In summary, infants begin to use perceptual characteristics to form categories by the time they are 3 months old. By 7 months, they form conceptual categories that allow for considerable perceptual variability. By 14 months, they clearly apply categories in their behavior with objects. Their early conceptual categories tend to be rather broad, with more specific subcategories appearing at around 18 months.

MEMORY DEVELOPMENT IN INFANCY

A number of years ago, one of the authors of this book and his family were in a car accident while on vacation. The author’s son, then less than a year old, was taken to a hospital by ambulance to have minor injuries treated. Two years later the family was driving through the town where the accident occurred. The little boy, now 3 years old, looked around and spontaneously asked: “Are we going to see the ambulance now?” Did he remember the accident from two years earlier, when he had known the meaning of only a few words, ambulance certainly not among them? And if babies can form lasting memories of things that happen to them, why do most adults recall almost nothing about their infancies?

Piaget believed that infants were capable of recognition memory—simply perceiving a particular stimulus as familiar, which could be based entirely on sensorimotor information and schemes. However, he did not believe they could engage in recall—actively retrieving information from memory, which would require mental representation (Flavell et al., 1993). Research on infant memory has revealed that Piaget was partly right, but the full picture is somewhat more complicated. In the first six months of life, infants’ memory abilities seem to match Piaget’s expectations, but in later infancy they appear to go beyond what he thought was possible.

In the following sections, we first review memory development in early and later infancy. Then we examine the role of brain development in infant memory before returning to the question of why memories of infancy do not survive into later life.

Memory in Early Infancy

Babies have some memory capabilities from birth. Newborns readily habituate to repeated sights and sounds, indicating that they remember enough about a stimulus to perceive it as familiar (Schneider and Bjorklund, 1998; Slater, 1995). In fact, as mentioned in Chapter 4, newborns quickly learn to recognize their mothers’ face, voice, and smell, and they can even recognize the sound patterns of a story their mothers read aloud repeatedly while they were in the womb. Most of these examples involve recognizing stimuli that were seen or heard seconds earlier or have been experienced repeatedly over a long period of time, but some evidence indicates that babies just a few days old can recognize a newly experienced stimulus for as long as twenty-four to forty-eight hours (Nelson, 1995).

Until they are about 3 months old, babies seem to have trouble storing information about relationships between visual stimuli, even very simple relationships like the angles formed by two straight lines. Cohen and Younger (1984) repeatedly showed 6- and 14-week-olds the same angle until they became habituated. Then they showed them either exactly the same angle, the same angle turned a different way, a new angle formed from lines with the same orientations as in the original angle, or a new angle formed from lines with different orientations. As shown in Figure 5.7, 6-week-olds appeared to remember the orientation of individual lines, not the combination of lines that forms an angle. They disacclimated to any angle in which the orientation of the lines changed, including the original angle turned in a new direction. The 14-week-olds, however, seemed to remember angles rather than the orientation of individual lines.

Studies using simple laboratory stimuli such as these help us understand why very young infants have difficulty remembering more relevant stimuli. If they remember visual features independently rather than in relationship to other features, they cannot remember
Figure 5.7
INFANT MEMORY FOR ANGLES
Cohen and Younger habituated 6- and 14-week-olds to various angles. After habituation, several angles were presented to the infants as test stimuli. Longer looking times indicated which angles were seen as different from the habituation stimulus. (Source: Adapted from Cohen and Younger, 1984.)

<table>
<thead>
<tr>
<th>Habituation stimulus</th>
<th>Test stimuli</th>
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<tbody>
<tr>
<td></td>
<td>Habituation stimulus</td>
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<table>
<thead>
<tr>
<th>6-week-olds</th>
<th>14-week-olds</th>
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<tr>
<td>Looking time (in seconds)</td>
<td></td>
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<tr>
<td>16</td>
<td>11</td>
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<td>14</td>
<td>9</td>
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<td>12</td>
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<td>8</td>
<td>3</td>
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</table>

Cued recall:
A type of memory in which a familiar stimulus triggers recall of stored information.

complex patterns, such as human faces. Studies that directly explore babies' memories for faces generally support this view. As mentioned in Chapter 4, before 3 months of age, babies don't seem to organize and store detailed concepts of particular faces (Olson and Sherman, 1983).

The capacity to retain a memory for more than a few hours or days increases during the first months of life. In one study, infants who at 3 months of age saw a film of an unusual object in motion still showed signs of recognizing its motion pattern three months later (Bahrick and Pickens, 1995). There is even clearer evidence that 2- to 4-month-olds can retain a memory involving actions of their own for several weeks, as demonstrated in an interesting set of studies by Carolyn Rovee-Collier and her colleagues (Rovee-Collier, 1993; Rovee-Collier and Hayne, 1987). In these studies, babies were placed in a crib with an overhead mobile, and the mobile was attached to one of their legs by a ribbon. Even the 2-month-olds quickly learned that the mobile moved when they kicked. Six to eight days later, these infants showed they remembered what they had previously learned by starting to kick when they were placed in the crib with the mobile. But there were limits to how long they could remember the connection; after two weeks, they no longer spontaneously kicked when they saw the mobile.

However, it turns out that even after two weeks the memory had not totally faded. If the babies were shown the mobile the day before testing, their memory of the connection between kicking and making the mobile move could be reactivated. This finding differs somewhat from Piaget's observations of his son Laurent learning to move a rattle attached to one of his arms with a string. Just seeing the rattle suspended above his crib was not enough to get Laurent to resume moving his arm. Piaget had to shake the rattle for Laurent to remember the connection. But in both of these experiments the babies' memories could be triggered by a perceptual reminder. In Laurent's case it was the sound of the rattle (probably its most salient feature); in Rovee-Collier's experiment it was the sight of the mobile's interesting shapes or colors. Apparently, although young babies do form long-term memories, they may have trouble retrieving them without clear-cut cues. This kind of memory is called cued recall because the sight of the mobile or the sound of the rattle cues, or triggers, the memory of the appropriate behavior.
In the first six months, infants' memory seems to be extremely context-bound. In other words, cued recall only seems to occur in contexts that are highly similar to the context in which the original experience occurred (Rovee-Collier, 1993). In Rovee-Collier's studies, memory was enhanced if babies were tested in a context identical to the one in which they learned that kicking would make the mobile move. Seemingly minor changes in the context, such as adding new objects to the mobile or changing the design or color of the crib liner, interfered with recall. Testing the baby in a different room than the one where the original learning occurred also disrupted recall, even if the mobile and crib were unchanged. Babies 6 months of age and younger seem to have limited ability to generalize learning to new contexts.

In summary, babies show considerable development in memory abilities in the first six months of life:

- They progress from being limited to simple recognition to engaging in cued recall.
- The length of time they can retain a memory increases.
- Their ability to remember relationships between visual stimuli increases.

However, even at 6 months, memory seems to be bound to particular contexts and to depend on immediate perceptual cues. The memory abilities that have been demonstrated in the first six months are consistent with Piaget's view that babies' memories are sensorimotor in nature and not true mental representations (Schneider and Bjorklund, 1998).

Memory in Later Infancy

Between 6 and 18 months, babies' memory abilities continue to improve. By the end of the first year of life, they show evidence of the ability to hold information in working memory briefly before using it to initiate some action. In addition, they show increases in the length of time they can retain memories and in their ability to engage in recall. The long-term memory skills that emerge in the second six months of life help to make possible the strong emotional bonds that infants develop with their parents at this time.

The clearest evidence for the development of working memory is 8- to 12-month-olds' gradual mastery of object permanence tasks that involve multiple hiding places. As already discussed, memory limitations are part of the explanation for the A, not-B error that is typical of babies in Piaget's sensorimotor stage 4. At 8 months, infants can find an object at a new location only after a delay of two seconds or less. The length of delay they can tolerate increases with age; by sometime between 12 and 15 months, they can still find the object after a delay of up to ten seconds (Diamond, 1985; Matthews, Ellis, and Nelson, 1996). This increase indicates a growth in the ability to take action based on information held in working memory.

At the same time that infants are developing the ability to use information held in working memory for a short time, they are also increasing their ability to retain information over long periods of time. One technique that has been used to study long-term memory in older infants is based on Piaget's concept of deferred imitation. In studies using this approach, an action or sequence of actions is modeled for babies, who are tested on their ability to reproduce it after a delay ranging from a few minutes to several months. Infants as young as 9 months have shown some ability to engage in deferred imitation. In a study by Andrew Meltzoff (1988), 9-month-olds watched adults demonstrate a number of actions with objects, such as pushing a button to produce a beeping sound, but were not immediately given a chance to do the actions themselves. The babies could reproduce the actions when they were shown the objects again after twenty-four hours, but not after a week.

Both the complexity of actions babies can remember and the length of time they can remember them increase with age. In another study, 11-month-olds who saw action sequences, such as putting a button through a slot in a container and shaking the container like a rattle, were able to reproduce them three months later (Mandler and McDonough, 1995). By 16 months, babies seem to be able to store memories of a longer action sequence, such as undressing and bathing a baby doll, for retrieval as much as eight months later.
Explicit or declarative memory:
Memory that is conscious, involves mental representation of images or ideas, and can be explicitly stated or declared.

Implicit or procedural memory:
Memory that is unconscious, involves memory for procedures or skills, and does not lend itself to explicit statement.

Brain Development and Infant Memory
As you can see, even though memories of infancy are not carried forward into later life, infants clearly do form memories. How can this apparent paradox be explained? The answer seems to be that the term memory covers several rather different processes that emerge at different points in infancy and develop on different timetables. A number of theorists have argued that a distinction should be made between explicit or declarative memory and implicit or procedural memory (Johnson, 1997; Nelson, 1995). Explicit memory is...
conscious, involves mental representation of images or ideas, and can be explicitly stated or declared. Implicit memory is unconscious, involves memory for procedures or skills, and does not lend itself to explicit statement. For example, your memory of what your first bicycle looked like would be explicit or declarative; your memory of how to ride a bicycle would be implicit or procedural. You can probably form a mental image of your first bicycle, of the occasion when you received it, and perhaps even of yourself learning to ride it—all explicit memories. When you get on a bicycle and start riding, however, you do not consciously call up a memory of how to ride; instead, you simply exercise a well-learned skill—an implicit memory.

Chuck Nelson (1995) has proposed that early memory development actually involves several different types of implicit and explicit memory systems, each of which depends on development in different parts of the brain. The types of memory that develop in the first six months of life, including those reflected in habituation and conditioning, are all implicit and depend on such brain structures as the cerebellum and the hippocampus. The types of memory that develop after 6 months of age, including those reflected in advanced object permanence tasks and deferred imitation, are explicit and depend on activity in the cerebral cortex or connections between the cerebral cortex and the hippocampus. This gradual development of different types of memory also helps to explain adults’ inability to recall memories from infancy, a phenomenon known as infantile amnesia. See the box on page 182 for further discussion of infantile amnesia.

**SOCIAL CONTEXT AND COGNITIVE DEVELOPMENT IN INFANCY**

Piaget argued that the role of the environment was to provide an overall context for children to explore. This active exploration led naturally to cognitive growth. Information-processing theorists frequently see the environment as providing more specific pieces of information or contexts for practicing more specific skills. However, many developmentalists, inspired by the work of Vygotsky, see both these views as far too limited in accounting for the influence of the environment.

Researchers working from a sociocultural perspective argue that adults structure the environment to foster the kind of learning they deem most important for children. This process begins in infancy and becomes increasingly pronounced as children grow older. For example, the pace of infants’ cognitive development is affected by the amount and type of stimulation provided in their homes. Middle-class American parents often surround their babies with objects designed to foster perceptual and cognitive development, such as toys and crib mobiles. Because of the value placed on academic achievement in the American middle class, some parents go even farther in attempting to accelerate their babies’ cognitive development, often with limited success, as described in the box on page 183. In families of lower socioeconomic status, where there is often less emphasis on academic achievement, infants tend to receive less cognitive stimulation, resulting in slower cognitive and linguistic development (Hart and Risley, 1995).

Cross-cultural research on infants’ sensorimotor development has found small variations in the ages at which babies can do Piaget’s object permanence tasks, but striking similarities across cultures in the processes of sensorimotor development (Dasen and Heron, 1981; Werner, 1979). Infants around the world appear to share the same skills for exploring the world and manipulating objects, especially early in development. For example, in one study French babies and babies from the Ivory Coast in Africa handled strings of paper clips and plastic tubes in strikingly similar ways, even though paper clips and plastic tubes were not familiar objects for the African babies (Dasen and Heron, 1981). One reason for this may be that the physical properties of objects are more salient for infants than their specific cultural meanings and uses.

However, infants vary in the opportunities they have for exploration and the types of objects available for manipulation. For example, middle-class American babies typically enjoy considerable “floor freedom” to crawl and explore the environment in their homes.
INFANTILE AMNESIA

Despite the fact that infants are clearly capable of forming relatively long-term memories of objects, people, and behaviors, autobiographical memory—enduring memory of one’s own past—does not begin until after infancy. Most people’s earliest memories date from around age 3½ to 4 years, although some people report memories from as early as age 2 (Schneider and Bjorklund, 1998; Usher and Neisser, 1993).

Freud was the first to use the term infantile amnesia to refer to this phenomenon. True to his psychosexual theory of development, Freud believed that memories from infancy are repressed because they are sexually charged and therefore not acceptable later in life. There is no evidence to support this explanation; indeed, there seems to be no way to test it.

A number of other explanations have been offered for infantile amnesia, but it is still not clear which one is best; in all probability, several factors are involved. Traditionally, the basic issue has been whether infantile amnesia is a memory storage problem or a memory retrieval problem—is it that no autobiographical memories are stored during infancy, or is it that they are stored, but for some reason become un retrievable later?

As we have already seen, infants do store various sorts of memories, in some cases for relatively long periods of time. And there is evidence that 2- and 3-year-olds can remember events from late infancy. In one study, children who had repeatedly visited a university perceptual development laboratory between 6 weeks and 9 months of age showed some memory for their experiences when they returned to the lab two years later (Myers, Clifton, and Clarkson, 1987). In another study, 3-year-olds were able to remember aspects of a trip they had taken to Disney World 18 months earlier, when they were 2 years old or less (Hamond and Fivush, 1991). However, we do not know what the upper limit is for the endurance of infant memories. It is possible that immaturity of the cerebral cortex and its connections with the hippocampus interferes with permanent storage of memories in infancy (Bachevalier, 1991; Nelson, 1995).

The simplest explanation for infantile amnesia would be that infant memories simply decay and are lost due to the passage of time. This explanation seems unlikely because the age of earliest memories remains the same from middle childhood through adulthood; 8-year-olds and 88-year-olds both report first memories from around the same age (Nelson and Ross, 1980). Thus, it seems likely that some change in early childhood makes autobiographical memory possible.

At one time it was believed that the relevant change might be the emergence of language. That is, either long-term memory storage was impossible before language appeared, or memories stored by infants became inaccessible once they acquired language (Nelson and Ross, 1980). We now know that infants do store relatively long-term memories before they have language, and that young children who have language can still retrieve memories from before they started to talk.

It is possible that the emergence of autobiographical memory reflects a change in how memories are organized, rather than the emergence of an entirely new type of memory. For example, increasing language skill may help children to organize memories into narratives that can be more easily retained and shared with others (Nelson, 1993). In addition, the emergence of a sense of self in early childhood may be necessary before true autobiographical memory can begin (Howe and Courage, 1993). Brain development could also be involved in this process, as increasingly complex connections in the cerebral cortex and between the cerebral cortex and the hippocampus make more organized and complete memories possible.

American parents often go to great lengths to make such exploration possible by baby-proofing their homes with electrical outlet covers, special latches on cupboard doors, and safety gates on stairs. In many cultures located in tropical areas, babies spend very little time on the ground because of dangers such as cooking fires, insects, and poisonous snakes (LeVine, 1988). Over time, these differences in infant care practices produce differences in motor and cognitive development.

With help from adults, infants can also learn to perform a variety of specialized motor skills at an earlier age than is typical. According to The Guinness Book of World Records, a baby named Parks Bonifay learned to water-ski before the age of 8 months. We can be fairly sure that Parks did not acquire this skill simply by being raised in an environment in which water and water skis were available for him to explore freely. Rather, we would expect that this accomplishment resulted from a large amount of instructional effort by the
Sometimes, influenced by “experts,” parents present their infants with special stimulation in hopes that they can dramatically advance their cognitive development. Thus, we hear of parents reading to a baby every night or buying flash cards of letters, words, or numbers to get a toddler started on the basics of reading and math.

These parents usually make two important errors in reasoning. First, they assume that stimulation that works at one age must be good at other ages. But what fosters development in an older child does not always work for a younger one. Flash cards may help a second grader master arithmetic, but they have little value for a baby. Parents of infants can do more to foster cognitive development through normal interactions with their babies, talking to them, responding to their vocalizations, and playing games like peek-a-boo. Second, these parents assume that accelerating some aspect of cognitive development will lead to higher academic performance and a higher IQ. However, earlier does not always mean better in the long run. A child taught to read at 4 is not likely to be a better reader at 21 than a child who started reading at the more typical age of 6.

**When Stimulation Programs Are Important**

Special infant stimulation programs do have their place. For example, premature babies can benefit from them. These infants are deprived of the tactile and motion stimulation experienced in the uterus during the last weeks of gestation. In addition, prematurity is often associated with poverty and maternal stress, factors that can place babies at risk for developmental problems.

Successful programs for premature infants provide age-appropriate stimulation. In the weeks after birth, babies receive tactile stimulation, such as handling, rocking, and the use of water beds. Such stimulation has been found to help prevent the motor and perceptual problems that can occur in preterm infants, probably by promoting central nervous system development.

Long-term programs typically provide more varied forms of stimulation and support. In one program, low-income families with premature babies were visited weekly at home for the first year, and the parents were helped to engage the baby in games and activities to foster cognitive, language, and social development (Brooks-Gunn et al., 1993b). In the second and third years, home visits occurred twice a month; the children attended a child development center daily, and a parents’ support group met six times a year. Compared with children in a control group who received only routine pediatric care and referral services, the children in this program experienced cognitive benefits. At age 2, they scored significantly higher on the Bayley Scales of Infant Development, and at age 3 they scored higher on the preschool Weschler Intelligence Scales. This program also promoted a more effective parent-child collaboration (Spiker, Ferguson, and Brooks-Gunn, 1993).

**Why Infant Stimulation is Effective**

From a Piagetian perspective, the optimal environment for cognitive development gives infants opportunities to explore the world in ways appropriate to their current level of functioning. From an information-processing perspective, stimulus programs should provide specific experiences that fit into infants’ existing knowledge structures. From a Vygotskian perspective, infants should not only have appropriately stimulating experiences, but should also develop an interaction system with caregivers that will support later social transmission of knowledge. The program described here, as well as others that have been successful (e.g., Campbell and Kamey, 1994), does all of this by simultaneously providing stimulating, age-appropriate experiences and fostering social interaction between the infant and adults.

Adults around him and that waterskiing and athletic prowess in general were highly valued by his family. It is also likely that Parks was already somewhat advanced in his overall motor development; most 8-month-olds could probably not be taught to water-ski, no matter how much instruction they were given.

Piagetians have argued that such direct training is not really development because it consists only of isolated skills that are not part of an integrated system for doing, thinking, and understanding. In some cases they may be correct, but there are other cases in which a skill taught early in life is culturally adaptive and becomes an important component in later development. For example, many Norwegian children begin to learn to cross-country ski as soon as they can walk and continue to develop and engage in this skill throughout life. In Polynesia, infants often learn to swim even before they can walk; for them, swimming is not just culturally valued but has obvious survival value.
Infants around the world manipulate objects in similar ways; for them, the physical characteristics of an object are more relevant than the object's cultural meaning.

The Vygotskian perspective makes several important observations that contribute to our understanding of cognitive development. First, infants frequently are more like guided tourists than like explorers as they develop cognitively—that is, what they are finding out about the world is what the adults around them already know. Second, infants in some cases can learn more rapidly from adults and in other cases are only able to learn things with substantial support from adults. Third, the skills that children learn from adults are almost always highly valued within those adults' social context or culture.

INDIVIDUAL DIFFERENCES IN INFANT COGNITIVE SKILLS

Both Maggie and Mikey were active, alert babies, but they did not follow the same developmental timetable. Much to Christine's delight as a first-time mother, Maggie seemed to do everything ahead of schedule—rolling over, sitting up, crawling, walking, saying her first word. By comparison, Mikey seemed to lag a little bit behind. When Christine consulted her baby book, she was relieved to find that he was actually reaching the major developmental milestones at fairly typical ages. Still, she wondered if the differences between them meant that Maggie would also do better in school.

Research confirms that normal babies vary considerably in the ages at which they reach various developmental milestones, and babies the same age often respond differently to the same task. Developmentalists have designed a variety of tests to measure these differences, including the Bayley Scales of Infant Development, the Gesell Developmental Schedule,
and the Cattell Intelligence Tests for Infants and Young Children. Table 5.2 shows some of the items contained in the Bayley Scales. Notice that the items designed to assess younger babies measure attention and sensorimotor coordination, while those designed to assess older infants and toddlers are more cognitive in nature.

Just as Christine wondered about the differences between Maggie and Mikey, developmental psychologists have wondered whether a baby’s performance on infant tests can predict that child’s performance on cognitive tests in later periods of development. In a longitudinal study that took many years to complete, Nancy Bayley (1949) tested a group of children repeatedly from the time they were 3 months old until they were 18 years old. She found that test scores at different ages did not reliably correlate with one another until after age 4. Other studies produced similar results; scores on developmental tests in infancy and toddlerhood were not very predictive of later IQ (e.g., Honzik, 1983). Many developmentalists took this to mean that individual differences in cognitive skills during infancy were not stable. However, a more likely explanation is that infant tests such as the Bayley measure different abilities than those measured by IQ tests for older children and adults (Bornstein and Sigman, 1986; Fagan and McGrath, 1981).

More recently, researchers have found other measures of infant cognitive ability that seem to be more closely related to cognitive skills in later developmental periods. Robert McCall and Michael Carriger (1993) reviewed the results of twenty-three studies that measured infants’ performance on memory tasks and then measured IQ in the same children when they were older. McCall and Carriger found moderate predictability of later IQ from early performance on memory tasks, with a correlation of about .40 between tests in infancy and later in childhood.

To illustrate what this relationship means, Figure 5.8 shows a set of data that would produce a correlation of .40 between infant cognitive scores and childhood IQ scores. In

<table>
<thead>
<tr>
<th>Table 5.2</th>
<th>SELECT ITEMS FROM BAYLEY SCALES OF INFANT DEVELOPMENT</th>
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</thead>
<tbody>
<tr>
<td><strong>Age (and Range)</strong></td>
<td><strong>Item</strong></td>
</tr>
<tr>
<td><strong>in Months</strong></td>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>0.1</td>
<td>Responds to sound of bell</td>
</tr>
<tr>
<td>0.7 (3–2)</td>
<td>Eyes follow moving person</td>
</tr>
<tr>
<td>1.6 (5–4)</td>
<td>Turns eyes to light</td>
</tr>
<tr>
<td>1.9 (1–4)</td>
<td>Blinks at shadow of hand</td>
</tr>
<tr>
<td>2.4 (1–5)</td>
<td>Reacts to disappearance of face</td>
</tr>
<tr>
<td>3.1 (1–5)</td>
<td>Reaches for dangling ring</td>
</tr>
<tr>
<td>3.8 (2–6)</td>
<td>Inspects own hands</td>
</tr>
<tr>
<td>4.1 (2–6)</td>
<td>Reaches for cube</td>
</tr>
<tr>
<td>4.4 (2–6)</td>
<td>Eye-hand coordination in reaching</td>
</tr>
<tr>
<td>5.4 (3–12)</td>
<td>Smiles at mirror image</td>
</tr>
<tr>
<td>5.8 (4–11)</td>
<td>Lifts cups with handle</td>
</tr>
<tr>
<td>7.1 (5–10)</td>
<td>Pulls string adaptively: secures ring</td>
</tr>
<tr>
<td>8.1 (6–12)</td>
<td>Uncovers toy</td>
</tr>
<tr>
<td>9.1 (6–14)</td>
<td>Responds to verbal request</td>
</tr>
<tr>
<td>10.4 (7–15)</td>
<td>Attempts to imitate scribble</td>
</tr>
<tr>
<td>12.0 (8–18)</td>
<td>Turns pages of book</td>
</tr>
<tr>
<td>12.5 (9–18)</td>
<td>Imitates words (Record words used)</td>
</tr>
<tr>
<td>14.2 (10–23)</td>
<td>Says 2 words (Note words)</td>
</tr>
<tr>
<td>16.7 (13–21)</td>
<td>Builds tower of 3 cubes</td>
</tr>
</tbody>
</table>

Source: “Bayley Scales of Infant Development.” Copyright © 1969 by the Psychological Corporation. Reproduced by permission. All rights reserved. "Bayley Scales of Infant Development" is a registered trademark of The Psychological Corporation.
Figure 5.8
RELATIONSHIP BETWEEN INFANT TEST SCORES AND CHILDHOOD IQ
These data illustrate a correlation of .40 between a cognitive measure in infancy and an IQ measure in childhood. Note that there is so much variability that it is not possible to accurately predict an individual child’s IQ score by knowing the cognitive score that child achieved in infancy.

this data set, children who score higher on the infant test generally also score higher on the later test, but there are exceptions. Some children who score high in infancy score average or below average later. Others who score low or average as infants later perform well above average. Children with the same scores on the infant test receive widely varying scores on the later IQ test; for example, the chart shows that the five children with a score of 16 on the infant test have IQ scores ranging from 90 (just below average) to over 130 (well above average). This data set illustrates two important points. First, although the data demonstrate a relationship between infant skills and later cognitive ability for groups of infants, the level of prediction is too low to be useful in making predictions about the intellectual skills of individual infants. Second, although there is some predictability from infancy to later childhood, there is no indication that cognitive ability is biologically fixed early in development. On the contrary, the data suggest that experience is critical for the development of cognitive skills, since children with the same scores in infancy can end up with such widely varying IQ scores later in childhood.

Recent longitudinal studies have found that information-processing factors, such as how long it takes infants to habituate to a stimulus and how rapidly they process perceptual information, predict IQ as late as age 11 or 12 (Rose and Feldman, 1995, 1997; Rose et al., 1997). John Colombo (1993) believes that two variables measured in the newer infant tests are particularly important for predicting future IQ: speed of information processing and capacity of working memory. Colombo argues that individual differences in these two variables may be influenced by both heredity and experience.

To summarize, traditional tests of infant cognitive abilities, which include many measures of attentional and motor skills, do not predict later performance on intelligence tests. Newer measures that focus on information-processing skills, such as habituation and novelty preference, seem to be more closely related to later cognitive abilities.

ADVANCES AND LIMITATIONS: AN OVERVIEW

At birth Malcolm responded to the world using his inborn reflexes. When the side of his face was gently stroked, he automatically turned his head. When an object came in contact with his mouth, he automatically sucked. Specific stimuli triggered specific responses, with no conscious intention on Malcolm’s part. When we see Malcolm seven months later, the contrast is dramatic. He is purposefully reaching for and inspecting Teresa’s drawings, trying out motor actions and observing the results. He is a busy, active learner trying to understand his world.

A great deal of cognitive development occurs in the first two years of life. Starting from a set of inborn abilities, babies develop an increasingly refined understanding of the
Chapter Summary

Plagel's Theory of Infant Cognitive Development

This chapter has five major themes:

- Cognitive development proceeds in an orderly way. Infants are active participants in their own development.
- Infants make use of their environment to advance their cognitive development. The following are the key assumptions of Piaget's theory:
- Infants' understanding of the world is limited to what they can know through sensory awareness and motor activity.
- Infants actively construct an understanding of the world.
- Infants' understanding of their own identity and relationships is influenced by experience and the environment. Infants' development is marked by both advances and limitations.

Piaget identified six stages in the sensorimotor period of cognitive development:

Stage 1: Birth to 1 month
- Primary Sensorimotor Reflexes:
  - Infant's inborn reflexes (e.g., sucking, smiling)
- Stage 1 (1 to 4 months)
- Early Sensorimotor Stage:
  - Infants learn to coordinate their movements and explore the world through trial and error.

Stage 2: 4 to 8 months
- Infants begin to explore the world through the use of their hands and feet.
- Infants begin to develop a sense of self.

Stage 3: 8 to 12 months
- Infants begin to understand the concept of object permanence.
- Infants begin to develop a sense of space and distance.

Stage 4: 12 to 18 months
- Infants begin to develop a sense of time.
- Infants begin to develop a sense of self.

Stage 5: 18 to 24 months
- Infants begin to develop a sense of identity.
- Infants begin to develop a sense of social relationships.

Stage 6: 2 to 3 years
- Infants begin to develop a sense of morality.
- Infants begin to develop a sense of self-regulation.

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Looking across various areas of cognitive functioning, infants seem to make major leaps in development at about 5 to 6 months and again at about 7 to 8 months. Infants that are around 4 months begin to understand basic concepts and abilities, such as object permanence, and the ability to hold information in memory.

World experiences are not simply a series of events. Instead, they are constructed by the mind as a coherent and meaningful whole. The mind is constantly organizing and interpreting the world.

The ability to understand the world is limited to what infants can know through sensory awareness and motor activity. Infants actively construct an understanding of the world.

In summary, infants are active participants in their own development. They construct an understanding of the world through their experiences and the environment. Infants' development is marked by both advances and limitations.