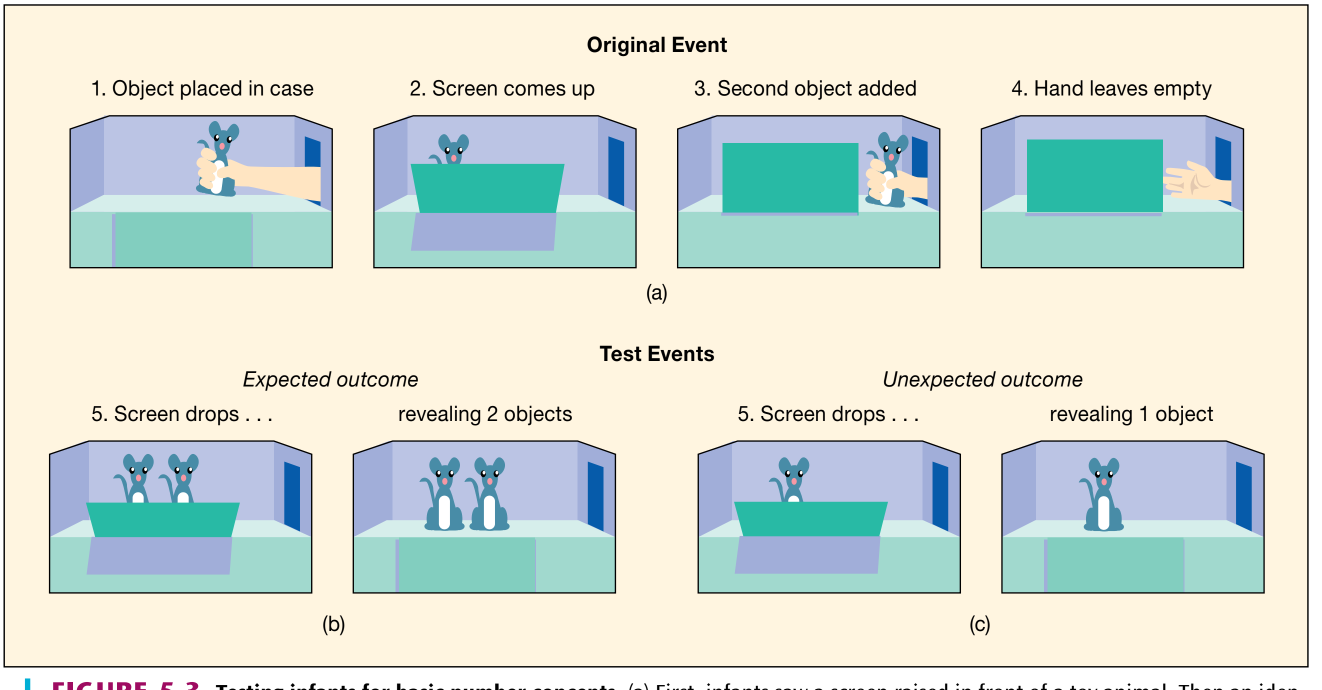

FIGURE 5.3 **Testing infants for basic number concepts.** (a) First, infants saw a screen raised in front of a toy animal. Then an identical toy was added behind the screen. Next, the researchers presented two outcomes. (b) In the *expected outcome,* the screen dropped to reveal two toy animals. (c) In the *unexpected outcome,* the screen dropped to reveal one toy animal. Five-month-olds shown the unexpected outcome looked longer than did 5-month-olds shown the expected outcome. The researchers concluded that infants can discriminate the quantities "one" and "two" and use that knowledge to perform simple addition: 1 + 1 = 2. A variation of this procedure suggested that 5-month-olds could also do simple subtraction: 2 – 1 = 1. (From K. Wynn, 1992, "Addition and Subtraction by Human Infants." Adapted by permission of Macmillan Publishers, Ltd. *Nature, 358,* p. 749.)

(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 answer correctly when asked to add and subtract small sets.

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 ongoing challenges from critics, 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. Follow-up research on Piaget's sensorimotor stage yields broad agreement on two issues. First, many cognitive changes of infancy are gradual and continuous rather than abrupt and stagelike, as Piaget thought (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 we turn 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. Today, researchers are far from consensus on how to modify or replace his account of infant cognitive development, and some believe that his general approach continues to make sense and fits most of the evidence (Cohen, 2010). Piaget's 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.

ASK YOURSELF

REVIEW Using the text discussion on pages 155–158, construct your own summary table of infant and toddler cognitive development. Which entries in your table are consistent with Piaget's sensorimotor stage? Which ones develop earlier than Piaget anticipated?

APPLY Several times, after her father hid a teething biscuit under a red cup, 12-month-old Mimi retrieved it easily. Then Mimi's father hid the biscuit under a nearby yellow cup. Why did Mimi persist in searching for it under the red cup?

REFLECT What advice would you give the typical U.S. parent about permitting an infant or toddler to watch as much as 1 to 1½ hours of TV or video per day? Explain.

Information Processing

Information-processing researchers agree with Piaget that children are active, inquiring beings. But instead of providing a single, unified theory of cognitive development, they focus on many aspects of thinking, from attention, memory, and categorization skills to complex problem solving.

Recall from Chapter 1 that the information-processing approach frequently relies on computer-like flowcharts to describe the human cognitive system. Information-processing theorists 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). The computer model of human thinking is attractive because it is explicit and precise.

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 5.4 on page 162). 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, or disappears, 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" that we use to accomplish many activities in daily life. From childhood on, researchers assess changes in working-memory capacity by presenting individuals with lists of items (such as numerical digits or short sentences), asking them to "work" on the items (for example, repeat the digits backward or remember the final word of each sentence in correct order), and seeing how well they do.

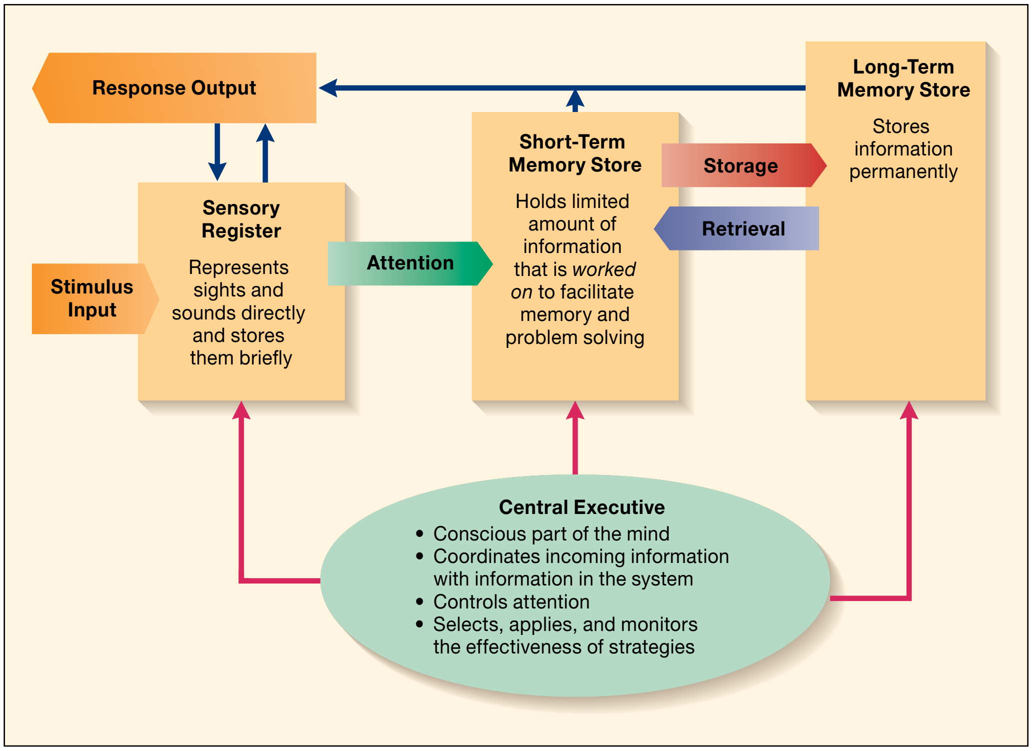

FIGURE 5.4 Model of the human information-processing system. Information flows through three parts of the mental system: the *sensory register,* the *short-term memory store,* and the *long-term memory store*. In each, mental strategies can be used to manipulate information, increasing the efficiency and flexibility of thinking and the chances that information will be retained. The *central executive* is the conscious, reflective part of the mental system. It coordinates incoming information with information already in the system, decides what to attend to, and oversees the use of strategies.

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 in the first place.

Information-processing research indicates that several aspects of the cognitive system improve during childhood and adolescence: (1) the *basic capacity* of its stores, especially working 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, & Spiker, 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; dramatic strides will follow in childhood and adolescence.

Attention

Recall from Chapter 4 that around 2 to 3 months of age, infants shift from focusing on single, high-contrast features to exploring objects and patterns more thoroughly. Besides attending to more aspects of the environment, infants gradually become more efficient at managing their attention, taking in information more quickly. Habituation research reveals that 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, & Janowski, 2001; Slater et al., 1996).

One reason that very young babies' habituation times are so much longer is their difficulty disengaging attention from a stimulus (Colombo, 2002). When Carolyn held up a colorful rattle, 2-month-old Caitlin stared intently until, unable to break her gaze, she burst into tears. The ability to shift attention from one stimulus to another improves by 4 months—a change believed to be due to development of structures in the cerebral cortex controlling eye movements (Blaga & Colombo, 2006; Posner & Rothbart, 2007a).

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, especially when children play with toys. 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 (see Figure 5.5) (Hartshorn et al., 1998).

Even after 2- to 6-month-olds 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, without being physically active. Sometimes, they do so 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 135 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.*

In Chapter 4, we saw that 3- to 5-month-olds are excellent at discriminating faces. But their memory for the faces of unfamiliar people and for other visual patterns is short-lived—at 3 months, only about 24 hours, and at the end of the first year, several days to a few weeks (Fagan, 1973; Pascalis, de Haan, & Nelson, 1998). By contrast, 3-month-olds' memory for the unusual movements of objects (such as a metal nut swinging on the end of a string) persists for at least three months (Bahrick, Hernandez-Reif, & Pickens, 1997).

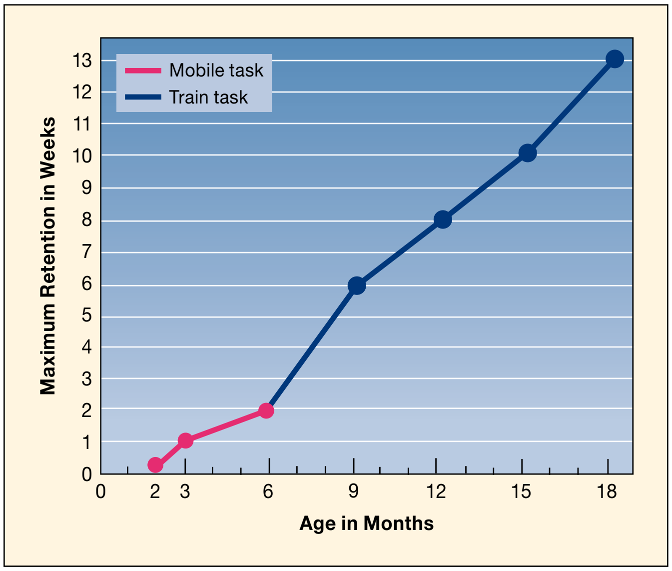

FIGURE 5.5 Increase in retention in two operant conditioning tasks from 2 to 18 months. Two- to 6-month-olds were trained to make a kicking response that turned a mobile. Six- to 18-month-olds were trained to press a lever that made a toy train move around a track. Six-month-olds learned both responses and retained them for an identical length of time, indicating that the tasks are comparable. Consequently, researchers could plot a single line tracking gains in retention of operant responses from 2 to 18 months of age. The line shows that memory improves dramatically. (From C. Rovee-Collier & R. Barr, 2001, "Infant Learning and Memory," in G. Bremner & A. Fogel, eds., *Blackwell Handbook of Infant Development,* Oxford, U.K.: Blackwell, p. 150. Reprinted by permission of Blackwell Publishing Ltd.)

Biology and Environment

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 5.6. 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 "shrunken" 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. As language develops, preschoolers can use it to refer to preverbal memories. But their ability to do so is fragile, requiring strong contextual cues, such as direct exposure to the physical setting of the to-be-recalled experience (Morris & Baker-Ward, 2007). Only after age 3 do children 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).

By 10 months, infants remember both novel actions and features of objects involved in those actions equally well (Horst, Oakes, & Madole, 2005). Thus, over the second half-year, sensitivity to object appearance increases. This change is fostered by infants' increasing ability to manipulate objects, which helps them learn about objects' observable properties.

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, pressing a lever, 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. For example, 1-year-olds can retain short sequences of adult-modeled behaviors for up to 3 months, and 1½-year-olds can do so for as long as 12 months (Rovee-Collier & Cuevas, 2009).

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 above for a discussion of *infantile amnesia.*

Categorization

Even young infants can *categorize,* grouping similar objects and events into a single representation. Categorization reduces the enormous amount of new information infants encounter every day, helping them 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

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.

(a) (b) (c)

FIGURE 5.6 The Magic Shrinking Machine, used to test young children's verbal and nonverbal memory of an unusual event. After being shown how the machine worked, the child participated in selecting objects from a polka-dot bag, dropping them into the top of the machine (a), and turning a crank, which produced a "shrunken" object (b). When tested the next day, 2- to 4-year-olds' nonverbal memory for the event was excellent. But below 36 months, verbal recall was poor, based on the number of features recalled about the game during an open-ended interview (c). Recall improved between 36 and 48 months, the period during which infantile amnesia subsides. (From G. Simcock & H. Hayne, 2003, "Age-Related Changes in Verbal and Nonverbal Memory During Early Childhood," *Developmental Psychology, 39,* pp. 807, 809. Copyright © 2003 by the American Psychological Association. Reprinted with permission of the American Psychological Association. *Photos:* Ross Coombes/Courtesy of Harlene Hayne.)

Figure 5.7 on page 166. 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, as long as they have sufficient familiarity with category members, infants group objects into an impressive array of categories—food items, furniture, birds, land animals, air animals, sea animals, plants, vehicles, kitchen utensils, 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, separate people's natural actions (walking) from other motions, and expect people (but not inanimate objects) to move spontaneously (Spelke, Phillips, & Woodward, 1995; see also Chapter 4, pages 144–145).

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 (Cohen, 2003; Mandler, 2004; Quinn, 2008). Older infants can even make categorical distinctions when the perceptual contrast between two categories is minimal (birds versus airplanes).

As they gain experience in comparing to-be-categorized items in varied ways and as their store of verbal labels expands, toddlers start to categorize flexibly: When 14-month-olds are

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FIGURE 5.7 Investigating infant categorization using operant conditioning. Three-month-olds were taught to kick to move a mobile that was made of small blocks, all with the letter *A* on them. After a delay, kicking returned to a high level only if the babies were shown a mobile whose elements were labeled with the same form (the letter *A*). If the form was changed (from *A*s to *2*s), infants no longer kicked vigorously. While making the mobile move, the babies had grouped together its features. They associated the kicking response with the category *A* and, at later testing, distinguished it from the category *2*. (Bhatt, Rovee-Collier, & Weiner, 1994; Hayne, Rovee-Collier, & Perris, 1987.)

given four balls and four blocks, some made of soft rubber and some of rigid plastic, their sequence of object touching reveals that after classifying by shape, they can switch to classifying by material (soft versus hard) if an adult calls their attention to the new basis for grouping (Ellis & Oakes, 2006).

In addition to touching and sorting, toddlers' categorization skills are evident in their play behaviors. After watching an adult give a toy dog a drink from a cup, most 14-month-olds shown a rabbit and a motorcycle offered the drink only to the rabbit (Mandler & McDonough, 1998). They clearly understood that certain actions are appropriate for some categories of items (animals) and not others (vehicles).

By the end of the second year, toddlers' grasp 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 18 months, toddlers more often imitate a nonlinear motion with a toy that has animate-like parts (legs), even if it represents an inanimate (a bed). At 22 months, displaying a fuller understanding, they 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 highly 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 of a set of objects with a consistently applied word ("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; Waxman, 2003).

Variations among languages lead to cultural differences in development of categories. Korean toddlers, who learn a language in which object names are often omitted from sentences, develop object-sorting skills later than their English-speaking counterparts (Gopnik & Choi, 1990). At the same time, Korean contains a common word, *kkita,* with no English equivalent, referring to a tight fit between objects in contact (a ring on a finger, a cap on a pen), and Korean toddlers are advanced in forming the spatial category "tight fit" (Choi et al., 1999).

Evaluation of Information-Processing Findings

The information-processing perspective underscores the continuity of human thinking from infancy into adult life. In attending to the environment, remembering everyday events, and categorizing objects, Caitlin, Grace, and Timmy think in ways that are remarkably similar to our own, though their mental processing is far from proficient. Findings on memory and categorization join with other research in challenging Piaget's view of early cognitive development. Infants' 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: Information processing 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* (see Chapter 4, pages 137–138) to early cognition. In this approach, 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; Thelen & 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.

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 help. With adult support, Grace will gradually become better at matching shapes to openings and dropping them into the container. Then she will be able to perform this and similar activities on her own.

Vygotsky's sociocultural theory emphasizes that children live in rich social and cultural contexts that affect the way their cognitive world is structured (Bodrova & Leong, 2007; Rogoff, 2003). Vygotsky believed that complex mental activities have their origins in social interaction. 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. This form of teaching—known as *scaffolding*—promotes learning at all ages, and we will consider it further in Chapter 7.

Vygotsky's ideas have been applied mostly to older children, who are more skilled in language and social communication. Recently, however, his theory has been extended to infancy and toddlerhood. Recall that babies are equipped with capacities that ensure that caregivers will interact with them. Then adults adjust the environment and their communication in ways that promote learning adapted to their cultural circumstances.

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 and motor skills had improved, interaction centered on how to use the toy. The adults guided the baby's hand in turning the crank and putting the bunny back in the box. During the second year, adults helped from a distance, using gestures and verbal prompts, such as making a turning motion with the hand near the crank. Research indicates that this fine-tuned support is related to advanced play, language, and problem solving in toddlerhood and early childhood (Bornstein et al., 1992; Charman et al., 2001; Tamis-LeMonda & Bornstein, 1989).

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. This strategy, common in Western middle-SES homes, is well-suited to lessons in which children master skills apart from the everyday situations in which they will later use those skills. In contrast, Guatemalan Mayan adults and 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 (Chavajay & Rogoff, 2002; Correa-Chavez, Rogoff, & Mejía-Arauz, 2005; Philips, 1983).

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 on page 168 presents additional evidence for this idea, and we will see even more in the next section.

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Using simple words and gestures, this mother brings a challenging task—rotating the plane's propeller—within her toddler's zone of proximal development. By adjusting her communication to suit the child's needs, she transfers mental strategies to him and promotes learning.

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 when a cake was in the making, 21-month-old Peter stood on a chair at the kitchen sink, busily pouring water from one cup to another.

"He's in the way, Dad!" complained 4-year-old David, trying to pull Peter away from the sink.

"Maybe if we let him help, he'll give us room," Ken suggested. As David stirred the batter, Ken poured some into a small bowl for Peter, moved his chair to the side of the sink, 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.

Piaget and his followers concluded that toddlers discover make-believe independently, once they are capable of representational schemes. Vygotsky challenged this view, pointing out that society provides children with opportunities to represent culturally meaningful activities in play. Make-believe, like other complex mental activities, 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 one observational 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). These maternal cues encourage toddlers to join in and probably facilitate their ability to distinguish pretend from real acts, which strengthens over the second and third years (Lillard & Witherington, 2004; Ma & Lillard, 2006).

Also, when adults participate, toddlers' make-believe is more elaborate (Keren et al., 2005). They are more likely to combine pretend acts into complex sequences, as Peter did when he put sand in the bucket (making the batter), carried it into the kitchen, and, with Ken's help, put it in the oven (baking the cake). The more parents pretend with their toddlers, the more time their children devote to make-believe.

In some cultures, such as those of Indonesia and Mexico, where extended-family households and sibling caregiving are common, make-believe is more frequent and complex with older siblings than with mothers. As early as age 3 to 4, children provide rich, challenging stimulation to their younger brothers and sisters, take these teaching responsibilities seriously, and, with age, become better at them (Zukow-Goldring, 2002). In a study of Zinacanteco Indian children of southern Mexico, by age 8, sibling teachers were highly skilled at showing 2-year-olds how to play at everyday tasks, such as washing and cooking (Maynard, 2002). They often guided toddlers verbally and physically through the task and provided feedback.

A Kenyan child guides his younger brother in pretend play. In cultures where sibling caregiving is common, make-believe play is more frequent and complex with older siblings than with mothers.

In Western middle-SES families, older siblings less often teach deliberately but still serve as influential models of playful behavior. In a study of New Zealand families of Western European descent, when both a parent and an older sibling were available, toddlers more often imitated the actions of the sibling, especially when siblings engaged in make-believe (Barr & Hayne, 2003).

As we will see in Chapter 7, make-believe play is a major means through which children extend their cognitive skills and learn about important activities in their culture. Vygotsky's theory, and the findings that support it, tell us that providing a stimulating physical environment is not enough to promote early cognitive development. In addition, toddlers must be invited and encouraged by more skilled members of their culture to participate in the social world around them. Parents and teachers can enhance early make-believe by playing often with toddlers, guiding and elaborating on their make-believe themes.

ASK YOURSELF

REVIEW What impact does toddlers' more advanced play with toys have on the development of attention?

CONNECT List techniques parents can use to *scaffold* the development of categorization in infancy and toddlerhood, and explain why each is effective.

APPLY When Timmy was 18 months old, his mother stood behind him, helping him throw a large ball into a box. As his skill improved, she stepped back, letting him try on his own. Using Vygotsky's ideas, explain how Timmy's mother is supporting his cognitive development.

REFLECT Describe your earliest autobiographical memory. How old were you when the event occurred? Do your responses fit with research on infantile amnesia?

Individual Differences in Early Mental Development

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 had only a handful of words in his vocabulary, 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, school achievement, and adult vocational success. This concern with prediction arose nearly a century ago, when French psychologist Alfred Binet designed the first successful intelligence test, which predicted school achievement (see Chapter 1). It inspired the design of many new tests, including ones that measure intelligence at very early ages.

Infant and Toddler Intelligence Tests

Accurately measuring infants' intelligence is a challenge because babies cannot answer questions or follow directions. All we can do is present them with stimuli, coax them to respond, and observe their behavior. 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, especially with older infants and toddlers.

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. The standardization sample for the Bayley-III included 1,700 infants, toddlers, and young preschoolers, reflecting the U.S. population in SES and ethnic diversity.

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 5.8 on page 170). 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

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A trained examiner administers a test based on the Bayley Scales of Infant Development to a 1-year-old sitting in her mother's lap. Compared with earlier editions, the Bayley-III Cognitive and Language Scales better predict preschool mental test performance.

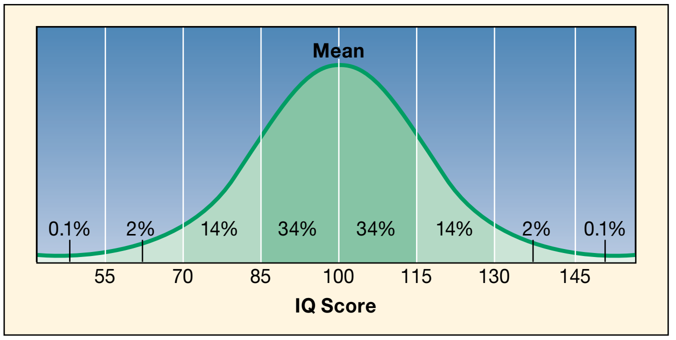


FIGURE 5.8 Normal distribution of intelligence test scores. To determine the percentage of same-age individuals in the population a person with a certain IQ outperformed, add the figures to the left of that IQ score. For example, an 8-year-old child with an IQ of 115 scored better than 84 percent of the population of 8-year-olds.

his or her test performance deviates from the standardization-sample mean.

The IQ offers a way of finding out whether an individual is ahead, behind, or on time (average) in mental development compared with others of the same age. For example, if Timmy's score is 100, then he did better than 50 percent of his agemates. A child with an IQ of 85 did better than only 16 percent, whereas a child with an IQ of 130 outperformed 98 percent. 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). But because most infant test scores do not tap the same dimensions of intelligence assessed in older children, they are conservatively labeled **developmental quotients (DQs)** rather than IQs.

Infant tests are somewhat better at making long-term predictions for extremely low-scoring babies. Today, they are largely used for *screening*—helping to identify for further observation and 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; Kavsek, 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. Many studies have examined the relationship of environmental factors to infant and toddler mental test scores. As we consider this evidence, 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). Applying What We Know on the following page lists factors measured by HOME during the first three years. Each is positively related to toddlers' mental test performance. Regardless of SES and ethnicity, an organized, stimulating physical setting and parental affection, involvement, and encouragement of new skills repeatedly predict better language and IQ scores in toddlerhood and early childhood (Fuligni, Han, & Brooks-Gunn, 2004; 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, with whom they share not just a common environment but also a common heredity. Parents who are genetically more intelligent may provide better experiences while also giving birth to genetically brighter children, who evoke more stimulation from

A mother plays actively and affectionately with her baby. Parental warmth, attention, and verbal communication predict better language and IQ scores in toddlerhood and early childhood.

Applying What We Know

Features of a High-Quality Home Life: The HOME Infant–Toddler Subscales

Home Subscale	Sample Item
Emotional and verbal responsiveness of the parent	Parent caresses or kisses child at least once during observer's visit. Parent spontaneously speaks to child twice or more (excluding scolding) during observer's visit.
Parental acceptance of the child	Parent does not interfere with child's actions or restrict child's movements more than three times during observer's visit.
Organization of the physical environment	Child's play environment appears safe and free of hazards.
Provision of appropriate play materials	Parent provides toys or interesting activities for child during observer's visit.
Parental involvement with the child	Parent tends to keep child within visual range and to look at child often during observer's visit.
Opportunities for variety in daily stimulation	Child eats at least one meal per day with mother and/or father, according to parental report. Child frequently has a chance to get out of house (for example, accompanies parent on trips to grocery store).

Sources: Bradley, 1994; Bradley et al., 2001.

their parents. Research supports this hypothesis, which refers to *gene–environment correlation* (see Chapter 2, page 72) (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 sensitively with Timmy, while also assuring her that Timmy's current performance need not forecast his future development. Warm, responsive parenting that builds on toddlers' current capacities is a much better indicator than an early mental test score of how children will do later.

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, 2012b). Child care for infants and toddlers has become common, and its quality—though not as influential as parenting—affects mental development. Research consistently shows that infants and young children exposed to poor-quality child care—whether they come from middle-class or from low-SES homes—score lower on measures of cognitive and social skills (Belsky et al., 2007a; 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).

In contrast to most European countries and to 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 individual states and vary widely. In studies of quality, only 20 to 25 percent of U.S. child-care centers and family child-care settings (in which a caregiver cares for children in her home) provided infants and toddlers with sufficiently positive, stimulating experiences to promote healthy psychological development. Most settings offered substandard care (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, along with challenges they faced in finding child care. Are the parents knowledgeable about the ingredients of high-quality care?

Unfortunately, many U.S. children from low-income families experience inadequate child care (Brooks-Gunn, 2004). But U.S. settings providing the very worst care tend to serve middle-SES families. These parents are especially likely to place their

Applying What We Know

Signs of Developmentally Appropriate Infant and Toddler Child Care

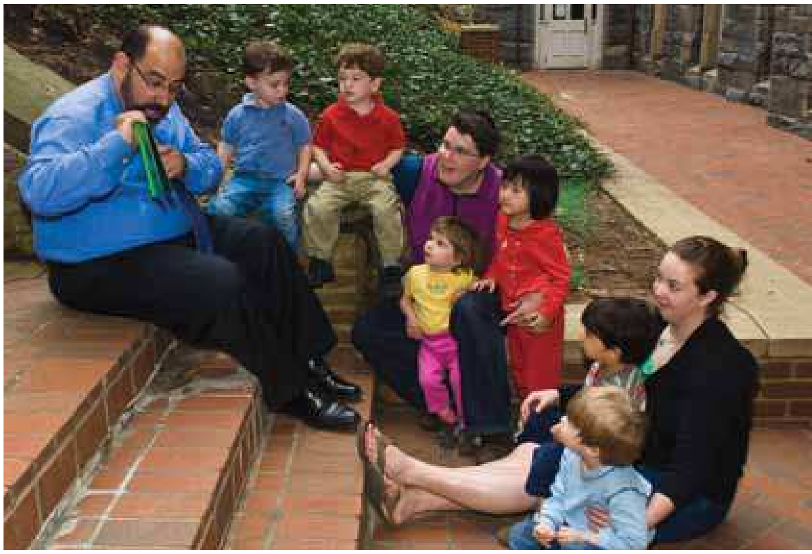
Program Characteristics	Signs of Quality
Physical setting	Indoor environment is clean, in good repair, well-lighted, and well-ventilated. Fenced outdoor play space is available. Setting does not appear overcrowded when children are present.
Toys and equipment	Play materials are appropriate for infants and toddlers and are stored on low shelves within easy reach. Cribs, highchairs, infant seats, and child-sized tables and chairs are available. Outdoor equipment includes small riding toys, swings, slide, and sandbox.
Caregiver–child ratio	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. Staffing is consistent, so infants and toddlers can form relationships with particular caregivers.
Daily activities	Daily schedule includes times for active play, quiet play, naps, snacks, and meals. It is flexible rather than rigid, to meet the needs of individual children. Atmosphere is warm and supportive, and children are never left unsupervised.
Interactions among adults and children	Caregivers respond promptly to infants' and toddlers' distress; hold, talk to, sing to, and read to them; and interact with them in a manner that respects the individual child's interests and tolerance for stimulation.
Caregiver qualifications	Caregiver has some training in child development, first aid, and safety.
Relationships with parents	Parents are welcome anytime. Caregivers talk frequently with parents about children's behavior and development.
Licensing and accreditation	Child-care setting, whether a center or a home, is licensed by the state. In the United States, voluntary accreditation by the National Association for the Education of Young Children *(www.naeyc.org/academy),* or the National Association for Family Child Care *(www.nafcc.org)* is evidence of an especially high-quality program.

Sources: Copple & Bredekamp, 2009.

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. Caitlin, Grace, and Timmy are fortunate to be in family child care that meets these standards.

Child care in the United States is affected by a macrosystem of individualistic values and weak government regulation and funding. Furthermore, many parents think that their children's child-care experiences are better than they really are. Unable to identify good care, they do not demand it (Helburn, 1995). In recent years, recognizing that child care is in a state of crisis, the U.S. federal government and some states have allocated additional funds to subsidize its cost, primarily for low-income families. Though far from meeting the need, this increase in resources has had a positive impact on child-care quality and accessibility (Children's Defense Fund, 2009).



High-quality child care, with a generous caregiver–child ratio, well-trained caregivers, and developmentally appropriate activities, can be especially beneficial to children from low-SES homes.

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 (Bradley et al., 2001; Gutman, Sameroff, & Cole, 2003). These problems are 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 (we will discuss these in Chapter 7), 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; Sweet & Appelbaum, 2004).

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 5.9 shows, by 12 months of age, the IQs of the two groups diverged. Treatment children sustained their advantage 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, 2011). 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.

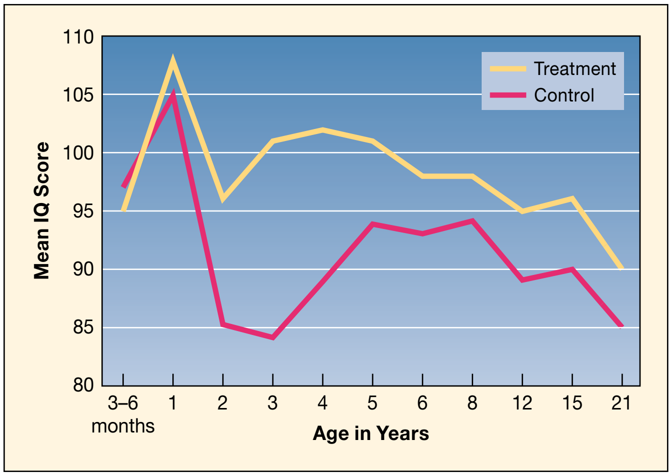


FIGURE 5.9 IQ scores of treatment and control children from infancy to 21 years in the Carolina Abecedarian Project. At 1 year, treatment children outperformed controls, an advantage consistently maintained through age 21. The IQ scores of both groups declined gradually during childhood and adolescence—a trend probably due to the damaging impact of poverty on mental development. (Adapted from Campbell et al., 2001.)

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?

CONNECT Using what you learned about brain development in Chapter 4, explain why it is best to initiate intervention for poverty-stricken children in the first two years rather than later.

APPLY Fifteen-month-old Joey's developmental quotient (DQ) is 115. 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?

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 word meanings and, around 12 months of age, say their first word. Sometime between 1½ and 2 years, toddlers combine two words (Gleason, 2009). By age 6, children understand the meaning of about 10,000 words, speak in elaborate sentences, and are skilled conversationalists.

To appreciate this awesome task, think about the many abilities involved in your own flexible use of language. When you speak, you must select words that match the underlying concepts you want to convey. To be understood, you must pronounce words correctly. Then you must combine them into phrases and sentences using a complex set of grammatical rules. Finally, you must follow the rules of everyday conversation—take turns, make comments relevant to what your partner just said, and use an appropriate tone of voice. How do infants and toddlers make such remarkable progress in launching these skills?

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 a unique human accomplishment, 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. Also, the ability to master a grammatically complex language system seems unique to humans, as efforts to teach language to nonhuman primates—using either specially devised artificial symbol systems or sign language—have met with limited success. Even after extensive training, chimpanzees (who are closest to humans in terms of evolution) master only a basic vocabulary and short word combinations, and they produce these far less consistently than human preschoolers (Tomasello, Call, & Hare, 2003).

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 lipreading, 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. Chomsky's 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; Tomasello, 2005). Second, children do not acquire language as quickly as nativist theory suggests. They refine and generalize many grammatical forms gradually, engaging in much piecemeal learning and making errors along the way. As we will see in Chapter 9, complete mastery of some grammatical forms, such as the passive voice, is not achieved until well into middle childhood (Tager-Flusberg & Zukowski, 2009; Tomasello, 2006). This suggests that more experimentation and learning are involved than Chomsky assumed.

Finally, recall from Chapter 4 that for most people, language is housed largely in the left hemisphere of the cerebral cortex, consistent with Chomsky's notion of a brain prepared to process language. But our discussion also revealed that language areas in the cortex *develop* as children acquire language. Although the left hemisphere is biased for language processing, if it is injured in the early years, other regions take over (see page 126 in Chapter 4). So localization of language in the left hemisphere is not necessary for effective language use. Furthermore, brain-imaging research shows that many regions of the cerebral cortex participate in language activities to differing degrees, depending on the language skill and the individual's mastery of that skill (Shafer & Garrido-Nag, 2007).

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; Elman, 2001; Munakata, 2006; Saffran, 2009). These theorists note that brain regions housing language also govern similar perceptual and cognitive abilities, such as the capacity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Infants communicate from the very beginning of life, as this interchange between a mother and her 1-month-old illustrates. How will this child become a fluent speaker of her native language within just a few years? Theorists disagree sharply on answers to this question.

to analyze musical and visual patterns (Saygin et al., 2004; Saygin, Leech, & Dick, 2010).

Other theorists blend this information-processing view with Chomsky's nativist perspective. They agree that infants are amazing analyzers of speech and other information. But, they argue, these capacities probably are 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 similarly 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. Furthermore, in studies of older children and adults with left-hemispheric brain damage, grammar is more impaired than other language functions (Stromswold, 2000).

Still other interactionists emphasize that children's social skills and language experiences are centrally involved in language development. In this *social-interactionist* view, an active child, well-endowed for making sense of language, strives to communicate. In doing so, she cues her caregivers to provide appropriate language experiences, which help her relate the content and structure of language to its social meanings (Bohannon & Bonvillian, 2009; Chapman, 2006).

Among social interactionists, disagreement continues over whether or not children are equipped with specialized language abilities (Lidz, 2007; Shatz, 2007; Tomasello, 2003, 2006). Nevertheless, 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 language progress. In reality, native endowment, cognitive-processing strategies, and social experience probably operate in different balances with respect to each aspect of language. Table 5.3 provides an overview of early language milestones that we will examine in the next few sections.

Getting Ready to Talk

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

TABLE 5.3 **Milestones of Language Development During the First Two Years**

APPROXIMATE AGE	MILESTONE
2 months	Infants coo, making pleasant vowel sounds.
4 months on	Infants observe with interest as the caregiver plays turn-taking games, such as pat-a-cake and peekaboo.
6 months on	Infants babble, adding consonants to their cooing sounds and repeating syllables. By 7 months, babbling starts to include many sounds of spoken languages. Infants begin to comprehend a few commonly heard words.
8–12 months	Infants become more accurate at establishing joint attention with the caregiver, who often verbally labels what the baby is looking at. Infants actively participate in turn-taking games, trading roles with the caregiver. Infants use preverbal gestures, such as showing and pointing, to influence others' goals and behavior and to convey information.
12 months	Babbling includes sound and intonation patterns of the child's language community. Speed and accuracy of word comprehension increase rapidly. Toddlers say their first recognizable word.
18–24 months	Spoken vocabulary expands from about 50 to 200 to 250 words. Toddlers combine two words.

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 "nananananana."

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 speech-like 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 include a broader range of sounds. Around 7 months, it starts to include many sounds common in spoken languages. As caregivers respond to infant babbles, babies modify their babbling to include sound patterns like those in the adult's speech (Goldstein & Schwade, 2008). By 8 to 10 months, babbling reflects the sound and intonation patterns of children's language community, some of which are transferred to their first words (Boysson-Bardies & Vihman, 1991).

Deaf infants exposed to sign language from birth babble with their hands much as hearing infants do through speech (Petitto & Marentette, 1991). Furthermore, hearing babies of deaf, signing parents produce babblelike hand motions with the rhythmic patterns of natural sign languages (Petitto et al., 2001, 2004). 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 (to talk about an object) or other goals (to obtain an object) (Brooks & Meltzoff, 2005; Senju, Csibra, & Johnson, 2008). This **joint attention,** in which the child attends to the same object or event as the caregiver, who often labels it, 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; Carpenter, Nagell, & Tomasello, 1998; 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. But even 4-month-olds are sensitive to the structure and timing of these interactions, smiling more to an organized than to a disorganized peekaboo exchange (Rochat, Querido, & Striano, 1999). By 12 months, babies participate actively, trading roles with the caregiver. In this way, they practice the turn-taking pattern of conversation, a vital context for acquiring language and communication skills. Infants' play maturity and vocalizations during games predict advanced language progress in the second year (Rome-Flanders & Cronk, 1995).

This baby uses a preverbal gesture to draw his caregiver's attention to a picture. The caregiver's verbal response promotes the baby's transition to spoken language.

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, pointed to the cupboard when she wanted a cookie, and pointed at her mother's car keys lying on the floor. Carolyn responded to these gestures and also labeled them ("That's your bear!" "You want a cookie!" "Oh, there are my keys!"). In this way, toddlers learn that using language leads to desired results. Soon toddlers integrate words with gestures, using the gesture to expand their verbal message, as in pointing to a toy while saying "give" (Capirci et al., 2005). Gradually, gestures recede, and words become dominant. But 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. When 6-month-olds listened to the word "Mommy" or "Daddy" while looking at side-by-side videos of their parents, they looked longer at the video of the named parent (Tincoff & Jusczyk, 1999). 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). In their first 50 words, toddlers rarely name things that just *sit there,* like "table" or "vase."

When young children first learn words, they sometimes apply them too narrowly, an error called **underextension.** At 16 months, Caitlin used "bear" only to refer to the worn and 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, trucks, and fire engines. Toddlers' overextensions reflect their sensitivity to categories (MacWhinney, 2005). They apply a new word to a group of similar experiences: "car" to wheeled objects, "open" to opening a door, peeling fruit, and untying shoelaces. This suggests that children often overextend deliberately because they have difficulty recalling or have not acquired a suitable word. And when a word is hard to pronounce, toddlers are likely to substitute a related one they can say (Bloom, 2000). As vocabulary and pronunciation improve, overextensions disappear.

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. A 2-year-old who refers to trucks, trains, and bikes as "car" may look at or point to these objects correctly when given their names (Naigles & Gelman, 1995). Still, the two capacities are related. The speed and accuracy of toddlers' comprehension of spoken language increase dramatically over the second year. And toddlers who are faster and more accurate in comprehension tend to show more rapid growth in words understood and produced as they approach 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).

How do toddlers build their vocabularies so quickly? In the second year, they improve in ability to categorize experience, recall words, and grasp others' social cues to meaning, such as eye gaze, pointing, and handling objects (Dapretto & Bjork, 2000; Golinkoff & Hirsh-Pasek, 2006; Liszkowski, Carpenter, & Tomasello, 2007). In Chapter 7, we will consider young children's specific strategies for word learning.

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." But their word-order regularities are usually copies of adult word pairings, as when the parent says, "How about *more sandwich?*" or "Let's see if you can *eat the berries*" (Tomasello, 2003; Tomasello & Brandt, 2009). These findings indicate that young children first acquire "concrete pieces of language" from frequent word pairings they hear. Only gradually do they generalize from those pieces to construct word-order and other grammatical rules (Tomasello, 2006). As we will see in Chapter 7, children master grammar steadily over the preschool years.

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 (Fenson et al., 1994; 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.

Young children have distinct styles of early language learning. Caitlin and Grace, like most toddlers, used a **referential style;** their vocabularies consisted mainly of words that refer to objects. A smaller number of toddlers use an **expressive style;** compared with referential children, they produce many more social formulas and pronouns ("thank you," "done," "I want it"). These styles reflect early ideas about the functions of language. Grace, for example, thought words were for naming things. In contrast, expressive-style children believe words are for talking about people's feelings and needs (Bates et al., 1994). The vocabularies of referential-style toddlers grow faster because all languages contain many more object labels than social phrases.

What accounts for a toddler's language style? Rapidly developing referential-style children often have an especially active interest in exploring objects. They also eagerly imitate their parents' frequent naming of objects (Masur & Rodemaker, 1999). Expressive-style children tend to be highly sociable, and their parents more often use verbal routines ("How are you?" "It's no trouble") that support social relationships (Goldfield, 1987).

The two language styles are also linked to culture. Nouns are particularly common in the vocabularies of English-speaking toddlers, but Chinese, Japanese, and Korean toddlers have more words for social routines. Mothers' speech in each culture reflects this difference (Choi & Gopnik, 1995; Fernald & Morikawa, 1993; Tardif, Gelman, & Xu, 1999). American mothers frequently label objects when interacting with their babies. Asian mothers, perhaps because of a cultural emphasis on the importance of group membership, teach social routines as soon as their children begin to speak.

At what point should parents be concerned if their child talks very little or not at all? If a toddler's language is greatly delayed when compared with the norms in Table 5.3 (page 175), then parents should consult the child's doctor or a speech and language therapist. Late babbling may be a sign of slow language development that can be prevented with early intervention (Fasolo, Marjorano, & D'Odorico, 2008). Some toddlers who do not follow simple directions or who, after age 2, have difficulty putting their thoughts into words may suffer from a hearing impairment or a language disorder that requires immediate treatment.

Supporting Early Language Development

Consistent with the interactionist view, a rich social environment builds on young children's natural readiness to acquire language. For a summary of how caregivers can consciously support early language development, see Applying What We Know on the following page. Caregivers also do so unconsciously—through a special style of speech.

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).

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By using infant-directed speech, this father speaks in ways that are sensitive to his daughter's language needs and encourages her to join in. Dialogues about picture books are especially powerful sources of early language learning.

Applying What We Know

Supporting Early Language Learning

Strategy	Consequence
Respond to coos and babbles with speech sounds and words.	Encourages experimentation with sounds that can later be blended into first words. Provides experience with turn-taking pattern of human conversation.
Establish joint attention, and comment on what child sees.	Predicts earlier onset of language and faster vocabulary development.
Play social games, such as pat-a-cake and peekaboo.	Provides experience with the turn-taking pattern of human conversation.
Engage toddlers in joint make-believe play.	Promotes all aspects of conversational dialogue.
Engage toddlers in frequent conversations.	Predicts faster early language development and academic success during the school years.
Read to toddlers often, engaging them in dialogues about picture books.	Provides exposure to many aspects of language, including vocabulary, grammar, communication skills, and information about written symbols and story structures.

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.]* On it goes! Let's zip up. *[Zips up the jacket.]* Now, say bye-bye to Grace and Timmy."

Caitlin: "Bye-bye, G-ace. Bye-bye, Te-te.

Carolyn: "Where's your bear?"

Caitlin: *[Looks around.]*

Carolyn: *[Pointing.]* "See? By the sofa." *[Caitlin gets the bear.]*

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). As we saw earlier, parent–toddler conversation—especially, reading and talking about picture books—strongly predicts language development and reading success during the school years.

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 contrast, impatience with and rejection of children's efforts to talk lead them to stop trying and result in immature language skills (Baumwell, Tamis-LeMonda, & Bornstein, 1997; Cabrera, Shannon, & Tamis-LeMonda, 2007). 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 Why is the social interactionist perspective attractive to many investigators of language development? Cite evidence that supports it.

CONNECT Cognition and language are interrelated. List examples of how cognition fosters language development. Next, list examples of how language fosters cognitive 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?

SUMMARY

Piaget's Cognitive-Developmental Theory (p. 152)

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,** the internal rearrangement of schemes into a strongly interconnected cognitive system.

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 sudden solutions to sensorimotor problems, 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-tracking research, may be evident in the first few months.
- Around the first birthday, babies attain **displaced reference,** the realization that words may stand for things not physically present. By the middle of the second year, toddlers treat realistic-looking pictures symbolically; around 2½ 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.

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- 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. 161)

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. Dramatic advances will follow in childhood and adolescence.

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.** Both improve steadily with age.
- Infants group stimuli into increasingly complex categories, and toddlers' categorization gradually shifts from a perceptual to a conceptual basis. In the second half of the first year, infants have begun to grasp the animate–inanimate distinction, an understanding that expands during toddlerhood.

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

- Information-processing findings challenge Piaget's view of infants as purely sensorimotor beings who cannot mentally represent experiences. But information processing has not yet provided a broad, comprehensive theory of children's thinking.

The Social Context of Early Cognitive Development (p. 167)

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**—ones just ahead of their current capacities—through the support and 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. 169)

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. As a result, scores on infant tests are called **developmental quotients (DQs),** rather than IQs. Speed of habituation and recovery to visual stimuli are better predictors of future performance.

Discuss environmental influences on early mental development, including home, child care, 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.

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- Infant and toddler child care is increasingly common, and its quality 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 the poor academic performance of many poverty-stricken children.

Language Development

(p. 174)

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 the importance of children's social skills and language experiences.

Describe major language milestones in 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 infants' 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.

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- Girls show faster language progress than boys, and reserved, cautious toddlers may wait before trying to speak. Most toddlers use a **referential style** of language learning; their early words consist largely of names for objects. Some use an **expressive style,** in which social formulas and pronouns are common and vocabulary grows more slowly.
- 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 early language development and reading success during the school years.

Important Terms and Concepts

accommodation (p. 152)
adaptation (p. 152)
assimilation (p. 152)
autobiographical memory (p. 164)
automatic processes (p. 162)
babbling (p. 176)
central executive (p. 162)
circular reaction (p. 153)
cooing (p. 176)
core knowledge perspective (p. 159)
deferred imitation (p. 154)
developmentally appropriate practice (p. 172)
developmental quotient (DQ) (p. 170)
displaced reference (p. 157)
executive function (p. 162)
expressive style of language learning (p. 178)
Home Observation for Measurement of the Environment (HOME) (p. 170)
infant-directed speech (IDS) (p. 178)
infantile amnesia (p. 164)
intelligence quotient (IQ) (p. 169)
intentional, or goal-directed, behavior (p. 154)
joint attention (p. 176)
language acquisition device (LAD) (p. 174)
long-term memory (p. 162)
make-believe play (p. 154)
mental representation (p. 154)
normal distribution (p. 169)
object permanence (p. 154)
organization (p. 152)
overextension (p. 177)
recall (p. 164)
recognition (p. 164)
referential style of language learning (p. 178)
scheme (p. 152)
sensorimotor stage (p. 152)
sensory register (p. 161)
short-term memory store (p. 161)
standardization (p. 169)
telegraphic speech (p. 177)
underextension (p. 177)
video deficit effect (p. 159)
violation-of-expectation method (p. 155)
working memory (p. 161)
zone of proximal development (p. 167)