CHAPTER OVERVIEW

Section 9-1 Early Brain Development
- Outlines the study and structure of the brain, and discusses the engineering and organization of information in the brain.

Section 9-2 Intellectual Development During the First Year
- Describes a baby’s developing intellectual abilities, discusses Piaget’s theories, stimulating the senses, and the formation of concepts.

Section 9-3 Helping Infants Learn
- Addresses how caregivers can encourage a baby in their learning process with an emphasis on the importance of play, appropriate toys, and developing communication skills.

Thoughtful Reading:
Ask students to:
- Use index cards to list what they wonder about the content in each Section as they read Chapter 9.
- Volunteer to share opinions about what they have read. Discuss any shared myths.
- Write and turn in a paragraph summarizing what they read in each Section of Chapter 9. Use their papers to review the content of Chapter 9 before giving an assessment.

Online

CONNECTIONS
Is stimulation always good for children? One research study found that 87% of parents believe that the more stimulation a baby receives, the better off he or she is. Have students investigate this claim and present their findings.
Early Brain Development

Maya and Joe had watched six-month-old Abby’s every twitch, gulp, burp, gurgle, and coo with rapt attention. They often worried whether Abby was developing as she should. The doctor said she was healthy, but they wanted her to be smart as well. Their families and friends offered lots of advice, but some was contradictory. Sometimes they tried to guess what Abby was thinking, if she was thinking. When they took a parenting class they were amazed to find out how much was already going on in a six-month-old’s brain.

Objectives
- List the functions each part of the brain controls.
- Describe how brain cells work together.
- Explain how the brain becomes organized.
- Identify activities that support the development of brain pathways.
- Give an example of how neural pathways in the brain help a baby to acquire new skills.

Key Terms
- neuron
- neural pathways
- cortex
- axon
- myelin
- dendrite
- synapse
- neurotransmitter

The Study of the Brain

One of the most important areas of recent scientific research has been about the development of infant brain function. What scientists have learned has great significance for caregivers. It’s long been known that in the first year, babies’ intellectual and motor skills grow and change at an amazing rate—faster than at any other time of life. Yet recent research has shown that the infant brain’s capacities are even greater than scientists suspected.

It is clear that by providing new activities, parents and other caregivers can stimulate, or awaken, a baby’s senses of sight, sound, touch, taste, and smell. Doing so helps the infant’s brain develop new abilities. In fact, it now appears that much of a baby’s increased brain function is due not only to the capabilities of the brain itself, but also to the quantity and quality of experiences the baby has.

At birth, the brain has billions of nerve cells called neurons. In response to experiences, babies’ brains immediately...
begin to develop links between these neurons. See Fig. 9-1. These links, or neural pathways, “wire” the brain so that it can control different body functions and thinking processes. Neural pathways are created quickly. For example, babies just four days old have demonstrated that they are able to make fine distinctions in hearing, such as being able to distinguish between their parents’ voices and other people’s voices. This ability is the result of linkages in the brain that the baby has formed in the few days since birth. Such linkages form continuously during a child’s early years; they reach their peak number at about age ten. See Fig. 9-2.

The Structure of the Brain

How the brain develops in a baby’s first year of life has profound effects on the baby’s whole life. Before birth, while still in the mother’s womb, the fetus’s world is warm and dark. At birth, this state of affairs changes radically. The newborn child is showered with input to the senses. Eyes closed for so long are exposed to bright lights, there are new sounds and smells, and the baby feels a sudden drop in temperature from the familiar 98.6°F. It’s no wonder that so many babies cry when they come into the world! However, it is this variety of sensory input that the brain uses to build neural pathways.
pathways and babies’ brains will make use of every bit of noise and new sensations.

Newborns learn about the world through their senses—what they see, hear, smell, taste, and touch. A mobile moves when it is touched, and brightly colored objects move before the baby’s eyes. Caregivers’ voices sound familiar, and their smells are familiar too. A fist or a finger tastes different from milk. The blanket feels soft and warm.

In general, the responses of a newborn are reflexes. For example, the newborn will instinctively grasp a finger placed in its palm, and an overheated baby will kick until a blanket falls off. However, these are not deliberate actions that come from learned responses. They are only reflexes.

By the time the baby is six months old, he or she is aware that blankets and socks can be kicked, or even pulled off, when the child is uncomfortable. By the time a child is a year old, he or she has the ability to stack toys, stand up, and perhaps even walk. All these skills result from the brain’s growing ability to direct the body’s actions.

### Parts of the Brain

The brain is divided into different sections, each controlling specific functions of the body. The major sections are shown in Fig. 9-2, along with the functions they control.

**Cerebrum:** Receives information from the senses and directs motor activities. Controls such functions as speech, memory, and problem solving. Most of these activities occur in the outer layer, called the “cortex,” or “cerebral cortex.”

**Thalamus:** Connects the spinal cord and cerebrum. Controls expression of emotions.

**Pituitary Gland:** Secretes hormones that regulate growth, metabolism, and sexual development.

**Cerebellum:** Controls muscular coordination, balance, and posture.

**Brain Stem:** Controls involuntary activities such as breathing, heart rate, and blood pressure.

**Spinal Cord:** Transmits information from the body to the brain and from the brain to the body. It coordinates the activities of the left and right sides of the body and controls simple reflexes that do not involve the brain.
One of the most important parts of the brain is the **cortex** (CORE-tek-s), which is part of the cerebrum. Growth in this outer layer of the brain permits more complex learning. After one year of life, a baby’s cortex is far better developed than it was at birth. As babies experience more and more input from the world around them, their brains respond by forming more and more connections in the brain. It is in this way that the quality of caregiving affects brain growth. As caregivers hold, play with, and talk to an infant, the baby actually uses these experiences to build the brain’s capacity.

**How the Brain Works**

The brain contains billions of nerve cells called neurons. An infant is born with all the neurons he or she will have—none are added during life. Although neurons aren’t added, dramatic changes do take place in the brain after birth.

Neurons are connected by **axons** (ACKS-ons) and dendrites, which act as transmitters of information. Each axon is coated with a waxy, protein-based substance called **myelin** (MY-uh-lin). This substance helps transmit information from one nerve cell to another. At the end of

**Fig. 9-3 How Neurons Work**

1. **Step 1:** Dendrites receive information from other neurons or nerve cells. Each dendrite can have many different branches.

2. **Step 2:** The dendrites pass that information to the body of the nerve cell, where the information is processed.

3. **Step 3:** The nerve cell sends messages through axons, which transmit the messages to dendrites. Axons are coated with a waxy, protein-based substance called myelin. This substance allows information to be transmitted more easily.

4. **Step 4:** Chemicals called neurotransmitters are released by the axon and cross the gap to the dendrite of another nerve cell. That gap is called the synapse.

**Writing Activity**

**Brain Dialogue.** Discuss how the different parts of the brain “talk” to each other in order to properly function. Have students write a dialogue between the parts of the brain that expresses how the brain parts work with each other. Stress the importance of including accurate information in the dialogues as well as lively speech. Ask volunteers to perform a dramatic reading of the dialogue to the class.

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**Reading Check**

1. True or false: An infant is born with billions of neurons. **(True)**
2. True or false: An infant will add billions of neurons as she grows. **(False: No neurons are added during life)**
3. What are axons? (“Arms” of neurons that transmit messages from neuron to neuron)
4. What are dendrites? (“Arms” of neurons that receive messages from neurons)
5. What are the tiny gaps between neurons through which messages are sent? **(Synapses)**
6. What are chemicals released by an axon called? **(Neurotransmitters)**
7. Why is it important to give infants repeated sensory input? **(Repetition means axons and dendrites connect; the more times the same axon and dendrite connect, the stronger the connection grows)**
8. Name the three parts of a neuron. **(Dendrites, cell body, axons)**
each axon are branchlike **dendrites** that receive the messages. This process actually begins when the baby is developing in the mother’s uterus. After birth, it happens more quickly. As Fig. 9-3 shows, dendrites reach out toward the dendrites of other neurons. Although the dendrites don’t touch, they come very close. At the tiny gaps between them—the **synapses** (sin-ap-suhs)—messages are transmitted from one neuron to another. See Fig. 9-4.

The chemicals released by an axon are called **neurotransmitters** (NOOR-oh-tranz-mih-terz). These chemicals look for a dendrite to attach to—but they can only attach to those dendrites with the right kind of receptors. The more times the same axon and dendrite connect, the stronger the connection grows. As a result, they can send and receive messages more quickly.
Building the Brain

The more dendrites that neurons grow and the more links that develop between neurons, the more neural pathways are created in the brain. More pathways give the brain more power—it can do more tasks and control more actions. Think of a road system around a city. The more roads there are, the more places a driver can go.

These increased numbers of connections also give the brain more flexibility. Again, this is like a road system. The more roads there are, the more choices a driver has. If one road is shut down, there are alternate routes.

This increase in connections is the direct result of sensory input. The more the baby interacts with the world, the more complex the brain’s “wiring” becomes.

How the Brain Becomes Organized

Each child’s brain becomes organized in a unique way. This is because the organization is based on the particular experiences unique to that child. As connections between dendrites and axons grow stronger, a group of neurons becomes linked together. They become systems of nerve cells that control a particular action or thinking task.

For instance, one group of neurons can work together to control drinking from a cup. Each time a ten-month-old drinks from a cup, this network of synaptic connections fires together, in a particular sequence. At first, the connections take time to move the muscles. Eventually, after many repetitions, the neurons work together so well that it becomes easy for the child to drink from a cup. The child’s skills increase as a result of the increased number of neural pathways. The child learns.

These connections affect not only actions but all areas of behavior. Systems of neurons work together to influence how babies see and hear as well as think and remember. This process is how all learning takes place. The system is so flexible that humans are able to continue to learn new behaviors and form new ideas all their lives.

Note that the connections between neurons are not permanent. They can be broken when the behavior or idea is not repeated, and the synaptic pathways fade away if they are not used. People lose synapses in this way all through their lives; they forget what they have learned. At the same time that some connections are being lost, however,

1. Explain how we know that connections between neurons are not permanent. (Connections can be broken when the behavior or idea is not repeated; people forget)
2. True or False: The brain is organized only in the first year of life. (False: It is important to give young children a stimulating environment in their first years, but it is not necessary to expose them to every possible activity in the first few years of life)
3. What is myelin? (A waxy, protein-based substance that allows information to be transmitted through axons)
4. In what skill areas do babies first show development? (Motor abilities, vision, and hearing)

Lighting the Way. Help students to visualize the developing brain power of infants with the use of a circuit and lightbulbs. Demonstrate how closing the circuit allows the bulb to light up, and draw a comparison with the pathways between neurons in a baby’s brain.

Neural Pathways. Invite students to keep a journal tracking the development of a new skill they are learning. Meanwhile, have them consider how a baby they know is developing new skills too. Comment that their new skills develop because of increased neural pathways, in the same way that babies gain skill as their brains develop. At the end of several days, have students summarize and reflect on the process of learning a new skill at any age.
new ones are being added. The new connections become part of the brain as new skills are learned or new experiences are stored as memories.

Indeed, children form so many synaptic connections that they must lose some surplus connections in the process of refining a new skill and becoming proficient at it. Such neural “pruning” helps the brain focus only on useful connections, and thus acquire more skills.

Is the Brain Organized Only Once?

The answer is “no.” There are a number of circumstances that prove that this isn’t the case. Some children who suffered damage to the brain area that controls language have still learned to speak. Older people who suffer strokes—where neurons in an area of the brain die—can relearn skills by learning to use other areas of the brain. The brain can be reorganized. In practical terms, that means a child doesn’t have to be exposed to every possible activity in the first year—or even few years—of life. What is important is to give young children a stimulating environment. By doing so, parents and other caregivers help children’s brains develop many pathways and connections.

Speeding the Brain’s Work

Myelin, a waxy substance that coats axons, makes it easier for axons to transmit signals—it speeds their work. When a baby is born only those nerves that control basic instincts such as nursing have this myelin coating. See Fig. 9-5.

Other axons acquire a coating of myelin as the child grows. This process continues until about age twenty. The myelin coating is added in different areas of the brain at different times. Axons in the area of the brain that controls such skills as motor abilities, vision, and hearing receive the coating the earliest. As a result, those are the areas in which babies first show development.

Donna has always loved music, so it was only natural that she began to share it with baby Michael as soon as he was born. Donna sings to Michael every night when she puts him to bed. Michael falls asleep right away after she sings him his favorite lullaby. Donna was pleased to learn that listening to music may even have a positive effect on certain thinking skills. Some researchers believe that musical training actually creates new pathways in the brain. Now Donna tries to include music in Michael’s day in a number of ways that may help enhance his creativity and coordination. She enrolled Michael in a “Music for Tots” program at the park district. The musical stimulation helps strengthen the pathways in his brain, increasing his ability to learn. Music also helps him relax and fall asleep.

PERSONAL APPLICATION

1. Do you remember any songs or lullabies that you enjoyed when you were younger?

2. Do you think that listening to music can affect your brain development? Why or why not?

Answers to

PERSONAL APPLICATION

1. Answers will vary. Students may recall hearing such melodies as “Rock-a-bye Baby.” Students might also remember a certain tune but not the lyrics.

2. Yes, it can affect your brain development. Music is a form of stimulation that may make new pathways in the brain. It also is a way for babies to form memories and attachments, especially to a parent or caregiver who is creating the music, which supports healthy brain functioning.

Critical Thinking

Making Inferences. Read the following scenario to students: Rita and Bill wanted to make sure their son Lucas had a head start in learning. They showed Lucas flash cards of famous people, art, and places every day. They hoped Lucas would begin reading soon. When Lucas began to recognize printed words, Rita called to tell her sister who also had a child around the same age. During the phone call, Rita found out that her sister’s child had also started reading without the help of any flash cards or other prodding on her part. Have students make inferences about why Lucas developed his language and reading skills when he did.

Observing & Participating

Ask students to go to a public library (or bookstore) to review books, toys, and videos available for infants. Using the text material as a guide, ask them to analyze ten or so of the offerings.

Ask students to think about the role of these materials in facilitating intellectual development. As a class, discuss the results of the students’ investigations.
Brain development research suggests ways to help foster intellectual development:

- **Keep it simple and natural.** Everyday experiences such as changing a diaper or giving a bath build the pathways between neurons when combined with cuddling, talking, or singing to the baby. Experts urge parents to give children an environment rich with positive interaction and talking.

- **Match experiences to the child’s mental abilities.** Babies need physical experiences—that is how they learn. It is important to provide experiences at their level of understanding. For example, a safe interactive toy can help infants learn. However, flashcards are too advanced for a three-month-old.

- **Practice makes perfect.** The more repetition, the stronger the connections between neurons. Establish routines with the baby so a baby learns what to expect. Include reading a bedtime story, even when the baby can’t read. An infant will learn that sitting down with you and a book is important.

- **Actively involve the baby.** Provide experiences in which the child takes part. Children of all ages learn best by doing.

- **Provide variety, but avoid overload.** Some parents try to expose their baby to as many different experiences as possible to enhance brain development. Babies do benefit from a variety of experiences, but too many can overwhelm them.

- **Avoid pushing the child.** Children learn better if they are interested in what they are doing. Look for clues as to whether the child continues to show interest in the activity. If not, don’t pursue it.

**YOUR TURN**

**Encouraging growth.** Imagine that you are babysitting a 1-year-old child. What are some ways you could interact with the baby to help encourage his or her intellectual development?

**Answers will vary.** Some include playing with blocks or simple toys, singing, moving to music, playing peekaboo, reading books, telling stories, and rolling a ball.
Indeed, myelin is so crucial to the speed at which nerves function that if this coating is lost, it affects the way the brain and body function. Multiple sclerosis is a disease in which the absence of myelin plays a role. Scientists are working hard to find new treatments for this and other diseases.

### Reviewing the Section
1. In what part of the brain is the cerebral cortex?
2. What abilities does the cerebellum control?
3. How do dendrites and axons function together in the brain?
4. How does myelin help axons do their work?
5. How do repeated experiences help organize the brain?
6. What happens to synapses throughout life?
7. What impact on learning results from the rate of the spread of myelin?

### Observing and Interacting
Compare photographs of newborn infants with pictures of babies at six, twelve, and eighteen months.
1. What differences in their abilities can you infer from what you see?
2. Write a caption for each photograph, summarizing the baby’s abilities.

The rate at which axons receive this waxy coating may explain why some children have difficulty learning certain tasks. If the nerves handling a certain activity are not yet covered with myelin, it would be difficult for a child to learn the activity. The lack of myelin does not make it impossible to learn the task. The presence of myelin, however, makes learning much easier.

Indeed, myelin is so crucial to the speed at which nerves function that if this coating is lost, it affects the way the brain and body function. Multiple sclerosis is a disease in which the absence of myelin plays a role. Scientists are working hard to find new treatments for this and other diseases.

### Reviewing Section 9-1

#### Checking Comprehension
Have students complete the Section 9-1 Review and Activities.

#### Reteaching
Have students describe the functions and parts of the brain.

#### Enrichment
Have students research the career of a neurologist and prepare a short report about it.

#### Review Answers
1. The cortex is in the outer layer of the cerebrum.
2. Muscular coordination, balance, and posture.
3. Axons and dendrites, which transmit information, connect neurons. Axons transmit messages to dendrites.
4. Myelin makes it easier for axons to transmit signals—crucial to the speed at which nerves function.
5. Groups of neurons work together, controlling the way muscles work while doing an activity. Eventually, after many repetitions, the neurons work together so well that it becomes easier for the child to do the activity. Connections between neurons become part of the brain as new skills are learned or new experiences are stored as memories.
6. Connections between neurons are broken when a behavior or idea is not repeated, and the synaptic pathways fade away if they are not used. People lose synapses in this way throughout their lives.
7. If the nerves handling a certain activity are not yet covered in myelin, it is difficult for a child to learn the activity. The presence of myelin makes it easier for axons to transmit signals, facilitating learning.
### Intellectual Development During the First Year

During the first year of life, children undergo a greater change than they ever will again. In just 12 months, a helpless newborn becomes a whirlwind of energy and activity. From birth to one year, babies go from not being able to move to moving about by crawling or walking. As their social skills begin to emerge, a newborn communicates only by crying, whereas a one-year-old can use gestures or even words. By age one, a baby has likes and dislikes, an imagination, and a unique personality.

#### Objectives

- List four signs of intellectual growth in infants.
- Identify Piaget's first period of learning and describe specific abilities that babies learn during this period.
- Summarize the importance of sensory stimulation to the intellectual development of infants.
- Describe the progression of concept development in young children.

#### Key Terms

- perception
- attention span
- sensorimotor period
- object permanence
- imaginative play
- symbolic thinking
- concepts

#### Learning in the First Year

Right from birth, babies have a number of capabilities. Newborns can hear, see, taste, smell, and feel. They use these abilities as the building blocks of learning. A baby’s brain is fed by what is experienced through the senses. Babies’ ability to learn from sensory information, called perception, improves as experiences are repeated. The brain’s neurons begin to become organized, increasing the baby’s learning and skills. Newborns can’t purposely grasp and lift objects, but a three-month-old can. In time, babies’ hand-eye coordination improves further. They develop many skills. These developmental milestones of intellectual development are summarized on page 290.

In just the first year of life, babies also develop four abilities that show their growing intellectual abilities:

- **Remembering experiences.** In the first few months, babies develop the ability to remember. The information from the senses can be interpreted in...
light of past experiences. A two- or three-month-old baby may stop crying when someone enters the room because the baby anticipates being picked up.

- **Making associations.** This act—the baby’s ceasing to cry—also indicates association. The baby associates a parent or other caregiver with receiving comfort.

- **Understanding cause and effect.** Babies also develop an understanding of cause and effect, the idea that one action results in another action or condition. Sucking causes milk to flow. If the baby stops sucking, the milk stops. In short, every time the infant does something, something else happens.

As babies’ motor skills develop, cause-and-effect learning changes. By seven or eight months, babies can throw things deliberately. They can pull the cord on a toy and make the toy move. At this age, babies have a better understanding of their own power to make things happen.

- **Paying attention.** A baby’s attention span—the length of time a person can concentrate on a task without getting bored—grows longer. If the same object is presented over and over again, the baby’s response to the object will eventually become less enthusiastic. The baby’s diminishing response is a way of saying, “That’s old stuff. I’ve seen it before.” Generally, bright babies have a short attention span—they tend to lose interest sooner than babies of average or below-average intelligence. (Beyond infancy, children with above-average intelligence typically have a longer attention span than others their age.) See Fig. 9-6 on page 290.

Every few seconds, it seems, eight-month-old Jasmine drops a bowl from her high chair onto the floor. When she first started doing this, her father Darius was frustrated. She did the same thing over and over and he had to pick the bowl up every time. When he asked Jasmine’s pediatrician about it, he found that this was normal. Jasmine is learning by repetition. She simply wants to be sure that every time she drops the bowl, it will fall to the floor.

The pediatrician explained that repeated actions strengthen connections between nerve cells in the brain. As a result, they can work together in a coordinated way more smoothly and quickly.

**PERSONAL APPLICATION**

When have you used repetition as a form of learning?

When babies get bored, they often announce their boredom by letting out a loud wail. Parents can come to the rescue by giving the infant a toy to play with or by talking to or playing with the baby. Some parents and other caregivers use the television as a substitute. However, television can’t take the place of live interaction. Researchers have found that language not connected to the events around an infant is nothing but noise to the child.

**Answers to PERSONAL APPLICATION**

Answers will vary. Athletes use repetition when they practice a sport, and actors and singers use repetition when they rehearse. Students use repetition when they read a book, listen to a teacher, take notes, and write a report. It is no wonder that repetition helps a baby learn too.

**Television.** Emphasize the fact that television is a poor substitute for personal interaction for many reasons, including that babies perceive a television as noise. Ask students to list what real-life sights would interest a baby.
### Fig. 9-6 Developmental Milestones—INTELLECTUAL 1st Year

#### 1-2 MONTHS
- Gains information through senses
- Makes eye contact
- Prefers faces to objects
- Can distinguish between familiar and unfamiliar voices

#### 3-4 MONTHS
- Can distinguish between familiar and unfamiliar faces
- Makes vowel-consonant combinations such as “ah-goo”
- Can tell a smile from a frown

#### 5-6 MONTHS
- Is alert for longer periods of time, up to two hours
- Studies objects carefully
- Recognizes own name
- Distinguishes between friendly and angry voices
- Recognizes basic sounds of native language

#### 7-8 MONTHS
- Imitates the actions of others
- Begins to understand cause and effect
- Remembers things that have happened
- Sorts objects by size
- Solves simple problems
- Forms sounds such as da, ga, ma, ba
- Recognizes some words
- Babbling imitates speech inflections

#### 9-10 MONTHS
- Looks for dropped objects
- Responds to some words and phrases, such as “no” and “all gone”
- Takes objects out of containers and puts them back in
- May say a few words

#### 11-12 MONTHS
- Can point to and identify objects in books
- Fits blocks or boxes inside one another
- Says “Mama” and “Dada” for parents
- Understands simple words and phrases like “Come to Mommy”
- Speaks some words regularly

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1. Who was Jean Piaget? (A Swiss psychologist who observed infants and children and studied the growth of their ability to reason)
2. Name Piaget’s four major learning periods in the order in which they appear for all children. (Sensorimotor, preoperational, concrete operations, formal operations)
3. According to Piaget, do children have to master one thinking skill before moving on to another thinking skill? (Yes)
4. Why is it important for children to have constant learning opportunities? (According to Piaget, children who don’t get the opportunity to apply new skills during each period of development may never reach their full potential)

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Fig. 9-6. Have students imagine that they run a community program educating new parents in stimulating their babies’ intellectual growth. What specific bonding activities might the program suggest to parents to help their babies reach the milestones listed in Fig. 9-6?
Piaget’s Theories

Jean Piaget, a Swiss psychologist who died in 1980, had a great influence on what is known about how children learn. In an effort to understand how children’s intellectual skills developed, Piaget systematically observed infants and children and recorded his observations about the growth of their ability to reason—the increases in the level of their intellectual understanding. He found that intellectual development followed a pattern. His theory identified four major learning stages, or periods, that take place from birth to adulthood.

According to Piaget, these four periods appear in the same order in all children. They are the sensorimotor period, the preoperational period, the concrete operations period, and the formal operations period. Although the ages at which the periods emerge may vary from child to child, researchers have established average ages at which they appear. See Fig. 9-7.

Piaget determined that children must learn to master one thinking skill before they can move on to another. Children can’t be forced to understand a concept or master a skill any faster than the speed at which their abilities mature. He also noted that children who don’t get the opportunity to apply new skills during each stage of development might never reach their full potential. For this reason, it is important for children to have constant learning opportunities.

The Sensorimotor Period

The sensorimotor period, from birth to about age two, is Piaget’s first stage of learning. During this period, babies learn primarily through their senses and their own actions. This period coincides with the period during which the neurons in the infant’s brain establish pathways that enable learning. The exact role played by the brain in infant learning was not known when Piaget first developed his theories. Later scientific discoveries about neural pathways confirmed Piaget’s observations that sensory stimulation in the first year of life was crucial to fostering a child’s intellectual development.

Piaget noted that during the sensorimotor period, babies come to understand an important concept. Usually at about ten months of age, babies recognize that...
objects continue to exist even when they are out of sight. This concept is called **object permanence**. For example, at four months, when Megan drops her rubber ring toy and it rolls behind her, she simply looks for something else to play with. But at eleven months, when her ball rolls out of sight, Megan actively looks for it. She has learned the concept of object permanence.

### Six Stages

The sensorimotor period can be broken down into six shorter stages. At each stage, a baby has specific intellectual abilities. See Fig. 9-8, which explains these six stages. It will help you better understand how learning occurs. Note that the child’s abilities at each stage after Stage 1 build on the stage before. For example, the inborn grasping reflex in Stage 1 establishes a pattern that permits learning to grasp and hold a desired object. At Stage 2, an infant has learned how to grasp a desired object—a piece of food or a teething ring—and bring it to the mouth. Acquiring these abilities permits an infant to move on to learn a more complex set of skills at each stage.

At the end of the sensorimotor period, by Stage 6, children have used their experiences of the physical world to construct a consistent view of the world they live in. At this point, especially if they have been read to regularly, children can hold an image in their minds of a period beyond the immediate moment. Words such as “soon” or “later” now have meaning because the child is able to conceptualize a time in the future.

#### Fig. 9-8 Piaget’s Sensorimotor Period: Birth to Age Two

<table>
<thead>
<tr>
<th>Stage</th>
<th>Approximate Ages</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>Birth to 1 month</td>
<td>• Practices inborn reflexes.</td>
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<tr>
<td></td>
<td></td>
<td>• Does not understand self as separate person.</td>
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<tr>
<td>Stage 2</td>
<td>1 to 4 months</td>
<td>• Combines two or more reflexes.</td>
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<td></td>
<td></td>
<td>• Develops hand-mouth coordination.</td>
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<td>Stage 3</td>
<td>4 to 8 months</td>
<td>• Acts intentionally to produce results.</td>
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<td></td>
<td></td>
<td>• Improves hand-eye coordination.</td>
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<td>Stage 4</td>
<td>8 to 12 months</td>
<td>• Begins to solve problems.</td>
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<td>• Finds partially hidden objects.</td>
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<td></td>
<td></td>
<td>• Imitates others.</td>
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<tr>
<td>Stage 5</td>
<td>12 to 18 months</td>
<td>• Finds hidden objects.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Explores and experiments.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Understands that objects exist independently.</td>
</tr>
<tr>
<td>Stage 6</td>
<td>18 to 24 months</td>
<td>• Solves problems by thinking through sequences.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Can think using symbols.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Begins imaginative thinking.</td>
</tr>
</tbody>
</table>

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**Enrichment**

Encourage students to ponder how they learn things now compared with how they learned things when they were little. Give an example such as sunshine, and ask how they might learn about sunshine during each of Piaget’s four periods. Make sure students see the progression from concrete sensorimotor learning to more abstract learning, such as through language, reading, and symbolism.
Learning Through PLAY

Sensory Play

During the sensorimotor period of development, from birth to two years of age, children learn through their senses and their environment. In the first few months, babies learn about their own bodies—how to move hands and feet at will and handle bottles and small toys. At about eight months to one year, children learn to crawl and then to walk. This greatly expands the world they can explore. Everything in their path becomes an opportunity for learning. Besides seeing, touching, smelling, and listening, babies put almost everything into their mouths. Feedback from this sensory exploration teaches infants about their world. By providing everyday objects and toys that will stimulate the child’s senses, parents and other caregivers can enhance learning.

As the baby grows, new objects and toys that stimulate all of the senses can be introduced.

Imaginative play—pretending—is also possible at Stage 6. The child can imagine things that have not happened but might happen. (Imaginative play is sometimes called make-believe play or dramatic play.) This is also the time when symbolic thinking, the use of words and numbers to stand for ideas, begins, and the foundations for reading are established. Children can begin to learn pre-reading skills, such as the letters of the alphabet, and are able to understand that a letter represents a sound.

Stimulating Infants’ Senses

A child’s senses can be easily stimulated each and every day. For example, a baby’s senses of touch and taste are routinely stimulated as he or she is changed and fed. Very young infants prefer looking at people, rather than things. They can focus on and follow objects and can see shapes and forms. Hanging a mobile in an infant’s crib will help stimulate a baby’s sense of sight. Mobiles should be hung about 12

Following Up

What concepts might a young child learn from playing in a sandbox?

Answers to Following Up

Babies practice hand-eye coordination by manipulating a shovel or digging tool. They also can hide and find objects, like toys, buried in the sand. Babies might also begin to form an imagination as they build mounds with the sand.

Parenting in Action

Sensorimotor Period. Encourage students to stay attuned to a baby’s development during the sensorimotor period by:
• Noticing how babies change and develop new abilities.
• Providing experiences that are appropriate for a baby’s stage.
• Adapting activities as a baby moves to a new stage of development.
• Encouraging a baby to practice emerging skills and abilities.
• Reading and staying informed about the stages of development.

Critical Thinking

Drawing Conclusions. Ask students the following questions: What can you infer if a baby likes to play with dolls or play hide-and-seek? How can you encourage an older baby to engage in imaginative play?
inches from the baby’s eyes. Infants will respond to brightly colored objects, perhaps soft stuffed dolls with smiling faces and large eyes. Change the baby’s position from time to time to vary the view.

Infants are surprisingly sensitive to sound. They recognize the voices of family and friends and can be calmed by a loving voice even from another room. They are increasingly aware of their own voices and will babble back to an adult, mimicking the adult’s tone of voice. Talking, reading, singing, and humming are wonderful ways to vary and stimulate an infant’s hearing.

Touch is one of the most important ways to communicate love to an infant. The infant’s sense of security and trust are built through cuddling, rocking, and patting. This also helps the infant gain a sense of his or her own body. This sense is crucial to the development of motor skills. A slowly swaying rocking chair or baby swing is a deeply comforting sensation for a baby, and helps him or her develop an awareness of space.

In some areas, infant massage classes are available for learning more formal techniques for using touch to stimulate a baby’s sense of touch. See Fig. 9-9.

Beginnings of Concept Development

As they continue to learn, young children between ages one and three begin to organize the information they receive from their senses. They start to form concepts, general categories of objects and information. Concepts range from categories for objects such as “fruit” to qualities such as juice, or life. Ask students: How can you adjust your expectations to a child’s level of concept development? How can you help young children learn new words and concepts?
color or shape and to abstract ideas such as time.

Children learn words and concepts by using three principles:

- Children start by thinking that labels are for whole objects, not parts. Suppose Dwane’s father points to an animal and says “dog.” How does Dwane know that the label “dog” applies to that animal and not to its nose or its tail?
- Children believe that labels apply to the group to which the individual objects belong, not to the particular object. Any four-legged creature may elicit “doggyl!” from Dwane.
- Young children tend to believe that an object can only have one label. That may be why it takes time for young children to learn to use pronouns—to recognize that “mommy” and “she” can mean the same person.

As a child matures, concepts become more accurate. Babies begin with two broad concepts—“the baby” and “not the baby.” Later, children make very broad distinctions between people and things.

SECTION 9-2 Review and Activities

Reviewing the Section
1. What is a perception? Give an example of how a baby’s perception changes during the first year of life.
2. How can pull-toys help a baby learn about cause and effect?
3. Explain what attention span means.
4. What are Piaget’s four periods of learning, and what are their approximate age spans?
5. What do babies use to learn during Piaget’s first period of development?
6. Explain how the loving touch of a caregiver helps a baby develop certain senses that are important to the development of motor skills.
7. Compare a baby’s concept of the world to a three-year-old’s concept of the world.

Observing and Interacting
Play the game peek-a-boo with a partner. How do you think this game contributes to the development of object permanence?