Courtesy of Jackie Saccoccio and 11R, NY

7 Developmental Psychology

So far we have discussed perception, learning, memory, thinking, and intelligence, but we have not considered how these processes develop over the life span. This is what developmental psychologists study—how and why we change as we grow older. They examine our behavior and mental processing from conception until death. **Developmental psychology** is the scientific study of biological, cognitive, social, and personality development throughout the life span. This chapter will focus on three major types of development— biological, cognitive, and social (the next chapter will deal with personality).

Historically, a major issue for all types of development has been the nature-versus-nurture question (which we also confronted in our discussion of intelligence). As with intelligence, most psychologists now believe that nature and nurture interact to influence our development. Lingering controversial issues include exactly how nature and nurture interact and which is more important to the various aspects of our development (Harris, 1998). We will return to the nature–nurture issue at different points in the chapter.

Developmental psychologists usually divide the life span into several stages, beginning with the prenatal stage and ending with late adulthood. Table 7.1 provides a commonly used set of stages, each of which is characterized by different biological, cognitive, and social changes. Most of the major theories in developmental psychology that we will discuss are stage theories. Stage theories organize developmental change by providing the approximate age ranges at which we can expect certain types of behavior and cognitive functioning. Keep in mind, however, that the age at which individuals enter and leave stages can vary, that stage transition is probably more gradual than abrupt, and that stage definitions may vary across cultures.

This chapter is divided into discussions of different types of development, but it is important to remember that the various types of development occur simultaneously and so have an impact on each other. We begin with a discussion of the first two stages of the life span—prenatal development and infancy—to learn how development begins and progresses

developmental psychology The scientific study of biological, cognitive, social, and personality development across the life span.

Table 7.1 Dividing the Life Span Into Developmental Stages

Stage	Approximate Age Range
Prenatal	Conception to birth
Infancy	Birth to 2 years
Childhood	2 to 12 years
Adolescence	12 to 18 years
Young adulthood	18 to 40 years
Middle adulthood	40 to 65 years
Late adulthood	65 years and over

very early in our lives. Here we will be mainly concerned with physical development, specifically sensory and motor development. Next we will focus on our cognitive development from birth through adulthood by discussing early language development, Jean Piaget's influential stage theory of cognitive development, Lev Vygotsky's sociocultural approach to such development, and the question of whether intelligence declines across the life span.

In the last section of this chapter, we will consider social development. We will begin with a discussion of Lawrence Kohlberg's influential theory of the development of moral reasoning, then examine early social development with a discussion of the research on attachment formation, parenting styles, and theory of mind development, and conclude with a description of Erik Erikson's stage theory of social-personality development across the life span. This chapter will give you a better idea about where you are in your development, how you got there, and where you can expect to go.

Prenatal Development and Infancy

What happens in the prenatal environment? What sensory abilities do we have at birth? Is our brain fully developed at birth? These are the kinds of questions that we will address in this section. We know, for instance, that the brain is not fully developed at birth. Remember, we learned in Chapter 5, on memory, that we do not have any explicit memories about this period of our life because the hippocampus isn't fully developed until later. Thus, this next section should interest all of us, because we have no memory of our own life in the prenatal stage and infancy. Let's get started with the beginning of all development—the union of sperm and egg.

Prenatal Development

Human conception begins when a sperm (male reproductive cell) penetrates the membrane of an ovum, or egg (female reproductive cell). Each of these reproductive cells contains genetic instructions. When the two combine, a complete set of genetic instructions is formed, half from the father and half from the mother. The fertilized egg that is formed from the union of the sperm and egg cells is called a **zygote**. All other cells in the human body develop from this single cell, and each duplicate cell carries a copy of the genetic instructions of the original zygote. The zygote develops into a growing cluster as the cells duplicate.

The **gene** is the basic unit of genetic instruction. Genes are short segments of **chromosomes,** molecules of DNA (deoxyribonucleic acid) that hold the genetic instructions for every cell in our body. Except for reproductive cells (sperm and eggs), every cell of a normal human has 23 pairs

zygote The fertilized egg that is formed from the union of the sperm and egg cells in human reproduction.

gene The basic unit of genetic instruction.

chromosomes Molecules of DNA that hold the genetic instructions for every cell in the body.

of chromosomes, one of each pair coming from the mother and one from the father. Reproductive cells receive only one member of each pair, giving them only 23 chromosomes. This means that when a sperm combines with an ovum, the zygote will have the complete 46. It is the 23rd pair of chromosomes that determines a person's sex. In a female, there are two X-shaped chromosomes (XX); in a male, there is one X-shaped chromosome and one smaller Y-shaped chromosome (XY). It is the Y chromosome that leads to the development of a male; hence the sex of the zygote is determined by which sperm, X or Y, fertilizes the ovum.

In some cases, the growing cluster of duplicated cells breaks apart early in development, resulting in two clusters with identical genes. These clusters become **identical (monozygotic) twins.** They are identical because they originate from the same zygote. **Fraternal (dizygotic) twins** originate from the fertilization of two eggs at approximately the same time. Thus, fraternal twins are nonidentical and could be of different sexes and just as different as any two children with the same parents. You may be wondering why two children with the same parents can be very different in appearance. The answer is the same reason that children with different parents vary greatly in appearance—chance determines which one of the 23 pairs of chromosomes goes to a reproductive cell. This means that there are 2^{23} (eight million or so) chromosome possibilities for each reproductive cell in each parent. In addition, when the two reproductive cells unite to form the zygote, they interact to further increase the uniqueness of the zygote. This is why children from the same family can look so different.

Prenatal development (conception until birth) is divided into three stages—the germinal stage, the embryonic stage, and the fetal stage. The germinal stage begins with the formation of the zygote and ends after about two weeks, when the outer portion of the zygote's developing cluster of cells has attached itself to the uterine wall. This implantation leads to the formation of the placenta and umbilical cord, which allow oxygen and nutrients from the mother to enter and wastes to exit. The inner portion of the zygote becomes the developing organism, the embryo. During the embryonic stage (from two weeks to about two months), the major structures and organs of the body begin to develop, and the embryo starts to resemble a human being. During the fetal stage (from about two months following conception to birth), the developing organism is called a fetus, and through very rapid growth, the body structures and organs complete their development.

Both genetic and environmental factors impact prenatal development. The nature-nurture issue is relevant, even in prenatal development. This development is mainly a function of the zygote's genetic code (nature), but it is also affected by the mother's environment (nurture). **Teratogens** are environmental agents (such as drugs or viruses), diseases (such as German measles), and physical conditions (such as

identical (monozygotic) twins Twins that originate from the same zygote.

fraternal (dizygotic) twins Twins that originate from the fertilization of two eggs at approximately the same time (two zygotes).

teratogens Environmental agents such as drugs and viruses, diseases, and physical conditions that impair prenatal development and lead to birth defects and sometimes death.

fetal alcohol syndrome (FAS) A syndrome affecting infants whose mothers consumed large amounts of alcohol during pregnancy, resulting in a range of severe effects including intellectual disability and facial abnormalities.

sucking reflex An innate human reflex that leads infants to suck anything that touches their lips.

malnutrition) that impair prenatal development and lead to birth defects or even death. Expectant mothers who drink alcohol, smoke, or take drugs put their developing fetuses at great risk. **Fetal alcohol syndrome (FAS)** occurs when mothers consume alcohol during pregnancy, resulting in a range of severe effects including intellectual disability and facial abnormalities in the child. As alcohol consumption increases, the risk of FAS increases. And since there is no known safe limit of alcohol consumption, the best strategy is to avoid alcohol and other teratogens entirely during pregnancy. The effects of teratogens also vary depending on when during pregnancy the fetus is exposed. Early in pregnancy a teratogen may affect the formation of the eyes, whereas later it may be the brain that is affected. There are other maternal factors that affect prenatal development. Age is one such factor. The probability of health risks to the fetus increases for mothers who are very young, 15 or younger, or older, over 35 (Andersen, Wohlfahrt, Christens, Olsen, & Melbe, 2000; Phipps, Blume, & DeMonner, 2002).

Other risks to newborns include prematurity and low birth weight. Those that are born prematurely, before the 37th week, have a number of problems, which increase with the degree of prematurity. Major health problems of premature infants include immaturity of the lungs and the digestive and immune systems. Premature infants also have low birth weight, although some full-term infants can as well. Low birth weight increases the chances of neurological handicaps and death (Holsti, Grunau, & Whitfield, 2002). Many of the teratogens discussed above increase the likelihood of prematurity, although in about 50% of the cases there is no identifiable cause. So remember, a healthy woman providing a healthy prenatal environment enhances the probability of a healthy child.

How We Develop During Infancy

Motor development and sensory-perceptual development are the two major areas of development during infancy. We will start with an overview of our abilities at birth. Then we will discuss how these processes develop during infancy.

Motor development. The newborn comes equipped with several motor reflexes, which are unlearned responses. Some of these reflexes, such as the breathing reflex that provides us with oxygen, have obvious survival value and are permanent, but others aren't as necessary and disappear within the first year of life. Two examples of reflexes that disappear are the Babinski reflex, in which infants fan their toes upward when their feet are touched, and the grasping reflex, in which infants grasp any object that touches their palms. Two other motor reflexes, the sucking reflex and the rooting reflex, are concerned with getting nourishment and so are obviously related to survival. The **sucking reflex**

leads infants to suck anything that touches their lips, and the **rooting reflex** leads infants to turn their mouths toward anything that touches their cheeks and search for something to suck on.

rooting reflex An innate human reflex that leads infants to turn their mouth toward anything that touches their cheeks and search for something to suck on.

habituation A decrease in the physiological responding to a stimulus once it becomes familiar.

In this first year or so of life, infants learn to sit, stand, and walk. This is an orderly sequence; each new motor behavior builds upon previous ones. Infants learn to prop up and support their body, then to sit without support, then to crawl, then to stand while holding onto an object, then to stand without support, and finally to walk without support at somewhere around 12 months of age. It was once thought that motor development was primarily a maturational process that unfolded according to a genetic program. However, as with most achievements, the process is more complex. Learning how to walk, for instance, involves the interaction of multiple factors, such as increases in strength, body proportions, and balance (Thelen, 1995). During this first year, infants are also developing their perceptual abilities and learning to coordinate their body movements with perceptual input. In fact, the process infants go through when they learn how to move around by themselves leads to changes in depth perception (our ability to perceive the distance of objects from us). Infants who have experienced crawling develop a fear of heights and falling, whereas infants of the same age who are not yet crawling do not show this fear (Campos, Anderson, Barbu-Roth, Hubbard, Hertenstein, & Witherington, 2000).

Sensory-perceptual development. Psychologists have developed a number of interesting experimental techniques to study sensory-perceptual abilities in nonverbal infants. The preferential-looking technique, a procedure used to study vision, is surprisingly simple (Fantz, 1961, 1963). Two visual stimuli are displayed side by side, and the researcher records how long the infants look at each stimulus. If the infants look at one side longer, it is inferred that they can tell the difference between the two stimuli and have a preference. Another technique involves **habituation,** a decrease in the physiological responding to a stimulus once it becomes familiar. Infants will stare at a novel, unfamiliar stimulus, but this interest habituates and the infants look at it less and less. They get bored with it. If infants look longer at a new stimulus than an old one, then it is inferred that they must be able to perceive the difference between the two stimuli. Researchers may use measures other than viewing time. For example, infants intensify their sucking of a pacifier in their mouth when confronted with a novel, unfamiliar stimulus. When they habituate to the stimulus, the sucking returns to normal. Similarly, a developmental researcher may use changes in biological mechanisms, such as heart rate, to indicate infants' perceptual behavior.

Through these ingenious techniques we have learned that our five senses are functional at birth (though not fully developed). Vision, our dominant sense, is the least developed at birth. Newborns cannot see very clearly. Their visual acuity (resolution of visual detail) is estimated to be about 20/400 to 20/800 (Kellman & Banks, 1998). This means that the visual detail that a person with

Mark Richards/Photo Edit

The visual cliff. This photo shows an infant on the centerboard of the visual cliff apparatus and his mother trying to coax him to crawl toward her over the apparent steep drop-off. Research has shown that almost all infants, ages 6 to 14 months, will not do so.

normal 20/20 vision can see at 400 to 800 feet is what the infant sees at 20 feet. This lack of resolution is due to inadequate connections between the infant's eyes and the brain, but these connections develop quickly. Hence, acuity develops quickly and reaches 20/20 within the first year of life. Color vision develops even sooner, by two to three months, when it becomes comparable to that of adults (Kellman & Arterberry, 1998). We also know that depth perception develops rather quickly (Gibson & Walk, 1960). Demonstrations of this have used an apparatus called the visual cliff, a table with a glass top that gives the illusion of a very steep (cliff-like) drop-off at one end and a very shallow drop-off at the other end. There is a centerboard between the two ends. In experiments using the visual cliff apparatus, an infant is positioned on the centerboard, and the infant's mother is at one of the two ends, coaxing the infant to crawl to her. The infant demonstrates depth perception by refusing to crawl toward what he perceives as a steep drop-off but crawling over the apparent shallow drop-off. Gibson and Walk tested infants, ages 6 to 14 months. All of the infants crawled toward the mother over the apparent shallow drop-off, but almost none would crawl onto the apparent steep drop-off. These findings suggest that depth perception develops early in infancy and may be partially innate. However, more recent research indicates that learning (in the form of locomotor experience) definitely plays a role in in the development of infants' depth perception (Adolph, Kretch, & LoBue, 2014). When placed on the deep side of the visual cliff, crawling infants show accelerated heart rate (a fear response), but prelocomotor (not yet crawling) infants do not (Campos, Bertenthal, & Kermoian, 1992). In addition, infants need a few weeks of locomotor experience before they avoid the deep side of the visual cliff (Bertenthal, Campos, & Barrett, 1984). As infants become more mobile, their locomotor experience leads them to fear heights.

We also know that infants have a visual preference for faces, especially their mother's face, and other complex stimuli (Field, Cohen, Garcia, & Greenberg, 1984; Valenza, Simion, Cassia, & Umiltà, 1996). Infants' preference for such visual complexity may be due to the fact that such stimulation is necessary for proper development of the visual pathways and cortex during infancy (Greenough, Black, & Wallace, 1987). In addition to their visual preference for faces, recent research indicates that the ability to process configural information in upright faces (i.e., the structural relationships between the individual features on the face) may already be present at birth (Leo & Simion, 2009). The manner in which Leo and Simion demonstrated this is interesting because it involves what is called Thatcherization, an illusion created by Peter Thompson (1980) involving images of former Prime Minister Margaret Thatcher. Thatcherization is created by rotating the eyes and mouth 180° within the image of a face, causing the face to appear grotesque. See Figure 7.1. The top row looks like two upside-down Thatchers, but the bottom row looks like a Thatcher on the left and a horrible mutant on the right (her face has been Thatcherized). Although the Thatcher on the right in the top row looks ok, it isn't. It's the image on the bottom right flipped vertically. Turn the page upside down and the mutant Thatcher will reappear.

Adults readily detect changes in face patterns brought about by Thatcherization when the faces are viewed upright but not when they are viewed upside down (Thompson, 1980). This inability to quickly discriminate a Thatcherized face from an unaltered face when viewed upside down is thought to be caused by the disruption of configural processing, so that the structural changes from Thatcherization are no longer apparent (Bartlett & Searcy, 1993). Leo and Simion wanted to know if newborns would respond like adults to such faces. Using the

Figure 7.1 | The Margaret Thatcher Illusion | The top and bottom row of images of former Prime Minister Margaret Thatcher are identical to each other but flipped vertically. The top row looks like two upside-down Thatchers, but the bottom row looks like a Thatcher on the left and grotesque mutant Thatcher on the right. You do not notice that the Thatcher at the upper right is the mutant Thatcher because the eyes and mouth are right side up although the overall face is upside down. (Courtesy of Peter Thompson. From P. Thompson, "Margaret Thatcher: A new illusion," *Perception*, 9(1980), 383–384.)

habituation paradigm, they tested newborns' ability to discriminate a normal face and a Thatcherized face when presented upright and also upside down. Newborns could do so when the faces were upright (as in the bottom row of Figure 7.1) but not when the faces were upside down (as in the top row), the same inversion effect observed in adults. Hence, Leo and Simion concluded that newborns were sensitive to configural information in faces.

Hearing in the newborn is even more fully developed than vision. In fact, newborns can distinguish their mother's voice from those of others (DeCasper & Fifer, 1980). Research indicates this ability and several auditory preferences develop in the womb before birth (Dirix, Nijhuis, Jongsma, & Hornstra, 2009). Let's briefly consider one of the most famous studies indicating the effects of prenatal learning on auditory preferences after birth (DeCasper & Spence, 1986). During the final 16 weeks of pregnancy, mothers read Dr. Seuss's *The Cat in the Hat* aloud twice a day. Following birth, the researchers had the babies suck on an artificial nipple that, depending upon the infant's sucking pattern, would activate a tape of their mother reading the Dr. Seuss story or another story that the mother had never read aloud. Most of the infants sucked to hear *The Cat in the Hat*. The infants preferred the familiar story that their mothers had read to them while they were still in the womb. Then, Spence and Freeman (1996) carried out a similar experiment but used a low-pass filter to muffle recorded female voices so that they sounded as they would in the womb. Again, indicating the effects of prenatal learning, the infants preferred their mothers' filtered voices over those of other women. Infants also prefer the sound of the human voice and speech sounds versus other types of sounds (Shultz & Vouloumanos, 2010). By 6 months of age, although auditory perceptual performance remains immature, the infant's processing of the intensity, frequency, and temporal nature of auditory stimuli is nearly adultlike (Werner, 2007). Auditory perceptual processing continues to improve into childhood and adolescence.

One of the most remarkable hearing abilities that infants possess involves speech perception. **Phonemes** are the smallest distinctive speech sounds in a language. They allow us to distinguish between different words. For example, the difference between the words *pat* and *bat* is the difference in the *pa* and *ba* phonemes. In order to learn a language, infants must be able to detect these subtle differences between phonemes, and they are able to do so soon after birth. Different languages do not use all the same phonemes, and adults who are not native speakers of a particular language have difficulty detecting the speech sounds of that language. Japanese adults, for example, have trouble with the English *r* and *l* sounds. Infants, in contrast, can detect all phonemes whether or not they have been exposed to them. By 12 months of age, however, they no longer can easily detect speech sounds not in their native language (Kuhl, 2004). Interestingly though, a brief amount of exposure given through live social interaction is sufficient to maintain the ability to detect nonnative phonemes (Kuhl, Tsao, & Liu, 2003). It seems as though infants come into the world prepared to learn whatever language they happen to find themselves exposed to, and experience fine-tunes this ability.

phonemes The smallest distinctive speech sounds in a language.

The senses of smell, taste, and touch are also fairly well developed at birth. For example, infants can differentiate the smell of their mother from the smells of other people. Researchers discovered this by placing a nursing pad worn by the mother on one side of an infant and a pad worn by another woman on the other side, then measured how long the baby was turned toward each side. The infants spent more time turned toward their mother's pad (MacFarlane, 1975).

Some recent studies have indicated that infants' understanding of the physical world and their cognitive abilities may be much better than was previously thought. Researchers have demonstrated that very young infants may have an innate conceptual understanding of object movement—for instance, that objects cannot simply go through solid surfaces (Baillargeon, 1993, 2002). Other researchers have suggested that infants can perform simple mathematical operations such as addition and subtraction (Wynn, 1992). Needless to say, such claims are not without controversy—trying to understand the mind of a nonverbal infant is not an easy task (see Cohen & Marks, 2002).

Development of an infant's cognitive and perceptual abilities depends upon brain development. The brain contains about 100 billion neurons at birth, but the infant's brain is rather immature, and connections between neurons (neural networks) need to be formed. During the first few months of life, there is a large growth spurt for these connections between neurons, especially those in the cortex that control perception and cognition. Thousands of new connections are established for these neurons. The connections between the retina and the brain are a good example. Without visual experiences, these visual pathways do not develop, and vision will be permanently lost (Kalat, 2007). This is why a baby born with cataracts that prevent vision needs to have them removed as early as possible, so that normal vision will develop. During infancy, the networks of neurons that are used become stronger, and those that are not used disappear (Thompson, 2000).

Section Summary

Our prenatal development starts with conception, the fertilization of an egg by a sperm to form a zygote, and proceeds through the germinal stage (first two weeks), the embryonic stage (two weeks to two months), and the fetal stage (two months to birth). Prenatal development is guided by the zygote's genetic code (nature), but teratogens (environmental agents such as drugs or viruses, diseases, and malnutrition) can impact the prenatal environment (nurture) and result in birth defects and even death. Other factors that affect prenatal development include fetal alcohol syndrome and the age of the mother. Prematurity and low birth weight are also risks to newborns. The newborn comes equipped with several motor reflexes, some critical for survival, such as the rooting and sucking reflexes that lead to nourishment, and some not so critical, such as the grasping reflex, which disappear within the first year of life. Within this first year, the infant learns to sit, stand, and walk in a very orderly sequence; each new motor behavior builds upon previous ones. They also learn to coordinate their body movements with perceptual input.

Although not fully developed, our five senses are functional at birth, with vision being the least developed. To study early sensory-perceptual capabilities in the nonverbal infant, researchers developed special techniques that allow them to determine what an infant can discriminate. Such research has shown, for example, that infants have the remarkable ability to discriminate phonemes, the smallest distinctive speech units in a language. Sensory-perceptual development depends upon brain development in the form of a large growth spurt of neural networks, such as between the retina and the brain. If these visual pathways do not develop in infancy, vision will be permanently lost. The neural networks that are used grow stronger, and those that are not used are eliminated.

ConceptCheck | 1

Explain how the effects of teratogens are due to nurture and not nature.

Explain how habituation is used to study infant sensory-perceptual skills.

How We Think Throughout Our Lives

In this section, we will examine how our cognitive abilities, such as thinking and language, develop. Because we are verbal animals and our language ability differentiates us from all other animals, we will look first at how this ability begins its development, which will lead us back to the nature–nurture issue. Next we will outline one of the most important theoretical contributions to psychology, Swiss psychologist Jean Piaget's theory of cognitive development. According to Piaget, starting at birth all of us go through the same four stages of cognitive development, each of which is qualitatively different. Next we will discuss Russian psychologist Lev Vygotsky's sociocultural approach to cognitive development. Vygotsky's approach has recently become very popular because it emphasizes the importance of social and cultural contexts in development. Last, we will consider the question of whether intelligence declines throughout the adult portion of the life span.

How We Learn Language

Our ability to use language makes us unique. No other animal seems to be able to acquire and develop language ability as humans do. Although speechless at birth, our capacity for language begins to develop soon after. Children in different cultures learn to speak very different languages, but they all seem to go through the same sequence of stages. We will describe these stages of language acquisition and then consider the nature–nurture issue in explaining how language acquisition occurs.

Let's begin with the newborn infant and see how language develops. Infants are speechless, but one way they communicate is through crying. Infants cry differently, for example, to indicate hunger versus pain. Crying, movement, and facial expressions allow infants to communicate fairly well. Infants also prefer **baby talk (parentese)**,

baby talk (parentese) The different format of speech that adults use when talking with babies that involves the use of shorter sentences with a higher, more melodious pitch.

the different format of speech that adults use when talking with babies that involves the use of shorter sentences with a higher, more melodious pitch than normal speech. Actually, these exaggerated speech melodies parents use when speaking to their babies help the infants grasp the speaker's intentions. Fernald (1993) exposed 5-month-old infants from English-speaking families to approval and prohibition phrases spoken in German, Italian, and both nonsense and regular English parentese. Even though all of this speech was gibberish to the babies, they responded with the appropriate emotion, crying when they heard prohibitions and smiling when they heard approvals. Thus, the melodious nature and not the content of parentese conveys the message to an infant.

By two months or so, infants are making more meaningful noises such as cooing (repeating vowel sounds such as "oo" and "ah") and laughing. Infants use cooing as their response in vocal interactions with their parents. At about six or seven months, **babbling,** the rhythmic repetition of various syllables, including both consonants and vowels, begins. The syllables that are babbled are not limited to the sounds that the infant hears or those from their parents' language. However, this early babbling begins to include more and more sounds from the infant's native language over the next six months. The infant can now also understand some words such as "mommy" and "daddy." For example, the question "Where is mommy?" will lead the infant to look at her mother.

At about 1 year of age, infants begin to speak a few words. Their first words usually refer to their caregivers and objects in their daily environment. Sometimes, infants use a **holophrase,** a word that expresses a complete idea. A good example is a child going to the door and saying "bye-bye." Vocabulary grows slowly until about 18 months, and then there is a vocabulary spurt, maybe of 100 words or more per month. This is also the period during which overextension and underextension occur. **Overextension** is the application of a newly learned word to objects that are not included in the meaning of the word. **Underextension** is the failure to apply the new word more generally to objects that are included within the meaning of the new word. A couple of examples will make these concepts clearer. A good example of overextension is children's tendency to call any male "dada," overextending the word and deflating the father's ego. Underextension frequently occurs when children do not extend the categories of "dog" and "cat" to dogs and cats beyond the family's pet dog or cat. The words are applied too narrowly. As vocabulary expands, the incidences of overextension and underextension decrease. This expansion of vocabulary reflects the influence of cognitive development; as children acquire new concepts, they learn the names that go with them.

One of the challenges children face in acquiring a vocabulary is determining the meaning of words, because the context in which children hear language is often ambiguous.

babbling The rhythmic repetition of various syllables including both consonants and vowels.

holophrase A word used by an infant to express a complete idea.

overextension The application of a newly learned word to objects that are not included in the meaning of the word.

underextension The failure to apply a new word more generally to objects that are included within the meaning of the word.

For instance, if a mother points out a bird flying overhead and exclaims "look at the bird," the child has to consider many possibilities as the potential meaning of the word *bird*. For example, *bird* could refer to any object above them or any object in the sky. Research has shown, however, that children use many different types of cues to identify the speaker's intended meaning of *bird*. Some researchers have argued that children are particularly good at using social cues, such as the speaker's eye gaze, pointing, and emotional reactions to determine what the adult means when using a novel word (Baldwin & Moses, 2001; Brooks & Meltzoff, 2008; Golinkoff & Hirsh-Pasek, 2006). For instance, Tomasello, Strosberg, and Akhtar (1996) showed that children could use a speaker's emotional reaction to determine which novel object a speaker is labeling. In their task, an experimenter told 18-month-old infants that she was going to find a "toma" (a novel object). She then picked up a novel object but then rejected it and acted disappointed. She then picked up a second novel object and acted excited. She didn't name either of the two objects. The child was then shown both novel objects and asked to give the experimenter the "toma." If the child was able to use the emotional reaction of the experimenter to determine which object was the toma, she should select the object that the experimenter was excited about; and most 18-month-old children were able to do so even though it was not the first object seen.

The next step in language development is the combining of words into sentences. This begins during the vocabulary spurt between 18 and 24 months. Children engage in what is called **telegraphic speech,** using two-word sentences with mainly nouns and verbs. It is called telegraphic speech because the speech is like that in a telegram, concise and direct. Some examples are "Dada gone" and "Throw ball." These two-word statements begin to be expanded, and between the ages of 2 and 5, children acquire the grammar of their native language. Children learn these rules implicitly and in a very predictable order across all cultures. How they do so returns us to the nature–nurture issue.

Children acquire language early and easily, without direct instruction, and this acquisition process seems to be the same across cultures that have very different languages. This is why there is much support for the argument that language development is a genetically programmed ability (Chomsky, 1965; Pinker, 1994). Children, however, cannot develop normal speech without exposure to

telegraphic speech Using two-word sentences with mainly nouns and verbs.

human speech, and it is clear that caregivers can facilitate and enhance language development, indicating that experience definitely plays a role in language acquisition. As is usually the case with the nature-nurture issue, there is some evidence for both sides; nature and nurture provide interactive influences (Elman, Bates, Johnson, Karmiloff-Smith, Paisi, & Plunkett, 1996).

One of the best illustrations of children's special skill in learning a language is the existence of a critical period for acquiring it. A critical period is a time period when learning certain skills is most easily accomplished and is thought to reflect the influence of biology (brain maturation) on development. If children do not acquire a language by a certain age, usually thought to be around the time of puberty or perhaps earlier, then they will not learn it as well as younger children. For example, children who are isolated from human contact prior to puberty have difficulty learning a language, even after years of later exposure. The best known example of this is a girl known as "Genie" (Fromkin, Krasjen, Curtiss, Rigler, & Rigler, 1974). Genie was kept tied to a potty chair for most of the first 13 years of her life. During this time, Genie heard very little language and had minimal social interactions. After she was rescued, both researchers and therapists worked hard to rehabilitate her. Although she did make some linguistic progress and was able to learn several hundred words, her grammatical development never reached typical developmental levels, even after several years of trying. A similar critical period exists for children acquiring American Sign Language (ASL). Most deaf children of hearing parents are not as adept at ASL as deaf children of deaf parents because they are typically taught ASL later, since their parents are not signers themselves (Newport, 1991; Senghas & Coppola, 2001). A critical period also exists for second language learning. As you may know from your own struggles to learn a second language, children have a much easier time than adults (Birdsong & Molis, 2001; Johnson & Newport, 1989).

Language development occurs during the first few years of life when the brain and cognitive abilities, such as thinking and reasoning, are also developing. When children start talking, it is easy to start thinking of them as miniature adults, but this would be a big mistake. Their cognitive abilities are not at all like those of an adult. To see how these cognitive abilities develop, we'll consider Piaget's stage theory of cognitive development, which tells us how a speechless newborn develops into a cognitively complex adult.

Piaget's Theory of Cognitive Development

Jean Piaget was a twentieth-century Swiss psychologist whose research on children's thinking led to a landmark theory of cognitive development. He was named one of the twentieth century's 20 most influential thinkers by *Time* magazine in 1999. Piaget started his career in France working with Theophile Simon (of Binet-Simon intelligence scale fame) standardizing intelligence tests (Hunt, 1993). However, he soon returned to Switzerland and began his research on how children think. Piaget did not conduct formal experiments. In his loosely structured

Bill Anderson/Science Source

Jean Piaget interacting with a child attempting to solve a problem in one of Piaget's loosely structured studies.

interviews he instead posed problems for children to solve (he used his own three children in his early research), observed their actions carefully, and questioned them about their solutions. He was particularly interested in children's errors, which he thought provided insight into the child's thinking, especially into how it differed from adult thinking. He found that children of roughly the same age often gave the same wrong answers. From such data, he developed a theory of cognitive development that revolutionized our understanding of children's thinking and its development (Piaget, 1926/1929, 1936/1952, 1983).

Piaget's cognitive theory incorporated two of his interests, biology and philosophy. He assumed that cognitive development stems from a child's adaptation to the environment, and that children attempt to promote their survival by trying to learn about their environment. This means that a child is an active seeker of knowledge and gains an understanding of the world by operating in it. The child organizes this knowledge into what Piaget called schemes (now called schemas), which are frameworks for our knowledge about people, objects, events, and actions. Remember, we discussed these in Chapter 5. Schemas are the basic units of our knowledge that allow us to organize and interpret information about our world. In our long-term memories, we have schemas for concepts (such as books or dogs), events (such as going to a restaurant or to the dentist's office), and actions (such as riding a bicycle).

According to Piaget, cognitive adaptation involves two processes, assimilation and accommodation, both of which impact the development of schemas and thus learning. **Assimilation** is the interpretation of new experiences in terms of our existing schemas; **accommodation** is the modification of current schemas to allow for new experiences. Our earlier example of overextension—when infants call all men "dada"—would represent a child's attempt to assimilate. Children learn, however, that they need to accommodate and change their schemas. A child has only one father, but there are many men in the world. It is through accommodation that the number and complexity of a child's schemas increase and learning occurs. In accommodation, either new schemas are created for information that doesn't fit into one's present schemas or existing schemas are modified to include the new information (such as for father and men).

assimilation Piaget's term for the interpretation of new experiences in terms of present schemas.

accommodation Piaget's term for the modification of present schemas to fit with new experiences.

Piaget also proposed that major changes in children's thinking occur in stages. Each stage permits only certain kinds of thinking and involves qualitatively different

Table 7.2 Piaget's Stage of Cognitive Development

Stage (age range)	Stage Description
Sensorimotor (birth to 2 years)	Children use senses and motor abilities to learn about the world and develop object permanence.
Preoperational (2 to 6 years)	Children use symbolic thinking to understand the world but remain egocentric and lack the mental operations that allow logical thinking.
Concrete operational (6 to 12 years)	Children gain cognitive operations for logical thinking about concrete events, understand conservation, and perform mathematical operations, but they cannot reason abstractly.
Formal operational (12 years through adulthood)	Further development of cognitive operations enables adolescents to engage in abstract thinking and hypothetical-deductive reasoning.

cognitive functioning. Piaget further assumed that all children go through the same stages in the same order. He proposed four stages, outlined in Table 7.2. As you learn about each stage, realize that you will be changing your own schemas to accommodate all this new information about Piaget's theory. Then, after you have finished reading about the stages, look back at Table 7.2. You should easily be able to assimilate the stage descriptions into your modified schemas for Piaget's theory.

The sensorimotor stage. In the **sensorimotor stage,** from birth to about age 2, infants learn about the world through their sensory and motor interactions with it. Beginning with the simple reflexes that we discussed earlier, infants come to know the world by looking, listening, sucking, grasping, and manipulating. Infants less than 8 to 12 months old lack **object permanence,** the knowledge that an object exists independent of perceptual contact with it. For example, young infants do not understand that a toy continues to exist even if they can no longer see it. Object permanence develops over the first 2 years of life. Very young infants will not search for a toy that vanishes; but at about 4 to 8 months, they will sometimes search for it, especially if it is only partially hidden. At 8 to 12 months, they will search for a toy even if it is completely hidden, indicating that they realize that the toy still exists even if they cannot see it. Children continue to develop their understanding of object permanence and have a fairly complete understanding by 2 years of age. Similarly, symbolic representation of objects and events starts to develop during the latter part of the sensorimotor stage. Infants begin to use words as symbols to represent known objects at around 18 months. By 18 to 24 months, infants use telegraphic

sensorimotor stage The first stage in Piaget's theory of cognitive development, from birth to about age 2, during which infants learn about the world through their sensory and motor interactions with it and develop object permanence.

object permanence The knowledge that an object exists independent of perceptual contact with it.

The child in this cartoon is demonstrating egocentric behavior, so he would be in Piaget's preoperational stage of cognitive development. Given his egocentrism, he thinks that everybody sees what he sees regardless of where they are.

speech, which represents continuing development of symbolic representation.

The preoperational stage. In the **preoperational stage**, from age 2 to age 6, children's thinking becomes more symbolic and language-based, but remains egocentric and lacks the mental operations that allow logical thinking. Preoperational children can pretend, imagine, and engage in make-believe play. They have the ability to use one thing to represent another. Preoperational children might pretend that a broom is a horse to ride, or that their finger is a toothbrush. They no longer need to be interacting with an object to think about it. For example, they now can point to a picture of a dog and say "doggie" or crawl around and pretend to be a dog by barking like a dog. Word learning also continues at a rapid pace, and children have learned thousands of words by the end of the preoperational stage. Children also learn to produce narratives, descriptions of past events that have the structure of a story. However, preoperational children's thinking still has major limitations. Let's first consider what it means that their thinking is egocentric.

Egocentrism is the inability to distinguish one's own perceptions, thoughts, and feelings from those of others. This means that a preoperational child cannot perceive the world from another person's perspective. For example, preoperational children don't realize what they are doing when they block the view of the television. They assume that another's view is the same as their view. Egocentric behavior does not stem from selfishness or a lack of consideration. Preoperational children just have not developed the cognitive ability to see another person's view. It is important for parents to realize this cognitive limitation in their preoperational children. If not, they may misinterpret their children's behavior in a negative way, leading to unjust punishment of the child.

Next, to understand what Piaget meant by the lack of mental operations that allow a child to think logically, let's consider conservation. Some grasp of conservation marks the end of the preoperational stage and the beginning of the concrete operational stage. **Conservation** is the knowledge that the quantitative properties of an object (such as mass and number) remain the same despite changes in appearance. Simply put, the quantitative properties of an object do not change with a change in appearance. There are many Piagetian conservation tests, but a well-known one is the liquid/beakers problem (see Figure 7.2). In this test, the child is first shown two identical short, fat beakers

preoperational stage The second stage in Piaget's theory of cognitive development, from age 2 to 6, during which the child's thinking becomes more symbolic and language-based, but remains egocentric and lacks the mental operations that allow logical thinking.

egocentrism The inability to distinguish one's own perceptions, thoughts, and feelings from those of others.

conservation The knowledge that the quantitative properties of objects (such as mass and number) remain the same despite changes in appearance.

Tests of Various Types of Conservation

Type of Conservation	Initial Presentation	Transformation	Question	Preoperational Child's Answer
Continuous Quantity	Two identical beakers with equal amounts of liquid.	Pour one beaker into a taller, narrower beaker.	Which beaker contains more liquid?	The taller one.
Number	Two identical rows of checkers.	Increase the space between the checkers in one row.	Which row has more checkers?	The longer one.
Mass	Two equivalent lumps of clay.	Squeeze one lump into a long, thin shape.	Which shape has more clay?	The long one.
Length	Two sticks of identical length.	Move one stick.	Which stick is longer?	The one that is farther to the right.

Figure 7.2 | **Tests of Conservation** | These are examples of tests for conservation of continuous quantity, number, mass, and length. The typical preoperational child's responses are given in the last column.

with equal amounts of liquid in each. With the child watching, the liquid in one of the beakers is poured into a taller, thinner beaker. Then the child is asked if the two beakers have the same amount of liquid or if one has more liquid than the other. If the child understands conservation, then he can explain why the two differently shaped beakers have an equal amount of liquid in them. No liquid was taken away or added. However, a preoperational child will say that the two beakers have different amounts and most often that the taller, thinner beaker has more liquid. Like egocentric thinking, the failure to understand conservation illustrates one of Piaget's main points—a child is not like a miniature adult with less information. A child's way of thinking is very different, and how it is different depends upon the child's stage of cognitive development.

"Cut it up into a LOT of slices, Mom. I'm really hungry!"

A major reason why a preoperational child does not understand conservation is that the child lacks an understanding of **reversibility**—the knowledge that reversing a transformation brings about the conditions that existed before the transformation. As adults, you and I realize that you could easily pour the liquid in the taller beaker back into the shorter beaker to return to the starting state. A preoperational child does not understand this reversibility operation. A preoperational child's thinking also reflects **centration**—the tendency to focus on only one aspect of a problem at a time. In the liquid/beakers problem, for example, the child may only focus on the heights of the beakers and conclude that one has more because it is taller. Obviously, both the height and width of the beakers need to be considered in order to make a correct judgment. Other Piagetian conservation tests in addition to the liquid/beakers problem are illustrated in Figure 7.2. Find a preoperational child around 3 to 4 years of age and try these tests. The child's responses will not only amaze you but will also give you a much better understanding of the cognitive limitations of the preoperational stage of development.

The concrete operational and formal operational stages. During the **concrete operational stage,** from about age 6 to 12, children gain a fuller understanding of conservation and other mental operations that allow them to think logically, but only about concrete events. Different forms of conservation are developed at different times. For example, conservation of continuous quantity, number, and mass are acquired rather early, but conservation of length is more difficult and is acquired later in the concrete operational stage (Vasta, Miller, & Ellis, 2004). In addition to conservation operations, concrete operational children develop other mental operations that allow them to reason logically, such as transitivity (if $A > B$, and $B > C$, then $A > C$) and seriation (the ability to order stimuli along a quantitative dimension, such as a set of pencils by their length).

However, all of these operations are limited to reasoning logically about concrete events. For example, transitivity is limited to having the actual objects present, such as three sticks of different lengths. Children wouldn't be able to solve the transitivity problem without the sticks physically present. Similarly, concrete objects (such as beakers of liquid) would need to be present to solve the conservation of continuous quantity problem. This means that the reasoning of concrete operational children is tied to immediate reality (what is in front of them and tangible) and not with the hypothetical world of possibility. They cannot deal with what-if and if-then problems and abstract thinking. They also do not engage in systematic deduction to solve a problem, but rather use a haphazard trial-and-error strategy.

In the **formal operational stage,** starting at age 12 or so, children gain the capacity for such hypothetical-deductive thought. According to Piaget, this capacity allows adolescents to engage not only in hypothetical thought but also

reversibility The knowledge that reversing a transformation brings about the conditions that existed before the transformation.

centration The tendency to focus on only one aspect of a problem at a time.

concrete operational stage The third stage in Piaget's theory of cognitive development, from age 6 to 12, during which children gain a fuller understanding of conservation and other mental operations that allow them to think logically, but only about concrete events.

formal operational stage The last stage in Piaget's theory of cognitive development, starting at age 12 or so, during which a child gains the capacity for hypothetical-deductive thought.

Germinal - Embryo - Fetus - sensorimotor - pre operational -
0-10 day 10-8 weeks 2mo - birth birth - 2 2-6

Concrete operational 6-12

Formal operational 12+

in systematic deduction and tests of hypotheses, what could easily be referred to as scientific thinking. To understand the difference in thinking between concrete and formal operational children, Piaget used several scientific thinking tasks (Inhelder & Piaget, 1958).

In one of these tasks, children or adolescents are shown several flasks of what appear to be the same clear liquid and are told that one combination of two of these liquids would produce a blue liquid. The task is to determine the combination that would produce the blue liquid. The concrete operational children just start mixing different clear liquids together haphazardly. The formal operational children, however, proceed very differently. They develop a systematic plan for deducing what the correct combination must be by determining all of the possible combinations (hypotheses for the correct combination) and then systematically evaluating each one. To accomplish this plan, they systematically mix the liquid in one beaker with each of the other liquids. If none of these combinations produced the blue liquid, they deduce that the liquid in that beaker is not relevant to the sought-after combination and then proceed to test each of the other clear liquids in the same manner until they find the correct combination.

Formal operational adolescents can also evaluate the logic of verbal statements without referring to concrete situations; the concrete operational child can only do so with concrete evidence. For example, in one formal operational study, the experimenter asked whether a statement about some colored poker chips was true, false, or uncertain (Osherson & Markman, 1975). When the experimenter hid a chip in his hand and asked about the statement, "Either the chip is red or it is not red," the formal operational children realized that the statement was true regardless of the color of the hidden chip, but the concrete operational children were uncertain of the statement's truth status. The formal operational children understood the disjunctive logic of the statement, and the concrete operational children did not. Concrete operational children also have difficulty with propositional logic that contradicts reality (Moshman & Franks, 1986). For example, concrete operational children would judge the following reasoning to be faulty, "If cats are bigger than horses and horses are bigger than mice, then cats are bigger than mice," because the first relationship does not hold in real life. Concrete operational children are tied to the realistic truth of the content (what is) in their logical reasoning, but formal operational children are not.

Evaluation of Piaget's theory. Recent research has shown that cognitive development seems to proceed in the general sequence of stages that Piaget proposed (Lourenco & Machado, 1996). This means that Piaget's theory seems to have captured the general nature of cognitive development accurately. However, there are many issues with the specifics of Piaget's stage theory. For example, recent research has demonstrated that rudiments of many of Piaget's key concepts (such as object permanence) may begin to appear at earlier ages than Piaget proposed. Infants and young children may be more cognitively competent than Piaget theorized. Piaget's tests for the understanding of concepts may have been too complex and thus missed partial knowledge of the concept. For example, Piaget's test for object permanence required infants to reach for a hidden object. A complete understanding required the infants to search for the object after several invisible (hidden) movements. Later research that involved tracking infants' eye movements has found that infants (as young as 3 months) continue to stare at the place where the object disappeared from sight, indicating some degree of object permanence (Baillargeon, 1987).

More recent research on the formal operational stage also makes it clear that not all people reach this stage of thinking, especially in cultures that do not emphasize such thinking, and that those that do reach the stage may not always use such thinking (Dasen, 1994; McKinnon & Renner, 1971). For example, people in non-Western cultures do not usually do well on the specific scientific reasoning tasks used by Piaget, but they do very well and demonstrate formal operational thought on comparable tasks involving content that they are familiar with and that is significant within their culture (Vasta, Miller, & Ellis, 2004). Even Piaget, late in his life, realized that there were limitations on achieving formal operations (Piaget, 1972).

Other cognitive developmental researchers question whether Piaget's characterization of distinct stages of development is correct. In particular, the **information-processing approach to cognitive development** questions the existence of stages and argues that development is continuous and not composed of distinct stages. So how do information-processing developmental psychologists explain the growth in children's cognitive abilities? They attribute this growth to developmental changes in children's information-processing abilities—how they take in, store, and use information. The information-processing approach uses a computer metaphor to describe children's thinking. Just as a computer's ability to solve problems is affected by memory and requires specific processing steps, children's problem-solving ability involves similar information processing. Information-processing researchers study factors that affect such processing. For example, developmental improvements in speed of processing (Kail, 1991), storage capacity (Pascual-Leone, 1989), and knowledge base (Schneider, 1993) have all been found to influence improvements in children's memory and thinking. As children grow older, they become increasingly more adept at information processing.

We should mention two other major criticisms of Piaget's stage theory. One is that Piaget did not sufficiently consider the impact of culture and social environment on cognitive development (Miller, 2011; Segall, Dasen, Berry, & Poortinga, 1990). The second is that Piaget's stage theory of cognitive development ends with adolescence and the development of formal operations, instead of continuing through to adulthood. Although Piaget did not address these issues, other developmental psychologists have done so. We will discuss the first issue

information-processing approach to cognitive development An approach to studying cognitive development that assumes cognitive development is continuous and improves as children become more adept at processing information (taking in, storing, and using information).

in the next section when we examine the work of Russian psychologist Lev Vygotsky, whose theory did emphasize the sociocultural aspects of cognitive development. The second issue will be addressed in the section after that when we examine the question of what happens to intelligence from adolescence to old age. Does it decline as we age, especially in late adulthood? This discussion will allow us to examine two major research methods used by developmental psychologists, cross-sectional studies and longitudinal studies.

zone of proximal development According to Vygotsky, the difference between what a child can actually do and what the child could do with the help of others.

scaffolding According to Vygotsky, a style of teaching in which the teacher adjusts the level of help in relation to the child's level of performance while orienting the child's learning toward the upper level of his or her zone of proximal development.

Vygotsky's Sociocultural Approach to Development

Lev Vygotsky was a Russian developmental psychologist who was a contemporary of Piaget. Both were born in 1896, but Vygotsky died of tuberculosis at a very young age, 37, and did not have the opportunity to finish developing his theory. As with Piaget's work, there was little interest in the Western world in Vygotsky's work until the 1960s. Vygotsky's approach has become especially popular recently, however, because of its sociocultural emphasis on development.

Vygotsky (1930, 1933, 1935/1978, 1934/1986) stressed that cognitive abilities develop through interactions with others and represent the shared knowledge of one's culture. The social aspects of Vygotsky's approach are straightforward. We are social animals, and therefore much of our learning occurs within social interactions. In brief, we learn from other people—our parents, siblings, friends, teachers, and others. Vygotsky proposed that culture impacts both the content and the processes of the child's cognitive development, because a child's cognitive development occurs within this cultural context. Now that we have a general idea of Vygotsky's theory, let's take a look at two of his major theoretical concepts—the zone of proximal development and scaffolding.

In Vygotsky's theory, the **zone of proximal development** is the difference between what a child can actually do and what the child could do with the help of others. In Vygotsky's terms, this is the difference between the levels of actual development and potential development. It means that there are thinking skills that the child can display with the help of others but cannot perform independently. It also leads to a style of teaching called **scaffolding.** In scaffolding, the teacher adjusts the level of help in relation to the child's level of performance, while directing the child's learning progress toward the upper level of the child's zone of proximal development. The teacher gauges the amount of assistance necessary based on the learner's needs. The learning is structured in steps so that the child learns to achieve each step independently, but is guided and supported by the teacher throughout the learning process.

Sovfoto/UIG via Getty Images

Lev Vygotsky

To illustrate these two concepts and Vygotsky's theory, let's consider the example of a child trying to solve a jigsaw puzzle (Berger, 2006). A child may appear not to be able to solve the puzzle. However, Vygotsky would say that this particular problem-solving task could be within the child's zone of proximal development, but that she could not achieve it on her own. She needs a teacher to scaffold the task for her. How might this scaffolding proceed? The teacher would break the task down into manageable units; for example, the teacher might ask the child just to look for pieces for a particular section of the puzzle with specific suggestions about the size, shape, and colors of the relevant pieces. If this doesn't work, the teacher might actually place a few pieces in their proper places or move a few relevant pieces to their correct orientations, so their relevance is more obvious to the child. Throughout this scaffolding process, the teacher must be totally supportive of the child's progress and sensitive to how much help the child needs to progress toward solving the puzzle and how best to direct her to succeed in the next step of the solution process. After solving the puzzle, the teacher might have the child do it again, but this time with less guidance. Soon the child will be able to complete the puzzle independently. The teacher builds a scaffold to enable the child's learning. Once the learning is achieved, the scaffold is no longer necessary.

As recommended with Piaget's tests for the various types of conservation, find a young child and try to teach her how to solve a jigsaw puzzle using Vygotsky's scaffolding method. It will not only give you a better understanding of this approach but will also lead you to understand the social aspects of learning that Vygotsky stressed in his theory.

How Intelligence Changes in Adulthood

Piaget's description of intellectual development stops in adolescence with the onset of formal operations (hypothetical thought and systematic deduction), but it is important to examine what happens to intelligence across the various stages of adulthood from youth to old age. Do our cognitive abilities severely decrease across adulthood, especially in old age? The attempt to answer this question illustrates the differences between two major research methods in developmental psychology, cross-sectional studies versus longitudinal studies. In a **cross-sectional study**, people of different ages are studied and compared with one another at a single point in time. In a **longitudinal study**, the same people are studied over a long period of time. This involves collecting data periodically on the same people as they age. Longitudinal studies assess changes in people over time, whereas cross-sectional studies assess differences among age groups at a particular point in time. We will examine the use of both of these developmental research methods to answer the question about intelligence across the life span, learning the advantages and disadvantages of each.

cross-sectional study A study in which the performances of groups of participants of different ages are compared with one another.

longitudinal study A study in which performance of the same group of participants is examined at different ages.

cohort effects People of a given age (cohorts) are affected by factors unique to their generation, leading to differences in performance between generations.

The cross-sectional method. The early studies on this question about intelligence across the life span used the cross-sectional method. These studies used representative samples of people of various ages and consistently found that intelligence declined with age. Later studies, however, used the longitudinal method. When the same people were retested over a period of years, researchers found that intelligence did not decline with age, but remained rather stable and possibly increased until very late in life when it showed a decline. Now think about why there were two different answers to the intelligence question. First, consider the nature of a cross-sectional study and the possible problems with this method. A cross-sectional study compares people not only of different ages but also of different generations. This difference in generations can lead to what are called **cohort effects**—people of a given age (cohorts) are affected by factors unique to their generation, leading to differences in performance among generations. For example, there were significant differences in education and educational opportunities for the various generations across the twentieth century. Earlier generations generally received less education, which could certainly account for the intellectual decline observed in the cross-sectional studies. So, why would a researcher use the cross-sectional method, given such possible cohort effects? The cross-sectional method is far less time-consuming and less expensive than the longitudinal method. In addition, there is no need for continual retesting, as there is in longitudinal research.

The longitudinal method. Now consider the longitudinal research method. Although there is no possibility of cohort effects when using the longitudinal method, it is time-consuming and expensive, and repeated testing has to be conducted. In addition, another problem arises. Participants may discontinue their participation, move far away, or die. This means that the sample changes across time, which could have an impact on the research findings if those who disappear from the sample are unlike, in some relevant characteristic, those who stay. How might a changing sample lead to the misleading finding that intelligence remains fairly stable? Here's one explanation—those who survived to be tested at the older ages may have been the most intelligent and healthiest participants, those whose intelligence would be the most likely not to decline. This would also mean that the participants whose intelligence was likely to decline may have no longer been in the study. Given the shortcomings of both methods (see Table 7.3 on page 310), it has proven rather difficult to get a clear answer to this question of intelligence across the life span.

The type of intelligence that is being tested is also important and further complicates the search for an answer. Remember from the last chapter, in our discussion of types of intelligence, that we differentiated fluid intelligence and crystallized intelligence. Crystallized intelligence refers to accumulated knowledge, verbal skills, and numerical skills that increase with age; fluid intelligence involves abilities, such as abstract thinking and logical problem solving, that decrease with