Cognitive Development in Infancy

HOW SCIENTISTS KNOW WHAT BABIES KNOW 123
PIAGET AND INFANT COGNITIVE DEVELOPMENT 125
Assimilation and Accommodation
Stage Theory
Challenges to Piaget
MENTAL REPRESENTATION IN INFANCY 128
Categorizing
Remembering
Playing
INFANT “INTELLIGENCE” 133
Infant Tests
Infant Mental Development in Social Context
LANGUAGE DEVELOPMENT IN INFANCY 138
Language Norms and Methods of Study
Language Comprehension and Production
Individual Variation in Language Development
The Building Blocks of Language Making and Understanding Sounds
How Infants Learn Words
How Infants Learn Grammar
SUMMING UP AND LOOKING AHEAD 149
HERE’S WHAT YOU SHOULD KNOW 150
Did You Get It?
Important Terms and Concepts
The baby being carried in the infant seat is not a passive voyager, seeing, hearing, feeling, tasting, and smelling. She must make sense of all of this input. This is where cognitive development comes in. Just how does the infant make sense of these sensations? How do we know what’s going on inside her head?

In this chapter, we’re going to review what developmental scientists have learned about the mind of the infant in just the last 50 years or so. (Before then, whether babies think, and what they thought, were the subjects of speculation.) The topics will include Piaget’s views of cognitive development and some of the contributions of researchers who came after Piaget and questioned his views. (Piaget was a major figure in the field, and his writings energized the field of infant and child development. As often happens, however, those who followed him modified or revolutionized his thinking. Because he was so original, and his ideas formed a springboard to modern developments, we spend a little time with Piaget, even though the field has passed his specific work.) We then turn to cover mental representation in infancy, attempts to measure infant intelligence, and the development of communication. We consider norms and individual differences, how learning and cognition change over infancy, and how infants’ interactions with objects and people influence their mental development—especially the ability to communicate with others. Equally important, we look at how researchers know what infants think; after all, infants cannot tell us what’s on their mind.

**HOW SCIENTISTS KNOW WHAT BABIES KNOW**

How do researchers ask babies questions about what babies know, and how do babies answer them? Students of infancy have developed many different techniques and strategies to ask babies questions. Two techniques are based on the concepts of habituation and novelty responsiveness and use a similar approach. For example, a researcher shows a baby a picture once, and the baby will look at it for a while. But if the baby is shown the same picture over and over, the baby will look at it less and less. The first time, the picture was novel and attention grabbing. However, like you would, babies get “bored” with the same thing.

The baby’s getting bored is perfect for the researcher, because then the researcher knows that the baby has developed some sort of mental representation of the picture—otherwise, why should the baby look at the picture less the tenth time it is shown? The loss of interest suggests that the baby recognizes the picture. Presumably, the baby is comparing each new picture presentation with a developing memory of the picture based on previous exposures. This process of getting to know about a stimulus is called habituation. What happens if the researcher now shows the bored (habituated) baby something new? If the baby looks more at a new picture than at the one she’s been

---

**habituation** The process in which a baby compares each new stimulus with a developing memory of the stimulus based on previous exposures, thus learning about the stimulus.
One of the ways developmental researchers test infants is by showing them stimuli and noting infants’ reactions, like this 8-month-old baby boy looking at an image on a computer screen.

**novelty responsiveness**  Following habituation, the process in which a baby looks more at a new stimulus than at a familiar one.

shown over and over—called **novelty responsiveness**—that tells the researcher that the baby not only recognizes the old picture but also can tell the difference between the old one and the new one (Bornstein & Colombo, 2010; Sirois & Mareschal, 2002). Specifically, novelty responsiveness following habituation occurs when a baby looks more at a new stimulus than at a familiar one.

Using habituation and novelty responsiveness, researchers can ask a variety of “yes-no” questions of babies. For example, can babies tell the difference between a smiling and a frowning face? To do your own experiment, get two pictures, preferably of the same person: one happy and another frowning. Show one to the baby until he or she stops looking, then show the two pictures together. If the baby looks longer at the novel facial expression, then he is telling you that he can tell the difference between smiling and frowning. How good is a baby’s memory? By habituating (familiarizing) infants with a picture and testing them later with the same picture, it is also possible to study memory. (If the baby acts as if the picture is new, he obviously doesn’t remember it.)

A third approach to infant perception and cognition involves learning. Again, try your own experiment. Put a baby in a crib with a mobile hanging overhead. Now, take a baseline reading of how often she kicks. Then attach the mobile by a ribbon to the baby’s ankle so that, when the baby kicks, the mobile jangles. Babies quickly learn that their kicking moves the mobile. When attached to the mobile in this way, most babies kick at two to three times their baseline rate. Suppose now that you wait a day or two and then retest the baby. When an infant who has previously learned the association between kicking and mobile-moving *relearns* that association more rapidly than he or she did the first time, this tells us that the baby remembers (Rovee-Collier & Barr, 2001).

**INTERIM SUMMARY 5.1**

How Scientists Know What Babies Know

<table>
<thead>
<tr>
<th>Four Different Approaches Used to Learn About Infant Perception and Cognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Habituation—occurs when a baby compares each new stimulus with a developing memory of the same stimulus shown on previous exposures.</td>
</tr>
<tr>
<td>2. Novelty responsiveness—happens after habituation; if a baby looks more at a new stimulus than at the one shown repeatedly, the baby not only recognizes the old stimulus but also can tell the difference between the old and new.</td>
</tr>
<tr>
<td>3. Learning—an example is putting a baby in a crib with a mobile and taking a baseline reading of how often she kicks. Then conditions are changed, responses noted, and the baby is retested, which tells us about infant learning and memory.</td>
</tr>
<tr>
<td>4. Imitation—babies are shown a sequence of events and observed to see if they imitate the sequence.</td>
</tr>
</tbody>
</table>
Finally, scientists use a fourth approach to study what babies know by showing them a sequence of events and seeing whether they imitate the sequence. Consider this scenario. You are seated across the table from an older infant. You have a spoon, a small red box, and a larger blue box. While the baby is watching, you place the spoon inside the red box, and then place the red box inside the blue one. Then, you disassemble it all and do it again. Now, you give the baby the three objects. If the infant does exactly what you did, in the same order, this tells us she is able to observe and remember a sequence of events (Barr & Hayne, 2000).

Each of these ways of studying development has been used with the littlest infants. If you were to do some or all of these things with an infant you know, you’d rediscover what developmental scientists in the last half century have discovered. Although it might not always be apparent, infants have an active mental life. They are constantly learning, developing, and even testing—yes, testing—new ideas. (For a summary of this section, see “Interim Summary 5.1: How Scientists Know What Babies Know.”)

PIAGET AND INFANT COGNITIVE DEVELOPMENT

Between 1925 and 1932, the Swiss biologist and philosopher Jean Piaget watched closely as his own three children—Jacqueline, Lucienne, and Laurent—developed from infancy, noting the enormous intellectual progress each made during the first two years of life. Soon afterward, Piaget (1936/1952) published the Origins of Intelligence in Children, a collection of his observations and informal experiments that led to a revolutionary theory of cognitive development in infancy (Brainerd, 1996; Bremner, 2001; Lourenco, 1996).

Piaget suggested that each infant constructs an understanding of the world—including space, time, causality, and substance—on the basis of his or her own actions in the world. At the time, other developmental scientists viewed children as well-equipped, but basically passive, recipients of information from the environment. Piaget did not think that knowledge derives from sensations or perceptions, or from information provided by others. Rather, Piaget wrote that infants actively construct what they know. This basic notion has shaped the study of infant cognition ever since.

What does it mean to “actively construct” knowledge? Imagine that you and a friend have driven to a new restaurant in a neighboring town. A month later, you want to eat there again, so you decide to drive back. If you were the driver the first time, you’ll have an easier time remembering how to go than if you had been the passenger—because you actively constructed your knowledge of how to get there by doing the driving. Recall the kitten study conducted by Richard Held and Alan Hein (1963), which was discussed in Chapter 4. This study demonstrated the critical importance of self-produced activity for understanding the environment. The kittens that were allowed to move about on their own avoided the deep side of a visual cliff, stretched out their paws appropriately in preparation for contact with a solid surface, and blinked at approaching objects. By contrast, even after extensive transportation in the gondola, the passive cats failed to show such spatially sensitive behavior. To Piaget, an infant is the driver (not the passenger) in cognitive development; the active (not the passive) kitten.
Assimilation and Accommodation

To explain cognitive development, Piaget detailed the process of adaptation. Adaptation, in Piaget’s theory, is the process whereby knowledge is altered by experience. Adaptation involves two complementary, intertwined, and powerful processes: **assimilation** and **accommodation**. When information can be processed according to what the child already knows, the information is said to be **assimilated**. A child who understands that when she drops a rattle off her high chair, the toy falls downward onto the floor will easily understand that when she drops her Cheerios, they do the same thing; that is, she can assimilate this new knowledge. At times, the child’s understanding of the world does not permit assimilating new information. What happens when the child lets go of a balloon filled with helium? It goes up, not down. This violates the child’s understanding of the world (because until then, everything that was dropped followed the same pattern). When new information cannot be assimilated into the child’s existing understanding, two things can happen. One is that the child fails to assimilate and simply moves on to another activity. Alternatively, the child changes his or her understanding to permit new information to be processed. The modification of existing understanding to better accord with reality is termed **accommodation**; that is, children actively change so that they can understand the environment better. Following the experience with the helium balloon, the child understands that some objects rise or float and not all objects fall when released; through the process of accommodation, the baby has developed a new way of thinking.

Assimilation and accommodation are not separate processes, but alternatively occur so that the child’s understanding can match reality. In assimilation, children use their existing understanding to make sense of the world. In accommodation, they modify their understanding to appreciate reality better and better.

Stage Theory

Perhaps the best-known feature of Piaget’s theory is his **stages** of cognitive development. Piaget held that mental development unfolds in a fixed sequence of developmental steps. As a whole, the **sensorimotor period** occurs during infancy; it is followed, in Piaget’s theory, by the preoperational, concrete operational, and formal operational periods of childhood, preadolescence, and adolescence, respectively (discussed in the chapters on physical development in early childhood, middle childhood, and adolescence). During the sensorimotor period, “thinking” consists of putting sensory information with motor activity. According to Piaget, infants learn through actions: looking, listening, touching, sucking, mouthing, and grasping. Within the sensorimotor period in infancy, Piaget proposed a sequence of six stages (see Table 5.1). The child’s current stage defines the way the child views the world and processes information in it.

One more accomplishment during the sensorimotor period is learning that certain actions produce certain results (**causality**). For example, banging a spoon on a highchair tray produces a loud noise, attracts attention, and may bring dinner. Another major advance is **object permanence**. In early infancy, “out of sight is out of mind”—literally. The baby’s world consists of what he or she can perceive in the here-and-now. If you give a 3-month-old an interesting toy, his attention perks up. But if you cover the toy with a cloth, he doesn’t look for it; rather, he behaves as if the toy no longer exists. By 8 or 10 months, the infant is surprised when the toy disappears, and he searches for it. The infant realizes that something out of sight still exists (Bogartz, Shinskey, & Schilling, 2000; Krojgaard, 2003; Mash, Arterberry, & Bornstein, 2007; Xu, 2003). For Piaget, object permanence was a first step toward **mental representation**. No longer
dependent on immediate sensory data, the infant has images or thoughts of objects (including people) in mind when the object (or person) is not physically present. Piaget believed that mental representation did not develop until the end of the sensorimotor period.

**Challenges to Piaget**

Although Piaget’s view of infant cognition has been extremely influential, many of his claims about infant development have been challenged by empirical research. In general, it seems that Piaget underestimated what infants know at different ages.

One major criticism, for instance, is that Piaget focused on the ways that infants learn through movement (i.e., the “motor” in sensorimotor) and ignored other ways in which infants learn. For example, one study showed that limbless children (whose mothers took the sedative thalidomide during the first trimester of pregnancy) developed a normal cognitive life despite the absence of normal sensorimotor experience in infancy (Décarie & Ricard, 1996). This suggests that Piaget overestimated the importance of active (mobile and tactile) exploration—and underestimated other sensory and organizational capacities of infants. Babies make a lot of sense of the world by looking and listening without physically manipulating things.

Other research shows that object permanence and the capacity for mental representation of the physical world (i.e., the ability to hold an image or thought of something in the mind) appear much earlier in development than Piaget supposed (Baillargeon, 2004). Indeed, infants can imitate some behaviors they see (for example, sticking out their tongue) soon after they are born, which says that they have some capacity to represent the external world at birth (Meltzoff & Moore, 1999).

Not only can infants imitate another person within the first months of life, as early as 6 months of age they can imitate a model’s novel actions after a delay. For example, in one experiment, 6- to 9-month-old infants observed an adult model lean forward and

### TABLE 5.1 Stages of the Sensorimotor Period of Infancy

<table>
<thead>
<tr>
<th>Stage</th>
<th>Approximate Age</th>
<th>What the Baby Can and Cannot Do</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>Birth to 1 month</td>
<td>Infants do not accommodate, so mental development is minimal. Everything is assimilated into their existing understanding and very slowly.</td>
<td>They cannot recognize that stimuli belong to solid objects in the outside world—for instance, that sounds come from other things.</td>
</tr>
<tr>
<td>Stage 2</td>
<td>1 to 4 months</td>
<td>Infants coordinate different aspects of their understanding of the world.</td>
<td>They coordinate hand and mouth (deliberately putting their fingers in their mouth).</td>
</tr>
<tr>
<td>Stage 3</td>
<td>4 to 7 months</td>
<td>Infants are aware of relations between their own behavior and the environment.</td>
<td>When infants accidentally produce environmental events—kicking the side of the crib shakes the mobile that is attached to the railing, for instance—they may repeat them, suggesting that they want to review their effects on the environment.</td>
</tr>
<tr>
<td>Stage 4</td>
<td>7 to 10 months</td>
<td>Infants construct relations among environmental stimuli.</td>
<td>They coordinate a face and a voice as being from the same source.</td>
</tr>
<tr>
<td>Stage 5</td>
<td>10 to 18 months</td>
<td>Infants accommodate to the outside world and discover many unexpected relations among objects.</td>
<td>They attempt to see whether milk leaks out of a bottle at different rates depending on the angle of the bottle and the force with which it is squeezed.</td>
</tr>
<tr>
<td>Stage 6</td>
<td>18 to 24 months</td>
<td>Infants now can form a mental representation; for example, imagining the whereabouts of an invisible object.</td>
<td>When a ball rolls under a sofa, for example, a child will move around the sofa and anticipate the reemergence of the ball.</td>
</tr>
</tbody>
</table>

**mental representation** The ability to hold in the mind an image of objects (and people) that are not physically present.
press a panel with his forehead (a highly unusual, novel behavior) (Meltzoff, 1988). One week later, the infants who had viewed this behavior, and a control group of infants who had not, returned to the laboratory and were put in front of the panel. Infants who had not seen the experimenter never pressed their foreheads to the panel, whereas two-thirds of the infants who had previously witnessed this behavior did. So not only were babies able to imitate what they had seen, they were able to do so from memory!

Developmental scientists now agree that Piaget underestimated infants’ perceptual and cognitive capacities (Birney et al., 2005; Keil, 2006). Infants’ competencies in understanding sequences of events, means-ends relations, space, causality, and number are all in evidence much earlier in development than Piaget predicted. Infants are more organized and sophisticated cognitively than Piaget thought. Nevertheless, his contributions—especially his beliefs that infants are active learners and that infants think, although differently from older children and adults—laid the foundation for the study of infant cognition today. (For a summary of this section, see “Interim Summary 5.2: Piaget and Infant Cognitive Development.”)

MENTAL REPRESENTATION IN INFANCY

Piaget was interested in the broad picture—in the overarching features of cognitive development from birth through adolescence. Other developmentalists concentrate on specific elements of cognitive development—on what skills infants acquire and when. Students of infant cognition are particularly interested in categorization, memory, and pretend play. One reason is because each of these developments is related to representational thinking—the ability to think about objects and people that are not present. Piaget thought that this breakthrough did not occur until 18 to 24 months. Using different investigative techniques, though, contemporary researchers have found evidence of representational thinking at considerably younger ages.
Categorizing

Imagine going to a grocery store in which there is no rhyme or reason to the way that products are arranged. Chicken breasts are placed next to trash bags, which are alongside cream cheese. Chicken drumsticks are on the same shelf as toothpaste, which is right below the tangerines. What a nightmare shopping would be! Thankfully, though, grocery stores group similar or related objects near one another—into categories (poultry, cleaning supplies, dental products, fruits).

Categorization involves grouping separate items into a set according to some rule. A Ford, a Toyota, and a Mercedes-Benz are all cars. Oaks, elms, and pines are all trees. Sipping, slurping, and guzzling are all ways of consuming liquids. To better organize our experiences, we frequently treat different objects or events as similar; that is, we categorize. So do infants.

Categorization is important for a variety of reasons. It helps to simplify and order the infant’s world in three ways (Bornstein, 1984). First, the infant comes to understand that his brown teddy bear is the same teddy bear in the light and in the dark, when it is nearby and faraway, and so on. The environment into which infants are born, and in which they develop, is constantly changing, producing an infinite variety of sensations. Moreover, infants experience the world in biological states that are frequently changing (e.g., from being drowsy to being awake). Categorization structures and clarifies perception.

Second, the infant doesn’t have to remember every single aspect of every single object, such as every one of his or her mother’s facial expressions to recognize her face. Categorization facilitates the storage and retrieval of information. It supplies a principle of organization that allows more information to be stored in one “file” for mother, rather than multiple files.

Third, the infant’s learning that her family’s dog barks can be applied to other dogs as well. With categorization, knowledge of an attribute of one member of a category provides information about other members of the same category. And new observations (dogs also have tails) can be added to the category and automatically applied to other members of the category.

Evidence that infants categorize comes from habituation and novelty responsiveness tasks. In the habituation/novelty responsiveness paradigm, infants are first familiarized with several examples from the same category (say, several cats) and are then presented with a novel example from the same category (a new cat) and with a novel example from a different category (a dog). We know infants categorize because they pay more attention to a novel out-of-category dog than to a novel in-category cat; that is, they treat one novel stimulus as familiar and another novel stimulus as new. To understand this concept, try this: Habituate a baby to pictures of a horse, a cow, and a cat. Then show the baby either a dog or a rocking chair. The baby will tend to look longer at the picture of the rocking chair because it is not an animal (Arterberry & Bornstein, 2001, 2002).

Studies of the way children play with objects from similar and different categories also show that categorization abilities progress during the first 3 years. Here’s how it’s done: Give a child eight small three-dimensional models (see Figure 5.1), four each belonging to two categories, say, animals (cow, dog, goose, and walrus) and vehicles (train, bus, motorbike, and all-terrain vehicle), and encourage the child to play with them. Close analysis in such studies reveals that children touch objects within a category one after the other more frequently (at greater than chance levels) than objects across categories. That is, in the preceding example, the baby plays with animals and then with the vehicles but does not mix both together. Categories also function at different levels of inclusiveness, and understanding how children use them tells us how children mentally represent information (Rakison & Oakes, 2003). By 1 year, children show that they have a grasp (so to speak!) of the most inclusive categories.
infantile amnesia  The adult recollection of almost nothing of events that took place before the age of 3 or 4.

infantile amnesia  The adult recollection of almost nothing of events that took place before the age of 3 or 4.

Categorization Abilities
To understand infants’ categories of objects, researchers present them with plastic models—for example, four animals and four vehicles—and then analyze infants’ patterns of holding and looking at the two groupings.

Remembering
It is obviously important that infants attend to stimuli and events in their environment. But it is also crucial that they be able to store, retrieve, and use that information later. Memory representations underlie the child’s awareness, experience, knowledge, and interpretation of the world.

For years, people believed that infants could not remember much of anything. You probably don’t remember much of events that took place before you were 3 or 4 (see Bornstein, Arterberry, & Mash, 2004). Indeed, Sigmund Freud (1916/1917, 1966) coined the term infantile amnesia to describe this phenomenon, which he attributed to repression (excluding ideas from consciousness or holding them in the unconscious) of memories of traumatic events. Piaget (1954) also believed that memories may not be possible during the first year because infants do not have the capacity to encode information symbolically. We now know that this view is inaccurate. It is true that most adults may not be able to recall things from their first two or so years of life. But research shows that infants can remember previously experienced events. Whether adults accurately remember their infant experiences, and whether infants remember things from their very short past, are two different questions, with two different answers.
Human infant memory has been studied using many techniques. By habituating (familiarizing) infants with stimuli and testing them immediately afterward with the same stimulus, we can study short-term memory (i.e., see whether infants can tell the difference between something they’ve been shown and something new right away). Imposing a delay between habituation and a later test allows us to assess long-term memory. By varying the amount of delay between habituation and the subsequent test, it is possible to study the accuracy of infants’ memory over different time intervals and to see if this changes with age. We can also vary how long the initial period of familiarization is to see if there are changes with age in how much an infant must be exposed to something (study time) to remember it.

Research shows that infants’ ability to remember clearly improves with age. Infants habituate more quickly and more efficiently as they grow older. They also remember more information, across longer periods of time, as they get older and with helpful reminders (Hsu & Rovee-Collier, 2006; Sheffield & Hudson, 2006). Deferred imitation—showing children a series of actions, then seeing whether they reproduce these actions later—is even more advanced. One team of researchers used three events—pulling a mitten off a puppet’s hand, shaking the mitten, and then putting the mitten back on the puppet’s hand (Barr & Hayne, 2000). They found that recall of these actions after a 24-hour delay was lowest among 6-month-olds (who did not perform any better than infants who never observed the modeled sequence), intermediate among 12-month-olds, and highest among 18- and 24-month-olds. Babies did not require extremely long exposures to demonstrate short-term memory. In sum, as children grow they demonstrate an ability to hold events in memory for longer time spans, and they require fewer cues and shorter periods of familiarization to recall past events.

The study of very long-term memory in human infants poses challenges for another reason—you need to wait a long time for them to grow up! This is one of the reasons that some developmental scientists interested in early memory have turned to animals, like rats, whose lifecycles are substantially shorter. In one animal experiment, infant rats were stressed—they were deprived of nesting materials—and their ability to remember location and recognize objects was subsequently tested. In their young adulthood, memory was unaffected; by middle age, however, memory deficits appeared, and the deficits progressively worsened compared to unstressed rats (Brunson, Kramár, Lin, Chen, Colgin, Yanagihara, & Baram, 2006). Electrical activity in brain cells in stressed rats was adversely affected too. The suspicion is that, in human infants, stress caused by parental loss or abuse or neglect might likewise undermine long-term memory.

Playing

Play is fun and interactive, but also involves mental work—studying a doll, manipulating a busy box, building with a set of blocks, or interacting with an imaginary playmate at a make-believe tea party. Play frequently imitates life, and it is quite common to observe children reenacting in play specific events that they observed or participated in routinely (e.g., “driving” a toy car). Such behavior indicates that young children represent events mentally well enough to reproduce them.

Piaget proposed that play increases in sophistication as children mature, and that infants progress from exploratory play to symbolic, or pretend, play. In the first year, play is predominantly characterized by sensorimotor manipulation; infants’ play appears designed to extract information about objects—what objects do, what perceivable qualities they have, and what immediate effects they can produce. This is commonly referred to as exploratory play because children’s play activities are tied to the tangible properties of objects.

Deferred imitation Reproducing a series of actions seen at an earlier time.

Exploratory play Children’s play in which activities are tied to the tangible properties of objects.
In the second year, children’s play takes on a new quality: the cognitive goal of play now appears to be symbolic. In symbolic play, children enact activities performed by the self, others, and objects in simple make-believe scenarios, pretending to drink from empty teacups, to talk on toy telephones (as in Figure 5.2), and the like.

Most children pass through these two broad stages of play, but children of a given age vary greatly. On average, 15 percent of 1-year-olds’ total play is symbolic. However, some 1-year-olds never exhibit symbolic play, whereas others spend as much as 50 percent of their time in symbolic play. At 2 years, 33 percent of toddlers’ total play is symbolic on average. For some individual children as little as 2 percent is symbolic, whereas for others 80 percent is symbolic. (Elaborate pretend play such as dramatic sequences is typically not seen until early childhood, and is discussed in Chapter 7).

Play normally occurs in the context of social interaction. Children may initiate play, but adults influence its development by outfitting the play environment, engaging children actively, and responding to their overtures. How does adult social interaction affect play? When interacting with their mother, children’s play is more sophisticated, complex, and varied than is their solitary play (Bornstein, 2007). In a longitudinal study of mother-child play interaction, researchers found that, when mothers responded to their 18-month-olds’ object play in an “options-promoting” manner (i.e., encouraging, affirming, and/or expanding on the child’s activities), the children engaged in higher levels of symbolic play at 40 months of age than did children whose mothers responded in an “options-limiting” manner (i.e., disapproving of or obstructing the child’s play) (Stilson & Harding, 1997).

In some cultures, infant play is viewed as predominantly a child’s activity (e.g., in Mayan and many American Indian cultures), whereas other cultures assign an important role to parents as play partners (e.g., in middle-income U.S. culture). Differences between cultures also exist in views about the value of play (Gönçü & Gaskins, 2007). Some cultures believe that play provides important development-promoting experiences; others see play primarily to amuse. Presumably, cultural beliefs about play affect the nature and frequency of children’s play with parents, siblings, and peers.

Generally speaking, Japanese children and mothers tend to engage in more symbolic play than their U.S. counterparts, whereas U.S. children and mothers tend to engage in more exploratory play (Bornstein, 2007). In line with other social features of the culture, Japanese mothers organize infant-directed pretend play in ways that incorporate a partner into play. Japanese mothers encourage interactive (other-directed) activities (e.g., “Feed the dolly”), whereas U.S. mothers encourage self-exploration that is more functional (“Push the bus”). For Americans, play and toys are frequently the focus or object of communication. In contrast, for Japanese, the play setting and associated toys are used to promote mother-infant communication and interaction. This difference is consistent with cultural child-rearing practices more generally, which in Japan emphasize closeness and interdependency between people, and in the United States encourage interest in objects, interpersonal independence, and the acquisition of information.

In summary, infants’ categorization, memory, and play reflect mental representation as well as broader cultural themes and values. These abilities do not develop in isolation; indeed, they are fostered during social interactions with parents when parents are attuned to their child’s emotional cues and developmental level. (For a summary of this section, see “Interim Summary 5.3: Mental Representation in Infancy.”)
Developmental scientists are also interested in how much children of a given age understand, and how much children of the same age vary in their “intelligence”—a quantitative approach to cognitive development (Siegler, 2002, 2007).

Infant Tests

Beginning in the 1920s, about the same time that Piaget began making notes on his own children’s cognitive development, Nancy Bayley set out to measure mental and motor growth in infancy. She developed a scale of the performance of middle-income children, and they were tested regularly from birth through 18 years. The Bayley Scales of Infant Development have become the most widely used assessments of infant and early childhood development. Today, there are two scales: a Mental Development Index and a Psychomotor Development Index. They assess motor, sensation, perception, cognition, memory, language, and social behavior in infants and toddlers over the first years of life.

Measuring infant intelligence is challenging. If you wanted to assess the usefulness of an IQ measure, say, among college students, you might ask how well IQ scores tell you about performance on another index of intelligence, like achievement in school. From preschoolers to adults, standardized tests are appropriate (Lichtenberger, 2005), and there is modest agreement between IQ scores and other measures of intelligence. The degree to which a test measures what it was designed to measure—what is called the test’s validity—is assessed by comparing test scores with independent measures

validity The degree to which a test measures what it was designed to measure.
of the same or similar things. With infants, however, there is no definitive or obvious index of achievement with which to compare intelligence test performance. One way to assess the validity of infant tests is to compare infants’ performance early in life with their performance years later, when they grow up to be children or even as adults. Logically, if infants who perform well on infant tests do well on IQ tests as children or adults, then the infant tests must be telling us something about “intelligence” in infancy. This is a particular type of validity, called predictive validity (the ability of measurements to predict later outcomes, i.e., for infant tests of intelligence to predict later IQ scores). When Bayley (1949) studied the same children over time, she found essentially no relation between test performance in the first 3 to 4 years and intelligence test performance of the same children at 18 years. Only after children reached about 6 years of age or so did an association between childhood scores and later adult scores emerge. The Bayley Scales are useful in detecting developmental problems in infants; a very poor score on the Bayley may indicate serious developmental delays. It is not, however, predictive of later intellectual functioning (Bornstein & Colombo, 2010).

The absence of a connection between infant intelligence and child and adolescent intelligence could be due to several different things. It could reflect a genuine discontinuity in intellectual development. Maybe being a smart baby has nothing to do with being an intelligent first-grader. Or the absence of a link between infant test performance and later test performance could reflect a problem with the instrument—maybe the Bayley test is not a very good measure of the things that should predict later intelligence. The Bayley Scales test babies’ sensory capacities, and motor achievements, as well as responses that are influenced by the baby’s emotional state, like orienting, reaching, and smiling. For an older child, very different items are used in evaluating intelligence—skills related to language, reasoning, and memory. On these grounds, the lack of predictive validity of the Bayley Scales to foretell later IQ scores is not surprising.

Perhaps measures of infant mental ability that are more purely cognitive and do not include motor or emotional components would make more appropriate tests and have more predictive validity. What might show us how well a baby is thinking? One way is to watch how he or she pays attention. Generally speaking, infants who process information more efficiently acquire knowledge more quickly. We can measure the efficiency of an infant’s information processing with some of the tools described at the beginning of this chapter: habituation and novelty responsiveness.

Just as students vary in their ability to concentrate, so infants vary in the ways they perform on tests of habituation and novelty responsiveness. Studies find that those who are more efficient (i.e., who pay more attention to novel stimuli and less to familiar ones) also tend to explore their environment more competently and play in more sophisticated ways—two other indicators of infant cognitive competence. Furthermore, infants who are expected to show lower intelligence later in life—those with developmental disabilities such as Down syndrome—are poorer in managing attention when they are babies. Although infants’ scores on the Bayley do not predict later intelligence, performance on tests of habituation and novelty responsiveness do. That is, infants who show efficient information processing tend to perform better on traditional assessments of cognitive competence in later childhood (Bornstein & Colombo, 2010; Kavšek, 2004; Strid et al., 2006; Tasbihsazan, Nettelbeck, & Kirby, 2003; Tsao, Liu, & Kuhl, 2004).

Both low- and high-risk preterm and low- and very-low-birth-weight (VLBW) infants and children are at risk for impaired developmental outcomes in motor skills and behavior as well as attention and cognition (Bhutta, Cleves, Casey, Craddock, & Anand, 2002; Saigal, 2000; Salt & Redshaw, 2006; Taylor, Klein, & Hack, 2000; van de
Weijer-Bergsma, Wijnroks, & Jongmans, 2008). For example, even low-risk preterms, at 3 to 4 years of age, achieve lower results in an intelligence test, in a visual perception test, in a location memory test, and in a sustained-attention test (Caravale, Tozzi, Albino, & Vicari, 2009). Longitudinal studies of VLBW children confirm that many differences from normal birthweight children at all ages up to adulthood remain stable over time (Breslau, Paneth, & Lucia, 2004; Saigal et al., 2000; Taylor, Klein, Minich, & Hack, 2000). However, differences and delays are not pervasive. Monset-Couchard, de Bethmann, and Kastler (2002) found some “catch-up” on language skills among VLBW children (we first encountered this developmental recovery phenomenon in Chapter 4). This finding received further support from two studies, one demonstrating catch-up in vocabulary development between 3 and 8 years of age by Ment et al. (2003) and the other in reading skills between 9 and 15 years of age by Samuelsson and his colleagues (2006).

So, intelligence is neither innate nor fixed in early life. Certainly genes contribute to general mental development (Johnson, Bouchard, McGue, Segal, Tellegen, & Keyes, 2007; Segal, McGuire, Havlena, Gill, & Hershberger, 2007), but experience in the world is a major contributing factor to all psychological functions, including intelligence, and to be inherited does not mean to be immutable or nonchangeable. Longitudinal studies of intelligence show that individuals definitely change over time. Even heritable traits depend on learning for their expression, and they are subject to environmental effects (Lerner, Fisher, & Gianinno, 2006). So, infant and child learning are assisted and guided by others. This is the social context of mental development in infancy (Bornstein, 1991; Bornstein & Bradley, 2003; Bronfenbrenner & Morris, 1998; Rogoff, 2003).

**Infant Mental Development in Social Context**

In cultural communities as far flung as Turkey, Guatemala, India, and the United States, children participate actively in culturally organized activities; in this way, they gain an understanding of the world they live in. As apprentices in daily living, infants must learn to think, act, and interact with others in their culture to live successfully.

One way to think about how the environment influences child development is to take an ecological perspective, which you read about in Chapter 2. As you recall, children’s growth and development are influenced by some forces that are close at hand (parents, extended family, peers); other forces that are somewhat removed (their neighborhood, their parents’ workplaces); and still other forces that are quite removed, although still influential (social class, culture). Closer influences are called proximal, and more remote influences are called distal. Generally speaking, distal forces influence child development through proximal forces.

We know, for example, that low socioeconomic status (a distal influence) is linked to poor intellectual development in children (McLoyd, Aikens, & Burton, 2006). For example, using data from the Panel Study of Income Dynamics, which followed approximately 2,400 children born from 1955 to 1970 into adulthood, Sharkey (2009) discovered that experiencing high neighborhood poverty throughout childhood (say, experiencing a poverty rate of 25 percent compared to a rate of 5 percent) raised the chances of a person’s downward mobility by 52 percent. Growing up poor by itself isn’t all that influences the child’s IQ and life chances, though. In addition, fewer educated parents live in poor neighborhoods, and poorly educated parents typically provide their children with less verbal stimulation (Hoff, 2006) and fewer enriching life experiences (Bradley & Corwyn, 2002). These are proximal influences. In addition, other distal aspects of social life that are organized by geography exert coordinate influences. These include schools, government and electoral districts, and other local institutions. Public schools are partially funded by residential districts, so the quality
of the educational opportunities afforded children depends directly on where they live. Similarly, the quality of parks and recreation centers, the effectiveness of the police, as well as exposure to violence, gangs, toxic soil, and polluted air all depend on one’s neighborhood.

Risks associated with social deprivation early in life can be offset by intervention, as the long-term Carolina Abecedarian Project shows. Beginning in the 1970s, this project was administered to a group of predominantly African American children who were living with single mothers who had less than a high-school degree. The educational intervention started by age 3 months, and children in the treatment group received center-based child care for a full day, 5 days a week through kindergarten entry at age 5. Some services (nutritional supplements and medical care) were provided to the control group to ensure that those were not the factors accounting for different outcomes between the two groups. Experimental evaluations have found positive and lasting effects of this intervention on children’s IQ, reading, and math scores first detected at 18 months of age. Children who participated in the intervention were also less likely to be retained in a grade or placed in special education, and they were more likely to be enrolled in or have graduated from college, than children in the control group. As young adults (age 21 years), treatment participants showed a reduction in teen-aged pregnancy compared with controls. These findings suggest that sustained, high-quality, center-based interventions starting in infancy and continuing at least to school entry can produce long-term positive impacts (Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002).

Different social risks in early life (such as being born into poverty, to a single teenage mother, being low birth weight, etc.) tend to go together and add to one another to increase the long-term disadvantages (Burchinal, Roberts, Hooper, & Zeisel, 2000; Burchinal, Roberts, Zeisel, Hennon, & Hooper, 2006; Gutman, Sameroff, & Eccles, 2002). This is called multiple risks. One of those risks is the air children breathe. As noted in Chapter 3, polycyclic aromatic hydrocarbons (PAHs) are released into the air during incomplete combustion of fossil fuel, tobacco, and other organic material. Perera and her colleagues (2008, 2009) noticed delayed motor development at 2 years of age in a cohort of Chinese children exposed prenatally to PAHs from local coal-fired plant emissions. The effects were not seen in a second cohort conceived after the power plant had been shut. In a later study, they evaluated the relation between prenatal exposure to airborne PAHs and child intelligence. Children of nonsmoking African or Dominican American women residing in New York City were monitored from in utero to 5 years of age, with determination of prenatal PAH exposure through personal air monitoring by mothers during pregnancy and intelligence assessed at 5 years of age. After adjustment for maternal intelligence, quality of the home environment, environmental tobacco smoke exposure, and other potentially confounding factors, high prenatal PAH levels predicted lower childhood IQ scores. IQ scores of high-exposure children were 4 points lower than those of less-exposed children. Environmental PAHs at levels encountered in New York City air affect children’s IQ adversely.

Children reared in more advantaged homes show superior mental development both because of genetic factors and environmental ones (Petrill et al., 2004). The influence of the family on infant cognitive development is not a one-way street, however. Infant and caregiver jointly contribute to developing cognitive competence. Although children learn from the experiences they have with their parents, the experiences that parents provide their children are affected by children’s capabilities at various points in their development. In other words, the infant’s cognitive development is a product of the constant interplay between the child’s abilities and the environment, including experiences that their caregivers provide.
Parents influence their infants’ intellectual development in many ways: via teaching skills, by being responsive to their needs, and by providing books and toys. In infancy, the vast majority of experiences stem directly from interactions within the family. Parents take principal responsibility for teaching their infants: They engage infants in early games as well as in turn-taking exchanges in play. As carpenters do in constructing a building, parents sometimes use temporary aids—a process referred to as scaffolding—to help their child advance (Vygotsky, 1978). Later, as the edifice of intellect grows and is solidified, the scaffold may be replaced or taken down (see Chapter 7).

Parents vary in the scaffolds they favor, and some scaffolding strategies may be more effective than others, depending on the nature and age of the child. Positive stimulation in the first 3 years (responsiveness, for example) is one kind of interaction that supports later motor, cognitive, and social development (Bradley, Corwyn, Burchinal, Pipes McAdoo, & Garcia Coll, 2001a, b; Saltaris, Serbin, Stack, Karp, Schwartzman, & Ledingham, 2004). Joint attention occurs when a caregiver and a child are focused on the same object and promotes cognitive development; joint attention has been linked to improved communication skills in infants (Butterworth, 2001; Mundy & Sigman, 2006). Responsiveness occurs when parents react appropriately, contingently, and promptly in response to interactions that their infants initiate; this is another effective scaffolding strategy that has long-term positive outcomes for children’s cognitive and language development (Bornstein, 2002; Bradley et al., 2001b; Gros-Louis et al., 2006). For example, in their prospective study of a cohort of low-income, predominantly Caucasian mothers and their infants in Minneapolis, early care predicted reading and math achievement as measured at age 16 (Sroufe, Egeland, Carlson, & Collins, 2005). The material environment (toys and books) that parents provide for their infants is another effective scaffolding technique (Bradley, et al., 2001a, b; Gottfried, Fleming, & Gottfried, 1998). Toys that provide challenges and rewards (i.e., toys that infants can use with some help at first, but then by themselves) are ideal. Reading with children broadens their knowledge as well as developing prereading skills (see Chapter 7). The number of books and toys matters, but so does parental involvement with them. Generally, careful and considered early childhood stimulation programs have lasting positive effects into adult years (Reynolds, 2003).

What motivates infants’ parents to behave in the ways they do? Parental belief systems, called ethnotheories, help to determine how parents interact with their children. As a result, different approaches to scaffolding are seen around the world. For example, European American mothers tend to believe that physical development is the result of maturation but that knowledge comes from interaction with the environment. Kenyan Gisii mothers tend to believe that physical development depends on interaction but that knowledge comes from observation. Not surprisingly, European American mothers tend to encourage infant exploration more than Gisii mothers as a way of developing their babies’ cognitive skills, but Gisii mothers deliberately encourage physical development more than their European American counterparts. (For a summary of this section, see “Interim Summary 5.4: Infant ‘Intelligence.’”)

Parents have important roles to play in their infants’ learning about the world, as this dad shows in demonstrating for his 10-month-old girl how a new toy works.

---

**scaffolding** Providing learning opportunities, materials, hints, and clues when a child has difficulty with a task.

**ethnotheories** Parents’ belief systems that motivate them to behave in the ways they do.
LANGUAGE DEVELOPMENT IN INFANCY

The word infant derives from the Latin in + fans, which translated literally means “nonspeaker”; the word baby shares a Middle English root with “babble.” Beginning to speak—and understand speech—is one of most impressive, and essentially human, developments during infancy.

Language depends on perceptual, cognitive, and social development, and it involves many overlapping levels of production and comprehension. Sounds must be produced and perceived (phonology). The meaning of words (semantics) must be learned. The grammar (syntax) of language defines the ways in which words and phrases are arranged to ensure correct and meaningful communication.

Consider what the infant must do to understand his mother when she says, “Come-here-lovely-for-a-drink-of-juice.” The child must break up the sound stream into individual words, understand what each word means, and analyze the grammatical structure linking the words to decipher the overall meaning. To complicate matters further, these three types of decoding must take place as the mother is talking.

Scholars have disagreed over the relative contributions of biology and experience to the acquisition of language. Some theoreticians have argued that language learning is based solely on the child’s experiences. In the fourth century, Saint Augustinse wrote that children learn language by imitating their elders; in the twentieth century, B. F. Skinner (1957) argued that children acquire language through experience (learning). In contrast, other theorists have asserted that infants must come into the world with an inborn ability to acquire language (Chomsky, 1965; Jakobson, 1968). The truth is some combination of these two extremes. Language is too rich, unique, and complex a system for infants to learn through imitation and/or reinforcement, just as it is too rich, unique, and complex a system for infants simply to know without appropriate experience. The acquisition of language, like other developments, reflects a complex interaction between the child’s developing competencies (biology) and adult-child social communication (experience).

Language Norms and Methods of Study

Figure 5.3 depicts some milestones of language development in infancy. As you can see, the first 2 years of life are a time of remarkable growth. In the first month of life, infants coo and babble; by their 24th month, toddlers can speak grammatically correct
sentences. In the first month, infants respond to the sound of the human voice; by their 24th month, toddlers comprehend the meaning of prepositions (e.g., to, in, of).

To understand how language develops in infancy, we might simply observe, record, and analyze what children seem to understand or say as they grow up. Recordings capture and reveal that the infants’ early speech is more sophisticated than it sounds. For example, when children start saying words, it seems like they do not make certain distinctions clearly; a child might seem to pronounce the /p/ (pronounced “pa”) and /b/ (pronounced “ba”) at the beginnings of words in exactly the same way. However, close analyses of recordings of children’s attempts at /p/ and /b/ sounds reveal that some children actually make the sounds differently—but not differently enough for adults to hear clearly. One important implication of this finding is that children’s learning certain distinctions between sounds cannot be due solely to adult reinforcement, because adults are generally unable to hear children’s initial improvements. Another implication is that our naked ears may underestimate children’s abilities. This echoes a theme that arises again and again in the study of language development (and of cognitive development more generally): The roots of complex behaviors often exist long before those behaviors are clear and blossoming, and many capacities that seem to bloom overnight have in fact been developing for months.
Another strategy for studying the development of language uses parents’ reports. In fact, much of the classic information about language development comes from parents’ diaries of their own children (e.g., Bloom, 1976; Dromi, 1987; Leopold, 1949; Weir, 1962). As sources of information, diaries can be quite detailed, informative, and thought provoking, although they may also be biased and describe unrepresentative children (Bornstein, 2010). A variation of this method is the parent checklist, where parents note which words their child understands or uses on preprinted lists (Fenson et al., 1993; Maital et al., 2000).

Language Comprehension and Production

When examining child language, we have to distinguish between *comprehension* and *production*. If you play with a 1-year-old, you might notice that the child can follow your instructions well but cannot tell you anything about the simple game you two are playing. **Comprehension** is understanding language; **production** is speaking language. Comprehension nearly always comes before production developmentally. Infants might begin understanding words at 9 months but not say any until 12 months. On average, comprehension reaches a 50-word milestone at around 13 months, whereas production doesn’t reach this point until 18 months (Benedict, 1979). Both comprehension and production are immature in young children and continue to develop at least until early adolescence (see, e.g., Wassenberg, Hurks, Hendriksen, Meijs, Vles, & Jolles, 2007, for comprehension, and Berman, 2004, for production).

Individual Variation in Language Development

Children of the same age vary dramatically on nearly every measure of language development (Bates & Carnevale, 1993). One researcher (Brown, 1973) traced speech development in three children—Adam, Eve, and Sarah—by indexing their verbal growth in terms of their **mean length of utterance**, measured in the number of **morphemes** (units of meaning, including spoken words, like *play*, and word parts, like the “ing” in *playing*). Figure 5.4 shows that all three children achieved common **goals** and that their **growth rates** were nearly equivalent. However, Eve began talking considerably earlier than did Adam or Sarah. For example, Eve used an average of three morphemes in an utterance at about 2 years of age, whereas Adam and Sarah did not do so until approximately 3 years of age—one-third of their lifetimes later.

At 13 months, some toddlers produce no words, others 27 (Tamis-LeMonda & Bornstein, 1990, 1991). At 20 months, individual toddlers can range from 10 to 500 words in their productive vocabularies, and this is true across cultures (Bornstein et al., 2004). Over the course of early childhood, moreover, there is a fair amount of consistency within individual children: Infants who know more words at 1 year tend to know more words at 2 years. What is more, children who know more words may be at a long-term advantage. Knowing more words speeds learning to read, improves reading comprehension, and spills over into written language skills; vocabulary size at 2 years of age predicts linguistic and cognitive skills at 8 years (Marchman & Fernald, 2008).

Number of words and mean length of utterance are measures of quantitative differences among children; children also differ from one another qualitatively. Some children are **referential**; their vocabularies include a high proportion of nouns, and their speech provides information and refers to things in the environment (“ball,” “kitty,” “apple”). Other children are **expressive**; their early vocabularies have more verbs, and they use speech to communicate feelings and desires (“carry me,” “hungry,” “Mommy go”). One researcher video recorded two children at play with their mothers at home at 12, 15, and 18 months of age (Goldfield, 1985/1986). Johanna was a referential child. Of
Johanna’s first 50 words, 49 were names for things. In play, approximately half of her attempts to engage her mother involved her giving or showing a toy, and reciprocally Johanna’s mother consistently labeled toys for her. Caitlin was an expressive child. Nearly two-thirds of Caitlin’s first 50 words consisted of social expressions, many of them in phrases. For referential youngsters, the purposes of language are to label, describe, and exchange information, whereas for expressive youngsters, language is to note or confirm activity. Caitlin and Johanna are extremes, of course; most children are both referential and expressive and their speech depends on the situation.

**The Building Blocks of Language**

One of the principal tasks of the first 2½ years of life is for the infant to develop into a conversational partner. Adult and infant alike are focused on this common goal, and infants come very far very fast. In learning language, the child is neither ill equipped nor, typically, alone. There are many elements of language that infants and their caregivers utilize, such as infant-directed speech, turn-taking, and gestures.

**Infant-Directed Speech**  Think about the way you would speak to a baby: As we noted in Chapter 4, your inflection, speed, and choice of words are no doubt different from those you use in speaking to an adult. Although infants possess perceptual abilities that help in language learning (see Chapter 4), parents repack the
language directed at infants to match infant capacities. This synchrony is thought to facilitate language acquisition. As we discussed earlier, mothers, fathers, caregivers, and even older children adopt a special dialect when addressing infants, called infant-directed speech. The special characteristics of infant-directed speech include rhythm and tone (higher pitch, greater range of frequencies, more varied and exaggerated intonation); simplification (shorter utterances, slower tempo, longer pauses between phrases); redundancy (more repetition); special forms of words (like *mama*); and more limited content (restriction of topics to the child’s world). Infant-directed speech may be intuitive and not conscious (Papoušek & Papoušek, 2002), and cross-cultural developmental study attests that infant-directed speech is almost universal (Papoušek, Papoušek, & Bornstein, 1985). Even 2- to 3-year-olds engage in such systematic language adjustments when speaking to their 1-year-old siblings as opposed to their mothers (Dunn & Kendrick, 1982). And deaf mothers modify their sign language very much the way hearing mothers use infant-directed speech (Erting, Thumann-Prezioso, & Sonnenstrahl-Benedict, 2000).

**Turn-Taking** Turn-taking is fundamental to adult dialogue. It is impolite to interrupt; rather, we wait our turn to speak. Setting manners aside, it is likely that turn-taking evolved because the human nervous system cannot simultaneously produce and understand speech. Mothers and their infants take turns with one another much more than speaking at the same time (Jasnow & Feldstein, 1986). After a mother or a baby vocalizes, each will next suppress vocalization to permit their partner to join the conversation. When adults use conversational give-and-take patterns, infants produce more speech-like than non-speech-like sounds (Bloom, Russell, & Wassenburg, 1987). Infants participating in such conversations also vocalize with sounds that are more like real speech.

**Gesture** Gestures are a form of nonverbal communication and are often used to support spoken language (Blake et al., 2003; Goldin-Meadow, 2006; Locke, 2001). By the time infants are 9 months of age, parents already are labeling objects or events while pointing or gazing at them. Mothers use their hands to attract and maintain infant attention. For example, a mother might point and at the same time ask “What is that?” Infants are more likely to look at objects previously pointed to and labeled than at objects that were not labeled (Baldwin & Markman, 1989). That is, pointing and labeling increase infants’ attention to, and memory of, objects. At about 12 months, infants themselves start to point, although the age varies considerably: Some begin by 9 months, whereas others don’t start until 19 months (Hoff, 2006). Infants whose mothers respond to infants’ pointing by labeling (“Yes, that’s the moon.”) later become children with larger referential vocabularies.

Why do people use infant-directed speech, turn-taking, and gesture with babies? These strategies elicit the baby’s attention, change the baby’s state of arousal (by exciting him or her), communicate emotion, and, of course, facilitate language comprehension. For example, infants respond more to their own mother’s voice when mothers use infant-directed speech; infants also prefer to listen to infant-directed speech than to adult-directed speech even when spoken by strangers (Kitamura et al., 2002). Indeed, Zangl and Mills (2007) reported that infant-directed speech boosts neu-
ral activity to unknown words in 6- and 13-month-olds. Certain features of mothers’ speech are consistent across languages such as American English, German, and Mandarin Chinese. Mothers around the world use rising pitch to engage infant attention, falling pitch to soothe a distressed infant, and an up-then-down pattern to maintain infant attention (Papoušek & Papoušek, 2002; Papoušek et al., 1985). These adult modifications may make it easier for the baby to acquire language. For example, when presented with a sequence of syllables that contain some speech sounds (e.g., in English, the sound “bay” is a speech sound) and other sounds that are not a part of speech (“gwu”), infants discriminate speech sounds better in infant-directed speech than in adult-directed speech (Karzon, 1985).

Making and Understanding Sounds

At the most basic level, language and communication involve sounds. When we speak we make sounds, and when we hear we listen to sounds.

Sound Perception As you read in Chapter 4, the auditory system is well developed before birth, and so newborns hear, orient to, and distinguish all sorts of sounds from the moment they are born. But babies seem especially primed to perceive and appreciate human speech. Consider the seemingly impossible task of segmenting the speech stream—knowing where one word ends and the next begins—before knowing any words or even what a word is. Imagine figuring out that “Come here, lovely, for a drink of juice” is “Come here, lovely, for a drink of juice,” and not “Co mehe lo velyfor adrin kof jui ce”). Moreover, infants have to do this for different speakers and in different contexts. One competency that has evolved to address segmenting sounds and recognizing speech is categorization.

Infants perceive categories of speech sounds. Because sounds vary so much from one language to another, many scholars once thought that meaningful distinctions among sounds must be shaped by experience. It appears, however, that many speech sounds are not experienced as wholly different from one another or as random; rather, many sounds fit into manageable categories that infants recognize
from a very early age. The two sounds /b/ and /p/ are examples. Infants categorize different /b/s as similar and categorize different /p/s as similar, but distinguish /b/s from /p/s. Categorization of speech sounds is important to language acquisition for many reasons. For example, if infants heard each and every variant of /b/ as different, then learning “ball,” “box,” “bat,” “bottle,” and so forth would be more difficult, not to mention the challenges posed by the variations in /b/ produced by the same speaker at different times or by different speakers (mother and father).

**Sound Production** Infants pass through stages in early verbal development: a prelinguistic stage, a one-word stage, and a multilanguage stage.

Babies’ first means of vocal communication—crying and babbling—are prelinguistic, but this hardly means that they are unimportant. Few adults can disregard a baby’s cry. It compels us to respond (Bowlby, 1969), and the nearly universal response is to be nurturing in some way (Bornstein et al., 1992). The infant’s cry is also a very revealing vocalization. Babies’ cries are affected by many factors, including hunger and sleepiness, nutritional deficiency, respiratory disorder, prematurity, genetic disorders such as Down syndrome, and cocaine exposure during pregnancy. For example, parents perceive the cries of children with autism spectrum disorder (ASD), compared to typically developing children and children with developmental delay, as less mature and more negative (Esposito & Venuti, 2008).

If babies’ cries inform parents about their unhappy state, babbling is the first significant nondistress communication. In babbling, there are frequent repetitions of the same syllable sound or syllable—for example, ba-ba-ba— and this practice perfects the sounds, syllables, and sequences of syllables that later comprise full-blown speech. Babbling is typically accompanied by excitement and motor activity and alternates with attentive listening. Although babbling seems simple, there is more to it than first meets the ear (Dromi, 2001). Babbling is significant because it comprises infants’ first structured vocalizations, because it sounds like fun, and because it follows crying so common in early infancy on the one hand, and the advent of intelligible words during toddlerhood on the other. Even deaf infants “babble” using sounds as well as hand signs (Petitto et al., 2001). We can conclude that having heard speech is not critical to babbling. The similarities in manual signing and vocal babbling indicate that babbling is an abstract language capacity of human beings related to expressive capacity.

Every child uses two sources of information when beginning to speak: the speech of others and feedback regarding his or her own speech. As might be expected, deaf infants’ vocal babbling develops later than those of hearing infants (Oller, 2000). Auditory input is necessary for the normal and timely development of the ability to reproduce the full range of adult-like syllables; indeed, it is crucial to children developing normal vocalizations in their native language. Babbling in Chinese differs from babbling in French. Language experts and laypeople alike can identify the language of origin in samples of 6- to 10-month-olds’ babbling, even though the infants will not be producing their native languages for quite a while (Boysson-Bardies, Sagart, & Durand, 1984). Thus, the prelinguistic speech of infants as young as 8 months of age is influenced by the language they hear. In sum, infants’ very earliest sensitivities to sound and their earliest vocal expressions provide evidence of strong biological influences on language development. Very soon, however, both perception and production of sound are shaped by the linguistic experiences provided by parents and cultures.

**How Infants Learn Words**

Recall the “Comeherelovelyforadrinkofjuice” problem. To understand this simple statement, even after breaking it down into separate units correctly, the child (lovely) must determine which unit refers to him- or herself, which to objects (juice) in the environment, which to an action (come), and so forth. After all, connections between
word sounds and word meanings are arbitrary, so the decoding task is challenging.

Once the baby speaks his or her first word around 12 months on average, the baby uses the word for all kinds of things. A holo-
phrase is a single word that stands in for a phrase and has different meanings depending on the context—for example, “bear” can mean “that is a bear,” “the bear fell,” “I want my bear,” or “my bear drinks milk.”

After the child had attained one-word speech, word learning proceeds rapidly. The average 3-year-old possesses an estimated vocabulary of 3,000 words. Therefore, between approximately 12 and 36 months, the child acquires four new words per day on average (MacWhinney & Bornstein, 2003). Word learning is also developmentally important: Vocabulary is a key marker of children’s development; vocabulary is a prominent component of child language that parents hear, attend to, and make judgments on; and size of vocabulary is an indicator of intelligence (Neisser et al., 1996). Thus, infants cry, babble, and gesture to communicate effectively, but these methods of communication are limited. A major step in language development is when infants begin learning the connections between sounds and meanings of their languages.

To what do children’s first words refer? One would think that children’s first words might be those that they hear most often. But this is not altogether true—or at least the story is not this simple. The two most frequent English words said to infants are you and the, which are rarely among the first 50 words children produce. So word frequency is not predictive of early vocabularies, although all other factors being equal, frequency matters; American children learn cat before cap because they hear one much more frequently than the other. What about the grammatical class of early words? Nouns refer to concrete objects, verbs to actions, and adjectives to properties. Perhaps because notions like “dog” are easier to grasp than notions like “give” or “round,” children around the world learn nouns earlier on than verbs or adjectives (Bornstein et al., 2004). One way word learning occurs is through induction, or using examples to draw conclusions about new cases. Suppose a child sees a cup referred to as “cup.” For the child to recognize that the same word refers to other cups requires an induction using a learned example to make inferences about novel objects. This is not as simple as it sounds, and there are several problems to solve.

First, there is what we might call the immediate reference problem: Mommy is holding a mug of coffee and saying the word “cup.” But what does the sound “cup” refer to? Sometimes the speaker will be pointing to an object when labeling it, but even in these seemingly clear cases there are many logical possibilities. The word might refer to the mug or its handle or the coffee in the mug or the act of drinking or that it is not appropriate for babies your age, or any of an infinite number of conceivable meanings. How do infants get it right?

Second is the extension problem: Once the infant has guessed what “cup” refers to, the child extends this word to other objects belonging to the same category unless the word is a proper name. (Having learned bird, a child will spontaneously use the same word for other members of the same object kind, but won’t extend Joan to all girls.)
fast mapping A phenomenon that refers to how easily children pick up words they have heard only a few times.

whole object assumption A concept that refers to children's belief that a novel label refers to the "whole object" and not to its parts, substance, or other properties.

mutual exclusivity A concept that refers to an infant's assumption that any given object has only one name.

socioeconomic status (SES) The education, occupation, and income of householders.

But what makes a cup a "cup"? Its shape? Color? Function? We cannot simply say that cup designates things that are similar to the original cup; and without defining similar, we're right back where we started. Children manage to figure out fairly quickly how to extend the use of words correctly if adults use words carefully. Once adults consistently name an object as few as nine times, children pick up that name for the object (Markman, 1999; Schafer & Plunkett, 1998; Woodward, Markman, & Fitzsimmons, 1994). That is, they map the sound onto the object, a phenomenon aptly called fast mapping.

Children must have some rules to help them in their guesses about word meanings (Markman, 1999). An example is the whole object assumption. When an adult points to a novel object and labels it, the child is believed to initially think the novel label refers to the whole object and not to its parts, substance, or other properties (although it could very well refer to these other things). Another rule is mutual exclusivity: The child assumes that any given object has only one name.

Children vary dramatically in their early vocabularies. In the fourth century, Emperor Constantine wrote that infants could not speak well or form words because their teeth had not yet erupted—which, if correct, should lead to earlier language development among infants with the fastest dental growth; this turns out not to be true, though. Most subsequent accounts have focused on differences in children's experience, primarily in the speech children hear from their parents. Parents who are lower in socioeconomic status (SES) talk substantially less to their children than more affluent parents, and as a consequence, infants from lower SES homes speak later and less than infants from higher SES homes. Hart and Risley (1995) estimated that children from high SES families have been exposed to around 44 million utterances by the age of 4 years, compared to 12 million utterances for low SES children (Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002). But there is also a great deal of variation that SES does not account for. Even among mothers from the same SES group, some talk to their babies during as little as 3 percent of a typical home observation and others during as much as 97 percent (Bornstein & Ruddy, 1984). When both language amount (how much the parent talks) and verbal responsiveness (whether the parent's speech is responsive to the infant) are considered, verbal responsiveness is found to contribute more to children's language development than amount of speech (Bornstein, Tamis-LeMonda, & Haynes, 1999; Tamis-LeMonda & Bornstein, 2002). Moreover, children with verbally responsive mothers combine words into simple sentences sooner in development than do children with less verbally responsive mothers. When mothers teach infants a name for a novel toy, they tend to move the toy in synchrony with their labeling, which helps infants make the association (Gogate, Bahrick, & Watson, 2000). Thus, maternal verbal responsiveness facilitates the growth of infant language skills. Indeed, Connor, Morrison, and Katch (2004) estimated that the family environment is the major source of preparation for children's literacy skills at school entry.

Is language development biologically programmed in our genes or determined by the environment? You probably know the answer to this: Language competence is, as you likely guessed, the product of genes and experience (Pruden et al., 2006; Waxman & Lidz, 2006). One-year-old adopted children are like their biological and adoptive parents in their language abilities, indicating genetic and environmental influences on language development (Hardy-Brown & Plomin, 1985).

How Infants Learn Grammar

Grammar (or syntax) refers to the rules for combining words into meaningful and interpretable communications, and grammatical development is underway by just about the beginning of the child's second year (Bates, Devescovi, & Wulfeck, 2001). The speed with which children achieve grammatical competence is particularly remarkable in that children are able to detect syntactic rules and regularities as to their native languages even though these vary enormously across languages. In English, for
example, subjects usually precede verbs, which in turn usually precede objects. Thus, when you hear “Larry, Marc, Deborah, and Karen wrote this book,” you know the book was written by Larry, Marc, Deborah, and Karen. As English speakers, we are so accustomed to this word order that it seems natural, even logical. But a great many languages don’t work this way. For example, in Welsh, the verb usually comes first. In Turkish and Japanese, many sentences place the verb last, but subjects and objects do not have a fixed order. Given that these rules vary across languages, one would think that they must be learned.

As to children’s acquisition of syntax, Skinner (1957) argued that children learn grammatical rules by imitation and reinforcement. According to this way of thinking, children learn transitional probabilities among words, or which word is likely to come after which other word. “The dog ate my homework” is English, but “Homework my dog the ate” is not. According to this view, adults produce grammatical statements for children to imitate, and they also systematically reward children’s grammatically correct statements.

However, Noam Chomsky (1965) argued that Skinner’s account of grammatical development, with its emphasis on learned transitional probabilities, is far too simple. The grammatically correct use and meaning of an initial word in a sentence just as often depends on the end of the sentence (i.e., on an overall sentence plan) as it does on the next word. For example, “Colorless green ideas sleep furiously” is a grammatical sentence, although the transitional probabilities in the word string are nonsensically low. Thus, transitional probabilities cannot serve as a principle of the child’s grammatical development.

Second, Skinner’s notion of reinforcement requires parents to consistently reward children for producing grammatical utterances (and not for ungrammatical ones). In practice, though, parents do not do this; in fact, parents are much more likely to correct young children’s factual errors than their grammar. If a child who is eating an apple says, “Me eat banana,” parents are more likely to say, “No, that is an apple” than “No, say ‘I am eating a banana’.” Thus, parents do not directly teach children grammar the way schoolteachers do. (Also, children resist explicit correction of grammar; a child saying “Me eat banana” will not generally switch to “I am eating a banana” upon being corrected.)

Chomsky argued that a number of aspects of syntax are innate, built into every infant’s brain in what he called universal grammar. Universal grammar accounts for the fact that, although children’s language environments differ, children’s syntactic outcomes are strikingly similar. Variation in the vocabulary size of English-learning children can be traced to environmental factors such as parents’ verbal responsiveness, but variation in grammar among children learning the same language is minimal; poor, middle-class, and well-to-do U.S. children use the subject-verb-object syntax of American English when they speak, even if the numbers of nouns, verbs, and adjectives in their vocabularies differ dramatically. Chomsky likened learning language to the growth of an organ like the heart: As long as certain very basic preconditions are met, it (whether language or the heart) will develop in all children. The claim is not that language itself is innate (if it were, why would children in Boston learn the syntax of English and children in Berlin the syntax of German?). Rather, the claim is that children have innate abilities that facilitate grammatical development. The cross-language evidence suggests that, when children everywhere start to put two words together, they try to convey the same basic set of meanings, like possession and location, and as they progress from there the rate of grammatical errors is surprisingly small (Bates et al., 2001).

Can biological structures that support language development be identified in the brain? At present it is not possible to give a complete answer to this question. We can say that no special area of brain tissue is wholly dedicated to language; however, certain structures in the brain are involved in particular aspects of language processing. It is well known that the left hemisphere of the brain is generally concerned with
language processing. For example, injury to **Broca’s area** (in the left frontal lobe) tends to cause problems in producing fluent speech and in comprehending syntactic structure; injury to **Wernicke’s area** (in the left temporal lobe) tends to cause poor comprehension and fluent, but relatively meaningless speech (Sakai, 2005). (See Figure 4.4 for reference.)

When does brain lateralization begin in childhood? Mills, Prat, Zangl, Stager, Neville, and Werker (2004) examined auditory event-related potentials (ERPs) in response to words whose meanings infants knew and compared them with ERPs to words infants did not. From 14 to 20 months, ERP amplitude differences between known and unknown words could be observed over both the left and right hemispheres; by 20 months, the difference was limited to the left hemisphere, showing that word understanding is lateralized before children reach their second birthday.

### INTERIM SUMMARY 5.5

**Language Development in Infancy**

- Sounds must be produced and perceived (phonology).
- The meaning of words (semantics) must be learned.
- The grammar (syntax) of the language defines the ways in which words and phrases are arranged to ensure correct communication.
- Some children are **referential** (their vocabularies include a high proportion of nouns); some, **expressive** (their early language has more social routines).

**Infant-Directed Speech**

- Individuals use a special dialect when addressing infants.
- Turn-taking is used in parent-child dialogue as is gesture.

**Making and Understanding Sounds**

- Infants perceive categories of speech sounds.
- Infants pass through prelinguistic, one-word, and multiword stages in early verbal development.
- Babies’ first means of vocal communication are prelinguistic—crying and babbling.

**How Infants Learn Words**

- Babies tend to use a single word (or **holophrase**) for many things when they first speak (around 12 months on average).
- Between 13 and 36 months, infants acquire four new words a day on average.

**How Infants Learn Grammar**

- Noam Chomsky argued that a number of aspects of syntax are innate, built into every infant’s brain in a **universal grammar**.
- Children have a natural inclination to develop grammatically structured communication.
Was there once just one language? Would all children initially speak the same language if they weren’t influenced by their experience to speak the specific language they hear? The question of whether children possess a “natural language” has been asked with surprising frequency in history and by a surprising group of individuals, from pharaohs to phoneticians. James I of England (1566–1625), for example, posed the question and thought of how to address it. Long interested in the Bible—his is the King James version, of course—James sought to identify the original language of Adam and Eve. He proposed to place two infants on an otherwise uninhabited island in the care of a deaf-mute nurse. James reasoned that, if the two spontaneously developed speech, theirs would be the natural language of humankind. Although probably within his power, King James never (to our knowledge) conducted his study as such an experiment would be wholly unethical.

Natural experiments that approximate King James’s conditions suggest that children develop their own grammar and vocabulary in the absence of formal linguistic experience. For example, deaf infants who are of normal intelligence but whose parents (for various reasons) have prohibited their learning sign language have essentially no experience with any formal language, but their other life experiences are normal. These children develop their own signs to refer to objects, people, and actions, and they combine signs into phrases to express relations among words in ordered ways. Their communication system is not only structured, it incorporates many properties found in hearing children’s language. Clearly, in the absence of formal training and imitation, children develop syntactic rules: They sign nouns before verbs, and verbs before objects acted on.

Furthermore, the timing of deaf children’s invention of communication systems is roughly the same as that of hearing children learning spoken languages—their first “words” appear at around 12 months, and their first combinations of words appear several months later. Even children in challenging circumstances reveal a natural inclination to develop grammatical communication. (For a summary of this section, see “Interim Summary 5.5: Language Development in Infancy.”)

**SUMMING UP AND LOOKING AHEAD**

In the not too distant past, the notion that infants think would have been considered laughable. Today, however, we know better thanks largely to the work of Piaget and the decades of scientific study his work stimulated. Although Piaget’s timetable for development in this period has been challenged, his general theory of the sequence of cognitive development still stands: Children are active learners, who use their eyes and ears, hands and mouth to investigate and make sense of their world. Infants seem predisposed to form categories, build memories, play, and communicate with others. They are drawn to novelty and are primed to develop language. Although maturation plays a central role in this process, what infants discover, and the rate at which they develop, are shaped by experience and context. Cognitive development is in large part a social process, stimulated and influenced by the interactions of children with parents, siblings, peers, and adults outside the family.

There is much cognitive development that takes place after infancy, which builds on the foundation of language developed during these early years. As you will read in Chapter 7, tremendous strides in language, information processing, mathematical thinking, and social understanding take place between ages 3 and 5. But we are getting ahead of ourselves. We still have one more broad domain of infancy to cover before we leave babyhood behind. The development of the infant as a social being—and the relationships he or she forms with others—is the subject of our next, and final, chapter on the first 2 years after birth.
Did You Get It?

After reading this chapter, you should know:

- The techniques and strategies that developmental scientists use to confirm that infants have an active mental life
- Piaget’s contribution to the study of infant cognition, including his six stages of the sensorimotor period
- The development of infants’ abilities of categorization, memory, and play
- Infant intelligence tests and their limitations
- The processes of language development in infancy

Important Terms and Concepts

accommodation (p. 126)  grammar (p. 146)  mutual exclusivity (p. 146)  sensorimotor period (p. 126)
adaptation (p. 126)  habituation (p. 123)  novelty responsiveness (p. 124)  socioeconomic status (SES)
assimilation (p. 126)  holophrase (p. 145)  object permanence (p. 126)  symbolic play (p. 132)
Broca’s area (p. 148)  induction (p. 145)  phonology (p. 138)  syntax (p. 138)
categorization (p. 129)  infant-directed speech (p. 145)  predictive validity (p. 134)  universal grammar (p. 147)
comprehension (p. 140)  mental representation (p. 142)  production (p. 140)  validity (p. 133)
deferred imitation (p. 131)  infantile amnesia (p. 130)  referential (p. 140)  Wernicke’s area (p. 148)
ethnotheories (p. 137)  morphemes (p. 140)  scaffolding (p. 137)  whole object assumption (p. 146)
exploratory play (p. 131)  mental representation (p. 127)  semantics (p. 138)