CHAPTER 10

Intelligence

Key Themes in Intelligence

- **Nature/Nurture** What roles do nature and nurture play in the development of intelligence?
- **Sociocultural Influence** How does the sociocultural context influence the development of intelligence?
- **Child's Active Role** How does the child play an active role in the development of intelligence?
- **Continuity/Discontinuity** Is the development of intelligence continuous or discontinuous?
- **Individual Differences** How prominent are individual differences in the development of intelligence?
- **Interaction Among Domains** How does the development of intelligence interact with development in other domains?

Son Van Nguyen stared intently at the school psychologist's desk. Son was embarrassed to be stuck and especially embarrassed about the nature of the questions he was having trouble with. After three years in America, this ten-year-old was proud of the English he had learned. But he had been having serious problems with his reading and just couldn't stay focused on his work. The teacher had recommended to his parents that he be tested, but he really didn't understand what the test was for. He was relieved when the school psychologist announced that the test was done.

At lunchtime he approached Manuela Gomez, whom he considered to be an "expert" on American life because her family had lived in the States four years longer than his family had. "What does inscription *mean?" he asked her.*

"Oh, that's easy. It's words you write or carve on something, like a tombstone."

Son was impressed but suspicious. "How did you know that?"

"It's the same as in Spanish: inscripción."

Manuela was acting so superior that he almost didn't want to confess his ignorance. When he asked her another question from the test, she hooted with laughter. "Are you ever dumb! Don't you know anything? Everybody knows Christopher Columbus discovered America. We all knew that back in Chihuahua before we even moved here."

Son's worst fears about himself had just been confirmed. Although the teacher and the school psychologist had tried to explain to him about the test he was to take, he had not really understood. Now he did. And at that moment the truth seemed all too plain to Son: compared to Manuela, he was not intelligent.

Psychologists who have tested large numbers of children and adults on intelligence tests have found noticeable differences in individual performance, such as those that presumably existed between Son and his classmate. What do these differences mean? In contrast to cognitive psychologists, who are interested in identifying *common processes* in children's and adults' thinking, some researchers focus on identifying and explaining *individual differences* in mental capabilities. Researchers look for these differences in participants' responses on tests of word meanings, general knowledge, and visual-spatial performance and describe the results as a measure of intelligence.

But what *is* intelligence? To the layperson, the term usually includes the abilities to reason logically, speak fluently, solve problems, learn efficiently, and display an interest in the world at large (Siegler & Richards, 1982; Sternberg et al., 1981). Most of us probably have a sense that the abilities to profit from experience and adapt to the environment are also part of intelligent human functioning. We might even postulate that intelligent behavior is defined by different kinds of skills at different ages, as did the college-age participants in one study of popular notions of intelligence (see Table 10.1). Yet despite the average person's ability to give what sounds like a reasonable description of intelligent behavior, in the field of psychology the formal definition of

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 348

6-Month-Olds	2-Year-Olds	10-Year-Olds	Adults
Recognition of people and objects	Verbal ability	Verbal ability	Reasoning
Motor coordination	Learning ability	Learning ability; problem solving; reasoning (all three tied)	Verbal ability
Alertness	Awareness of people and environment		Problem solving
Awareness of environment	Motor coordination		Learning ability
Verbalization	Curiosity	Creativity	Creativity

Source: Adapted from Siegler & Richards, 1982

TABLE 10.1
Popular Notions of Age-Specific Intelligence

This table shows the five most important traits that characterize intelligence at different ages according to one survey of college students. The students identified perceptual and motor abilities as most important for infants. They saw problem solving and reasoning as abilities that become increasingly important later in development.

intelligence has proven surprisingly elusive. Although the concept has been the subject of research and theorizing for more than a century, no single definition has been commonly agreed on, and no one measurement tool assesses intelligence to everyone's satisfaction.

Despite the lack of consensus on how to define and measure intelligence, we now have many tests designed to measure it in children as well as adults. Most of the commonly used tests assess the kinds of thinking people do in academic settings as opposed to common sense or "practical intelligence" (Sternberg, 1995). These tests are routinely used in schools, as well as in medical, mental health, and employment settings, to make decisions about educational strategies, therapeutic interventions, or job placements. Given this use of intelligence tests in many different contexts, it is vital that we closely examine the concept of intelligence and how it is measured.

Our objective in this chapter is to present both historical and contemporary ideas about intelligence—what it is, how we measure it, and the factors that influence it—while keeping in mind that many of the long-standing controversies surrounding this topic are still unresolved. Particularly contentious is the age-old debate over nature versus nurture, that is, the degree to which intellectual ability is shaped by heredity or by experience. Although virtually all modern-day researchers acknowledge that genes and environment interact to produce intelligence, some experts place greater emphasis on biological concepts of heritability, whereas others focus on how intelligence is shaped by the particular context in which the individual grows up. This controversy highlights the importance of applying sound scientific principles and open-mindedness to a topic that has important implications for the ways individuals think about themselves and for social policy.

What Is Intelligence?

Among the many attempts to define intelligence, one prominent issue has been and continues to be whether intelligence is a unitary phenomenon or whether it consists of various separate skills and abilities. In the first view, an intelligent person has a global ability to reason and acquire knowledge that manifests itself in all sorts of ways, such as memorizing a long poem or solving a maze. Intelligence by this definition is a general characteristic that shows up in the multiple and varied observable behaviors and activities of any one person. In the second view, an intelligent person may possess specific talents in some areas but not in others and so, for instance, may be able to compose a sonata but unable to solve a verbal reasoning problem. The various component skills of intelligence are seen as essentially independent, and each individual may have areas of strength and weakness.

A second major issue has been the best way to conceptualize intelligence. Should it be defined in terms of the *products* individuals generate, such as correct solutions to a

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 349

series of mathematics problems or giving the precise definitions of words? Or should it be defined in terms of the *processes* people use to solve problems, such as the ability to integrate different pieces of information or to apply knowledge to new situations? The earliest theories about intelligence came from the *psychometric tradition,* which emphasized a product approach, quantifying individual differences in test scores to establish a rank order of capabilities among the participants tested. More recently, psychologists have put forth alternative ideas about the nature of intelligence based on theories about the cognitive processes people employ to acquire knowledge.

Throughout this discussion, you should notice that few theories explicitly describe the *development* of intelligence. Most models of intelligence are derived from data gathered from adults and provide few suggestions about the way intelligence changes from early childhood through adulthood. This state of affairs may surprise you given the rich theories of cognitive development—those of Piaget and Vygotsky—that we discussed in the chapters on cognition. The task of bringing our knowledge of the development of thinking to explaining individual differences in intellectual performance remains to be accomplished.

Psychometric Approaches

KEY THEME
Individual Differences

The notion that human beings may differ from one another in certain skills originated in the late nineteenth century with the work of Sir Francis Galton. Galton (1883) believed people differ in their ability to discriminate among varying physical stimuli, such as auditory tones of different pitch, and in their speed of reaction to sensory stimuli. Such differences, according to Galton, are largely innate. Expanding on these ideas, James McKeen Cattell (1890) devised a series of psychophysical tests that assessed a person's ability to sense physical stimuli or perform different motor actions. It was Cattell who coined the term *mental test*. Based on subsequent empirical studies, the idea that intelligence is functionally equivalent to psychophysical skill was temporarily shelved, but the notion of testing individuals to compare their levels of performance remained alive.

The first formal intelligence test was created in 1905 by Alfred Binet and Théophilius Simon. Commissioned by the minister of public instruction in Paris to devise an instrument that would identify children who could not profit from the regular curriculum in the public schools due to lower mental abilities, Binet and Simon (1905) designed a test that assessed children's ability to reason verbally, solve simple problems, and think logically. With the Binet-Simon test, the mental testing movement was born, and psychometrics became firmly entrenched as a model for understanding intelligence.

Psychometric models of intelligence are based on the testing of large groups of individuals to quantify differences in abilities. The basic assumption is that some people will perform better than others and that those who perform below some average or normative level are less intelligent, whereas those who perform above that level are more intelligent. Within the general psychometric framework, however, theorists have taken contrasting positions on the exact nature of intelligence.

• Spearman's Two-Factor Theory Charles Spearman (1904) believed that intelligence consists of two parts: *g,* a general intelligence factor that he equated with "mental energy," and *s*'s, specific knowledge and abilities such as verbal reasoning or spatial problem solving that are evident only in certain tasks. According to Spearman, *g* is a central aspect of any task requiring cognitive activity and accounts for commonalities in levels of performance that people typically demonstrate in various kinds of intellectual tasks. Thus the influence of *g* might enable a person to obtain a high score on a verbal test, as well as on a test of visual-spatial skill.

Spearman (1923, 1927) claimed to find high correlations among tests of various mental abilities, concluding that they were caused by the presence of the single factor *g*. Not all researchers agree that intelligence is a unitary phenomenon. However, this view

psychometric model Theoretical perspective that quantifies individual differences in test scores to establish a rank order of abilities.

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 350

continues to be a part of many contemporary ideas about intelligence (Thorndike, 1994).

Thurstone's Primary Mental Abilities In contrast to Spearman, Louis Thurstone (1938) believed that intelligence is composed of several distinct fundamental capabilities that are completely independent of one another. After analyzing the intelligence test scores of many college students, Thurstone concluded that there was little evidence for *g*. Instead, he proposed that the following seven *primary mental abilities* are components of intelligence: *visual comprehension,* as measured by vocabulary and reading comprehension tests; *word fluency,* the ability to generate a number of words (for example, those beginning with *b*) in a short period of time; *number facility,* the ability to solve arithmetic problems; *spatial visualization,* the mental manipulation of geometric forms or symbols; *memory,* the ability to recall lists of words, sentences, or pictures; *reasoning,* the ability to solve analogies or other problems involving formal relations; and *perceptual speed,* the ability to recognize symbols rapidly.

Subsequent studies found that the correlations among Thurstone's seven skill areas were higher than he initially thought, but Thurstone continued to maintain that any underlying general skill is secondary in importance to the separate skill areas themselves (Thurstone, 1947). In Thurstone's conception of intelligence, individuals possess areas of strength and weakness rather than the global entity of intelligence.

KEY THEME
Nature/Nurture

KEY THEME
Sociocultural Influence

Fluid and Crystallized Intelligence According to Raymond Cattell and John Horn, a distinction can be made between two types of intelligence, each with a unique developmental course (Cattell, 1971; Horn, 1968; Horn & Cattell, 1967). **Fluid intelligence** consists of biologically based mental abilities that are relatively free of cultural influence, such as the ability to remember a list of words or to group abstract figures together. **Crystallized intelligence** consists of skills one acquires as a result of living in a specific culture, such as knowledge of vocabulary, reading comprehension, or general information about the world. Cattell and Horn believed that fluid intelligence is tied to physiological maturation and that it increases until adolescence, when it levels off, and then declines in later adulthood. On the other hand, they hypothesized that crystallized intelligence increases over much of the life span because individuals continually acquire knowledge from the cultural groups in which they live.

Researchers have found that fluid intelligence does eventually decline with age, especially after ages seventy to eighty. Crystallized intelligence increases through the middle adult years but also declines with aging, although on a somewhat slower trajectory

According to Cattell and Horn, *crystallized intelligence* consists of skills that are acquired as the result of living in a specific culture. These Ugandan schoolgirls, for example, are learning to make baskets, a skill that is not likely to be acquired by children living in highly industrialized countries.

fluid intelligence Biologically based mental abilities that are relatively uninfluenced by cultural experiences.

crystallized intelligence Mental skills derived from cultural experience.

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 351

than fluid intelligence (Kaufman, 2001; McArdle et al., 2002). These decreases are probably linked to physiological changes in the ability of the brain and other portions of the nervous system to process information. It is important to note, however, that wide individual differences occur in age-related changes in intelligence (Brody, 1992).

KEY THEME Interaction Among Domains

KEY THEME Individual Differences

Modern-day versions of the theory of fluid and crystallized intelligence (often called *Gf-Gc*) emphasize a hierarchical structure to intelligence. John Horn (Horn, 1994; Horn & Noll, 1997), for example, believes that just as fluid and crystallized intelligence contribute broadly to the construct of intelligence, visual and auditory skills, short-term memory, processing speed, and quantitative skills make more specific contributions. Similarly, John Carroll (1993) postulates that at one level individuals possess varying degrees of specific abilities, such as speed of processing. Fluid and crystallized intelligence make up a second layer in the model, and *g*, a general intelligence factor, constitutes a third. Models such as these represent interesting ways to conceptualize intelligence as comprising both general *and* specific skills.

Information-Processing Approaches

Newer theoretical ideas about intelligence are directly derived from the information-processing model of cognition discussed in the chapter titled "Cognition: Information Processing." Rather than identifying the structures of mental ability, as the psychometricians did, information-processing theorists have focused on describing the mental processes necessary to accomplish different types of tasks. Thus each step involved in the chain of cognitive processes from encoding to retrieval, such as speed of processing, a growing knowledge base, or metacognitive skill, provides important insights about defining intelligence.

KEY THEME Individual Differences

● **Intelligence as Speed of Processing** Individuals vary in the speed with which they conduct certain cognitive activities. For example, consider a typical *choice reaction-time* task. A participant sits in front of an apparatus that contains eight lights, her finger resting on a "home" button. As soon as one of the eight lights comes on, the participant must move her finger to a button below that light to turn it off. People show notable differences in the speed with which they carry out this task. Several researchers have proposed that such individual differences in speed of processing information may be related to intelligence, particularly *g*, the general intelligence originally described by Spearman (Jensen, 1982; Jensen & Munroe, 1979; Vernon, 1983).

Is there evidence that speed of information processing is a component of intelligence? Researchers have observed at least moderate relationships between reaction-time measures and scores on standardized tests of intelligence among adults (Jensen, 1982; Vernon, 1983); these relationships are weaker among young children (Miller & Vernon, 1996). As we will soon see, though, recent research on the speed with which infants engage in visual processing is related to later intelligence test scores.

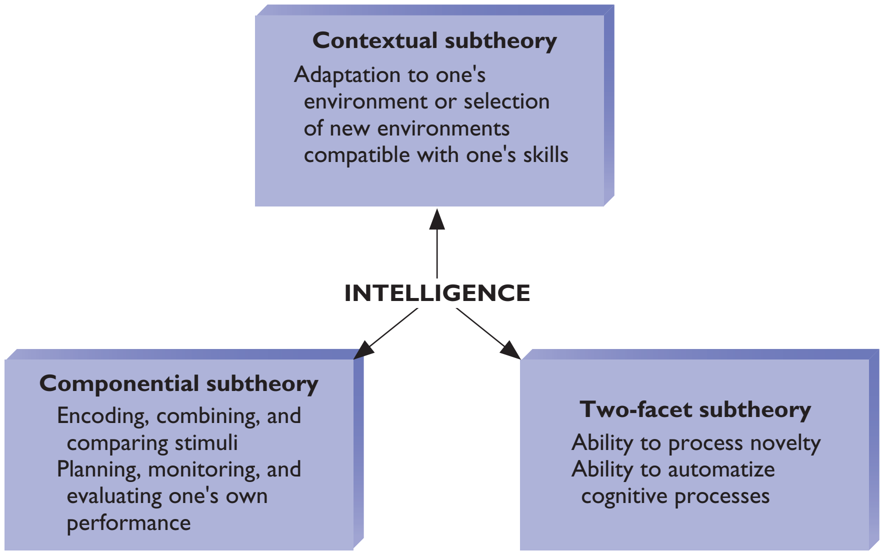
It is important to keep in mind that individuals may differ in their processing speed because of variations in motivation and attention to the task rather than differences in intellectual ability. Some participants in the choice reaction-time task may be distracted by the equipment in the experimental room or may become anxious, and hence slower, in their attempts to do their best. Because reaction times are measured in fractions of a second, they are particularly vulnerable to these types of disruptions. In addition, different cultures and ethnic groups place varying emphases on the value of speed in mental processes. In our own Western culture, we place high priority on getting things done quickly, but the same may not be true for cultures in which time is not a major factor in daily routines. A person who does not have a heightened consciousness of time and speed may not choose to perform mental tasks rapidly, even when he or she has the capability to do so (Marr & Sternberg, 1987). Finally, not all intelligent problem solving is done in a speedy way. Consider the problem of deciding on a career or whom to marry. Rushing to a solution can hardly be considered "smart" in these situations (Sternberg, 1982). Thus we must be cautious about interpreting the results of tasks that assess speed of processing as an element of intelligence.

KEY THEME Interaction Among Domains

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 352

FIGURE 10.1
The Triarchic Theory of Intelligence

According to Robert Sternberg, intelligence has three major facets, or "subtheories," all based on the individual's ability to process information.



Intelligence and Working Memory A promising new approach to understanding intelligence involves examining individual differences in working memory. Recall from the chapter titled "Cognition: Information Processing" that working memory involves a short-term psychological "work space" in which complex (and sometimes multiple) tasks are performed on incoming information. Individuals might be asked to read and confirm the truth value of a sentence and also to remember the last word in the sentence, for example. Researchers have reported that successful performance on working memory tasks is related to intelligence test scores and is also linked to specific patterns of brain activity in the parietal and occipital lobes (Van Rooy et al., 2001). Other research suggests that the capacity of working memory is an even better predictor of intelligence test scores than processing speed (Conway et al., 2002). Working memory probably involves some form of attentional control, the ability to regulate the amount of cognitive resources required to perform the components of a complex task (Engle, 2002; Miyake et al., 2001). Some researchers postulate that individual differences in this ability represent an element of *g*, the concept of general intelligence identified by Spearman (Engle, Kane, & Tuholski, 1999). Although this approach has been applied mainly to studies of adults, it holds promise in illuminating our understanding of developmental aspects of intelligence because of its emphasis on cognitive processes that have also been studied in children.

Sternberg's Triarchic Theory of Intelligence Robert Sternberg (1985) has proposed a broad contemporary theory of intelligence based on the principles of information processing. The **triarchic theory** of intelligence (see Figure 10.1) consists of three major subtheories that describe mental functioning in terms of what cognitive psychologists have learned in the past three decades about how people think.

KEY THEME
Sociocultural Influence

triarchic theory Theory developed by Robert Sternberg that intelligence consists of three major components: (1) the ability to adapt to the environment, (2) the ability to employ fundamental information-processing skills, and (3) the ability to deal with novelty and automatize processing.

The first of these subtheories, called the *contextual subtheory,* asserts that intelligence must be considered as an adaptation to the unique environment in which the individual lives. This means, for example, that we would not administer an intelligence test designed for children in the United States to children from a completely different culture, such as that of the Australian aborigines. In Sternberg's words, intelligence consists of "purposive adaptation to, and selection and shaping of, real-world environments relevant to one's life" (1985, p. 45). Intelligent people are thus able to meet the specific demands their environment places on them—by learning to hunt if their culture requires that skill or by perfecting reading or mathematical skills in societies that stress formal education. By the same token, intelligent people will change their environment to utilize their unique skills and abilities most effectively.

The contextual subtheory of Sternberg's triarchic theory of intelligence describes an individual's ability to adapt to the demands of the environment. Some cultures, for example, stress verbal abilities and literacy, but these skills may not be equally emphasized in other environments.

For instance, changing jobs or moving to a different locale may demonstrate what Sternberg calls "successful intelligence," which may be equally as important as or more important than "academic intelligence" (Sternberg, 2001).

The *componential subtheory* focuses on the internal mental processes involved in intelligent functioning, including the ability to encode, combine, and compare stimuli—the basic aspects of the information-processing system. Other components of intelligence are higher-order mental processes, such as relating new information to what one already knows. Finally, the ability to plan, monitor, and evaluate one's performance—the metacognitive activities we described in the chapter titled "Cognition: Information Processing"—is also part of intelligent functioning. Thus Sternberg stresses *how* individuals acquire knowledge rather than *what* they know as indicators of intelligence.

The *two-facet subtheory* describes intelligent individuals in terms of (1) their ability to deal with novelty and (2) their tendency to automatize cognitive processes. Devising a creative solution to an unfamiliar problem or figuring out how to get around in a foreign country are examples of coping successfully with novelty. Automatization takes place when the individual has learned initially unfamiliar routines so well that executing them requires little conscious effort. Learning to read is a good example of this process. The beginning reader concentrates on the sounds symbolized by groups of letters and is very aware of the process of decoding a string of letters. The advanced reader scans groups of words effortlessly and may not even be aware of his mental activities while in the act of reading.

By including practical abilities, analytical abilities, and creative abilities, the triarchic theory captures the enormous breadth and complexity of what it means to be intelligent (Sternberg, 1998; Sternberg & Kaufman, 1998). Sternberg believes it is difficult to assess this human quality with one measure or test score because such a number would mask the extremely different patterns of abilities that individuals show. One child may have exceptional componential skills but behave maladaptively in her environment. Another may be highly creative in tackling novel problems but show poor componential skills.

Gardner's Theory of Multiple Intelligences Howard Gardner defines intelligence as "an ability (or skill) to solve problems or to fashion products which are valued within one or more cultural settings" (1986, p. 74). Like Sternberg, Gardner believes that information-processing abilities are at the core of intelligence. Gardner's (1983, 1998) emphasis, though, is on the idea that people often show marked individual differences in their ability to process specific kinds of information. Accordingly, he identified the following eight distinct intelligences:

KEY THEME
Individual Differences

Linguistic: A sensitivity to the meanings and order of words, as well as the functions of language
Musical: A sensitivity to pitch, tone, and timbre, as well as musical patterns
Logico-mathematical: The ability to handle chains of reasoning, numerical relations, and hierarchical relations
Spatial: The capacity to perceive the world accurately and to transform and re-create perceptions
Bodily-kinesthetic: The ability to use one's body or to work with objects in highly differentiated and skillful ways
Intrapersonal: The capacity to understand one's own feelings and use them to guide behavior
Interpersonal: The ability to notice and make distinctions among the moods, temperaments, motivations, and intentions of others
Naturalistic: The ability to distinguish among, classify, and see patterns in aspects of the natural environment.

According to Gardner's theory of multiple intelligences, children may show exceptional abilities in some domains but not others. Among the eight types of intelligence he hypothesizes is musical intelligence, a sensitivity to pitch, tone, timbre, and musical patterns.

Gardner claims support for the existence of these discrete areas of intelligence on several fronts. For each skill, he says, it is possible to find people who excel or show genius, such as Mozart, T. S. Eliot, and Einstein. It is also possible, in many instances, to show a loss of or a deficit in a specific ability due to damage to particular areas of the brain. Lesions to the parts of the left cortex specifically dedicated to language function, for example, produce a loss of linguistic intelligence. Yet the other intelligences usually remain intact. Finally, it is possible to identify a core of information-processing operations uniquely relevant to each area. For musical intelligence, one core process is sensitivity to pitch. For bodily-kinesthetic intelligence, it is the ability to imitate the movement made by another person.

How do each of the intelligences develop? Gardner believes propensities or talents in certain areas may be inborn, but the child's experiences are also of paramount importance. Some children, for example, may show a unique ability to remember melodies, but all children would profit from exposure to musical sequences. Moreover, Gardner reminds us that it is important to remember the cultural values to which the child is exposed. In our culture, linguistic and logico-mathematical skills are highly valued and are emphasized as measures of school success. Among the Puluwat islanders of the South Pacific, the navigational skills required for successful sailing are critical, and hence spatial intelligence receives great recognition in that culture.

Gardner's theory has refueled the debate over intelligence as a unitary construct versus a set of distinct skills; the theory of multiple intelligences clearly falls into the latter category. However, although the theory has appealed to many educators and parents in its positive emphasis on each child's unique talents, some researchers caution that more independent empirical evidence is necessary to fully evaluate it (Klein, 1997). Tests assessing children's skills in each of the domains of intelligence are now available for preschoolers (Chen & Gardner, 1997; Krechevsky, 1994), and these will no doubt lead to a more thorough assessment of the theory.

FOR YOUR REVIEW

- What two major questions have surrounded attempts to define intelligence?
- What are the main features of psychometric approaches to intelligence?

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 355

- What are the principal ideas underlying the theories of Spearman and Thurstone, and *Gf-Gc* theory?
- What are the main features of information-processing approaches to intelligence?
- What are the principal ideas in Sternberg's and Gardner's theories of intelligence?
- How are speed of processing and working memory related to intelligence?

Measuring Intelligence

Over the years, we have come to use the term *IQ* as a synonym for *intelligence*. In fact, the abbreviation IQ means "intelligence quotient" and refers only to the score a person obtains on the standardized intelligence tests now widely used in Western societies. The results of these tests have become so closely associated with intelligence as an attribute of human functioning that we have virtually ceased to make a distinction between them. Yet, as we saw in the opening scene about Son, the IQ score may or may not be a good indicator of intelligent functioning.

Standardized tests of intelligence are based on many shared assumptions about how this characteristic is distributed among individuals. As Figure 10.2 shows, IQ scores are assumed to be normally distributed in the population, with the majority falling in the middle of the distribution and fewer at the upper and lower extremes. The average or *mean* IQ score on most tests is 100. Usually a statistical measure of the average variability of scores around the mean, or *standard deviation,* is also calculated. The standard deviation gives a picture of how clustered or spread out the scores are around the mean. On many tests, the standard deviation has a value of 15.

The normal distribution of scores can also be partitioned into "standard deviation units." As Figure 10.2 shows, the majority of IQ scores (about 68 percent) fall within one standard deviation on either side of the mean, and almost all scores in the population (about 99 percent) fall within three standard deviations above or below the mean. In reality, the percentage of scores below the mean is slightly greater than the theoretical normal distribution would predict. This fact is probably the result of genetic, prenatal, or early postnatal factors that can put young infants at risk for lower intellectual development (Vandenberg & Vogler, 1985; Zigler, 1967).

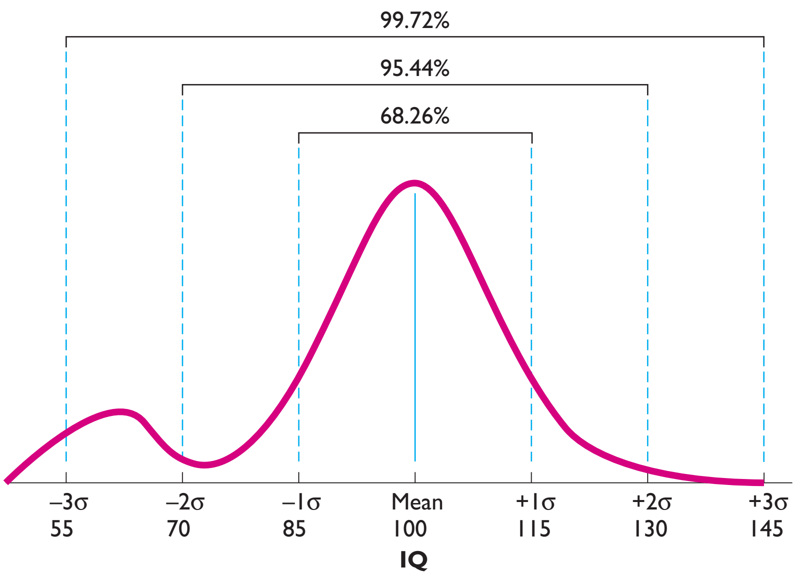


FIGURE 10.2 How Intelligence Is Distributed in the General Population of Intelligence

Intelligence scores are assumed to be normally distributed in the population, with a mean score of 100. Most people's scores fall within 15 points (or one standard deviation) above or below the mean, and almost the entire population falls within three standard deviation units of the mean. In reality, a slightly greater number of individuals than we would theoretically expect fall at the lower end of the distribution, probably due to genetic, prenatal, or early postnatal risks that can affect intelligence.

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 356

ATYPICAL DEVELOPMENT

Exceptional Intelligence

Less than 3 percent of the population falls outside the typical range of intelligence, that is, beyond two standard deviation units of the mean for IQ scores. A child who obtains an IQ score greater than 130 is generally regarded as gifted, whereas a child who obtains a score below 70 is often classified as mentally retarded.

Giftedness

According to the U. S. Department of Education (1993), gifted children show "high performance capability in intellectual, creative, and/or artistic areas, possess an unusual leadership capacity, or excel in specific academic fields." Gifted children may already display remarkably high levels of performance compared with other children of similar age or background experiences, or they may show the potential to perform at those high levels. Although unusual talent has been measured traditionally by IQ scores, more contemporary views provide alternative ways of understanding giftedness.

For example, drawing on his triarchic theory of intelligence, Robert Sternberg (1981, 1986) has demonstrated that gifted children show several unique information-processing skills. First, when solving problems, they tend to spend much of their time in planning—selecting and organizing strategies and information, for example—and less time in encoding the details stated in the problem. That is, their approach tends to be more "global" than "local," reflecting greater metacognitive skills, an idea that has received support in several studies of gifted children (Alexander, Carr, & Schwanenflugel, 1995). Second, Sternberg hypothesizes that gifted children are better able to deal with novelty and to automatize their information processing. Given novel, unusual insight problems, for example, gifted children are better able than children of average ability to recognize useful strategies for solutions (Sternberg, 1986).

Gifted children are also apparently more efficient and speedier in processing stimuli that match their particular talents. Veronica Dark and Camilla Benbow (1993) asked extremely gifted seventh- and eighth-graders to judge, as quickly as they could, whether two stimuli were the same or different. When the stimuli were digits, the response patterns of students most gifted in mathematics showed faster access to numerical representations than those of other children. The response patterns of students most gifted in verbal skills showed faster access to verbal representations when the stimuli were words. Based on their analyses of many studies of giftedness, Dark and Benbow concluded that the difference between gifted and other children is not qualitative; rather, it is simply a matter of degree, in this case, the degree to which basic cognitive skills are used quickly and efficiently.

What else do we know about the characteristics of gifted children? One of the most extensive studies was conducted by Lewis Terman beginning in 1921 (Terman, 1954; Terman & Oden, 1959). More than one thousand children with IQ scores of 140 or greater were studied longitudinally from early adolescence into their adult years. Contrary to popular stereotypes, they were not frail, sickly, antisocial, "bookish" types. They tended to be taller than average, were physically healthy, and often assumed positions of leadership among their peers. By the time they were young adults, about 70 percent of those in the sample had completed college (a very high proportion for that generation), and many had obtained advanced degrees. The majority entered professional occupations in which they became very productive as adults—authoring books, plays, and scientific articles, for example. Unfortunately, however, because the children in Terman's sample were nominated by their teachers, gifted children who were quieter or did not fit a teacher's conception of a "good student" were probably overlooked. Thus, Terman's results must be viewed with caution. Other more recent research has found that gifted children take advantage of accelerated educational opportunities and are far more likely to pursue postgraduate degrees than is the norm (Lubinski et al., 2001). They generally show healthy peer re-

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 357

lationships, good self-concepts, and are well adjusted. Those at the extreme end of the continuum, though, are more likely to be socially isolated and feel unhappy, probably because they are so different from their peers and have trouble "fitting in" (Robinson & Clinkenbeard, 1998; Winner, 1996, 1997).

KEY THEME
Nature/Nurture

Does giftedness simply reveal itself naturally during the childhood years? Not according to other researchers examining the underpinnings of exceptional talent. In one study, two children who were expert chess players and one who was an accomplished musician were found to spend many hours practicing their skills under the tutelage of special teachers (Feldman, 1979). In another study, world-class musicians, mathematicians, and athletes reported that their childhood years were marked by strong encouragement of their early natural abilities. Parents, coaches, and teachers were important sources of motivation, and typically these talented individuals spent years in intensive training of their skills (Bloom, 1982). Because of the exceptional drive and hard work that are involved in achieving high levels of success, most gifted children do not become unusually accomplished or eminent adults (Winner, 1997). A special concern for many researchers and educators is that the talents of gifted children be nurtured so that their potential can be realized (Winner, 2000).

SEE FOR YOURSELF
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Savant Syndrome

Mental Retardation

The American Association on Mental Retardation (2002) defines mental retardation as consisting of limitations in intellectual and adaptive functioning originating before the age of eighteen. *Adaptive functioning* refers to a range of skills typically required to function in the everyday world, such as self-care skills, the ability to get to school or home on one's own, or, eventually, the capacity to find a job and handle personal finances. Within this broad definition, four levels of retardation have been identified: mild, moderate, severe, and profound. Whereas a child with mild retardation can usually be expected to profit from school instruction and eventually hold a job and live independently as an adult, a child with profound retardation will require special assistance throughout life with almost every aspect of daily functioning.

As we saw in the chapters titled "Genetics and Heredity" and "The Prenatal Period and Birth," some instances of mental impairment are linked to genetic factors, as in the case of Down syndrome or PKU, or to experiences in the prenatal or perinatal environment that interfere with brain and central nervous system development and functioning, such as exposure to rubella or oxygen deprivation during birth. When a clear biological cause exists, the retardation is called *organic*. Generally, the most severe forms of retardation fall into this category. In other cases, the retardation has no obvious organic roots but is suspected to have resulted from an impoverished, unstimulating environment, the inheritance of the potential for a low range of intelligence, or a combination of both factors. About 70 to 75 percent of cases of mental retardation fall into this category, called *nonorganic* or *familial retardation* (Zigler & Hodapp, 1986). Usually the level of retardation among children in this second class is mild or moderate.

Do children with mental retardation differ qualitatively from children with at least average intelligence, or do their mental capacities differ only in degree? Psychologists who have studied the cognitive processing of children with familial retardation have noted that they show deficits on a number of fronts. First, they have difficulty focusing attention on the task at hand and become distracted easily. Second, they show notable deficits in working memory and an impoverished general knowledge base. One reason may be that they rarely produce the strategies for remembering typically displayed by children of average or above-average intelligence, strategies such as rehearsal and organization described in the chapter titled "Cognition: Information Processing." Thus their ability to retain information in both short- and long-term memory is hampered. Finally, children who have nonorganic retardation often fail to transfer knowledge from one learning situation to another. If the child was trained, for example, to repeat a string of digits to improve recall, he would fail to employ that strategy when given a new but similar task such as recalling a set of letters (Campione, Brown, & Ferrara, 1982). All of these findings suggest that children with mental

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 358

retardation develop just as children of average intelligence do, only slower. On the other hand, say some experts, we do not know whether children with organic retardation have the same structure of intelligence that others possess. Their developmental progression in attaining cognitive skills may be unique (Zigler & Hodapp, 1986).

With regard to the effective care and education of children with mental retardation, the trend in recent years has been to "deinstitutionalize" all but those with the most profound retardation. Likewise, the placement of children with mental retardation in special education schools and classrooms has given way to the practice of *mainstreaming* these children within normal classrooms, where they are encouraged to participate in and benefit from as many regular classroom activities as their abilities permit.

WHAT DO YOU THINK?

Does Mainstreaming Work?
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Standardized Tests of Intelligence

Educators, clinicians, and others who must assess and diagnose children have a number of standardized tests to choose from. Usually intelligence tests are administered in special situations, such as when parents or teachers suspect that a child is unusually gifted. Alternatively, there may be a need to assess a child whose schoolwork falls below the level of other children in the class, as in the case of Son described at the beginning of this chapter. Does the child have a learning disability (which is usually accompanied by normal intellectual functioning), or is the child's general ability to learn impaired? Are there other reasons (for example, emotional factors) the child is not performing well? A special educational plan designed to meet the needs of the student is then implemented. Intelligence tests may also be employed to assess the developmental progress of children who are at risk for any one of a number of reasons; perhaps they were premature at birth or suffered some trauma that could affect the ability to learn. Although many children will not have the experience of taking an IQ test, a variety of special circumstances may dictate administering such a test.

How are IQ tests designed? *Psychometricians,* psychologists who specialize in the construction and interpretation of tests, typically administer a new test to a large sample of individuals during the test construction phase, both to assess the test's *reliability* and *validity* (see the chapter titled "Studying Child Development") and to establish the norms of performance against which to compare other individuals. A central concern is to ensure that each item included in the test is related to the overall concept being measured, in this case, intelligence. Moreover, if the test is valid, the scores obtained should be related to scores on other, similar tests. Needless to say, the business of designing intelligence tests requires careful thought and skill. Some intelligence tests are designed to be administered to individual children; others can be given to large groups. Ethical standards dictate that psychologists be carefully trained in both the administration and scoring of IQ tests before being permitted to administer them.

SEE FOR YOURSELF
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Ethics and Testing

Infant Intelligence Tests Most tests of infant intelligence are based on norms for behaviors that are expected to occur in the first year or two of life. Because most of the infant's accomplishments are in the domains of motor, language, and socioemotional development, these areas appear most frequently on the various tests. Almost without exception, the tests are administered individually to infants.

Perhaps the most widely used infant test is the *Bayley Scales of Infant Development,* designed by Nancy Bayley (1993) to predict later childhood competence. The test consists of two scales. The Mental Scale assesses the young child's sensory and perceptual skills, memory, learning, acquisition of the object concept, and linguistic skill. The Motor Scale measures the child's ability to control and coordinate the body, from large motor skills to finer manipulation of the hands and fingers. Table 10.2 shows some sample items from each scale. Designed for infants from one through forty-two months of age, the test yields a *developmental index* for both the mental

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 359

TABLE 10.2 Sample Items from the Bayley Scales of Infant Development

Age	Mental Scale	Motor Scale
2 months	Turns head to sound Plays with rattle Reacts to disappearance of face	Holds head erect and steady for 15 seconds Turns from side to back Sits with support
6 months	Lifts cup by handle Looks for fallen spoon Looks at pictures in book	Sits alone for 30 seconds Turns from back to stomach Grasps foot with hands
12 months	Builds tower of 2 cubes Turns pages of book	Walks with help Throws ball Grasps pencil in middle
17–19 months	Imitates crayon stroke Identifies objects in photograph	Stands alone on right foot Walks up stairs with help
23–25 months	Matches pictures Uses pronoun(s) Imitates a 2-word sentence	Laces 3 beads Jumps distance of 4 inches Walks on tiptoe for 4 steps
38–42 months	Names 4 colors Uses past tense Identifies gender	Copies circle Hops twice on 1 foot Walks down stairs, alternating feet

Source: Bayley Scales of Infant Development. Copyright © 1969 by The Psychological Corporation, a Harcourt Assessment Company. Reproduced by permission. All rights reserved. "Bayley Scales of Infant Development" is a registered trademark of The Psychological Corporation.

and the motor scale. That is, the infant's scores are compared with the scores for the standardization sample (the large sample of normal infants whose performance was assessed at the time the test was developed) and are expressed in terms of how much they deviate from the average scores of that sample. The Bayley scales also contain a Behavior Rating Scale to assess the infant's interests, emotions, and general level of activity compared with the standardization sample.

One of the most recently developed measures of infant intelligence is the *Fagan Test of Infant Intelligence,* designed for infants between six and twelve months old and based on infants' recognition memory capabilities. During the test, the child sits on the parent's lap and views a picture for a predetermined period of time. The familiar picture is then presented alongside a novel one, and the infant's looking time to the novel stimulus is recorded. As you saw in the chapter titled "Cognition: Information Processing," infants show their "memory" for the familiar stimulus by looking longer at the new item. Several of these "novelty problems" are presented in succession. The test is designed to screen for children at risk for intellectual deficits based on the premise that their response to novelty is depressed. In one study, scores infants obtained on the Fagan Test of Infant Intelligence correlated in the range of +.44 to +.47 with their scores on several standard tests of intelligence at age eight years (Smith, Fagen, & Ulvund, 2002). Furthermore, a series of studies found that if infants directed fewer than 53 percent of their visual fixations to the novel stimuli, they were especially likely to fall into the category of "intellectually delayed" (Fagan & Montie, 1988).

Individual IQ Tests for Older Children The two most widely used individually administered intelligence tests for school-age children are the Stanford-Binet Intelligence Scales and the Wechsler Intelligence Scales for Children–III (or WISC-III). Both are based on the psychometric model and measure similar mental skills.

The *Stanford-Binet Intelligence Scales,* adapted from the original Binet scales by Lewis Terman of Stanford University, were most recently revised in 2003 (Terman, 1916; Roid, 2003). When Binet originally designed the test, he chose mental tasks that the average child at each age could perform. He also assumed that children of a

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 360

specific age—say, eight years—who performed as their older counterparts—say, ten years—did had a higher *mental age*. By the same token, an eight-year-old who passed only the items the average six-year-old could answer had a lower mental age. Thus intelligence was thought to be the extent to which children resemble their agemates in performance.

Terman translated, modified, and standardized the Binet scales for use in the United States. He also borrowed from William Stern, a German psychologist, an equation for expressing the results of the test. The child's **intelligence quotient,** or **IQ,** was computed as follows:

$$IQ = \text{mental age}/\text{chronological age} \times 100$$

Thus a ten-year-old who obtained a mental age score of 12 would have an IQ of 120. The Stanford-Binet Intelligence Scale rapidly came into use among educators and clinicians eager to find a useful diagnostic tool for children.

The Stanford-Binet test assesses five broad areas of mental functioning: verbal reasoning, knowledge, visual reasoning, quantitative reasoning, and working memory. The test is scaled for use with individuals from two years of age through adulthood. In the Stanford-Binet, the concept of mental age has been replaced by a **deviation IQ.** The child's score in each of the test areas is compared with those of similar-age children in the standardization sample, and Verbal and Nonverbal IQ scores are obtained. An overall IQ score can also be computed. Thus this test permits psychologists not only to assess the child's overall abilities but also to isolate specific areas of strength and weakness.

The *Wechsler Intelligence Scale for Children,* the major alternative to the Stanford-Binet, is scaled for use with children ages six through sixteen years. The original version was constructed in 1949 by David Wechsler and most recently revised in 1991 (Wechsler, 1991). The revised version, called the WISC-III, contains three scales: (1) the Verbal Scale, which includes items assessing vocabulary, arithmetic skills, digit span performance, and knowledge of general information; (2) the Performance Scale, which includes tests of visual spatial skill, puzzle assembly, and arranging pictures to form a story; and (3) a Full Scale IQ, which represents a composite of the two scales. Thus, like the Stanford-Binet, this test allows the examiner to assess patterns of strength and weakness in the child's mental abilities. In addition, like the Stanford-Binet, the child's score on the WISC-III is computed on the basis of the deviation IQ. Figure 10.3 shows some items resembling those from the Verbal and Performance scales of the WISC-III.

A relatively newer intelligence test for two- through twelve-year-olds is the *Kaufman Assessment Battery for Children* or *K-ABC* (Kaufman & Kaufman, 1983). This test is based on the assumption that intelligence is related to the quality of mental processing; the focus is on how children produce correct solutions to problems rather than on the content of their knowledge. The test includes three scales: (1) the Sequential Processing Scale, which assesses the ability to solve problems in a step-by-step fashion; (2) the Simultaneous Processing Scale, which tests the ability to solve problems through integration and organization of many pieces of information; and (3) the Mental Processing Composite, a combination of the first two scales. The K-ABC also includes an Achievement Scale to assess knowledge the child has acquired in the home and school. Figure 10.4 illustrates some of the items found on the K-ABC.

Most of the items on the K-ABC were specifically designed to be neutral in content so that processing differences among children could be validly assessed; that is, the intent was to minimize the influence of the child's previous learning history on performance. In addition, the emphasis in test administration is on obtaining the child's best performance. Whereas administration of the Stanford-Binet and the WISC-III requires strict adherence to test protocol, examiners giving the K-ABC are encouraged to use alternative wording, gestures, or even languages other than English to make sure the child understands what is expected. Thus, in terms of content and mode of administration, the K-ABC represents a departure from many traditional tests of intelligence.

intelligence quotient (IQ) Numerical score received on an intelligence test.

deviation IQ IQ score computed by comparing the child's performance with that of a standardization sample.

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 361

FIGURE 10.3
Sample Items from the Wechsler Intelligence Scale for Children–III

The WISC-III contains two scales, the Verbal Scale and the Performance Scale. Shown here are examples that resemble items from the several subtests that contribute to each scale.

VERBAL SCALE

General Information
1. How many nickels make a dime?
2. Who wrote *Tom Sawyer?*

General Comprehension
1. What is the advantage of keeping money in a bank?
2. Why is copper often used in electrical wires?

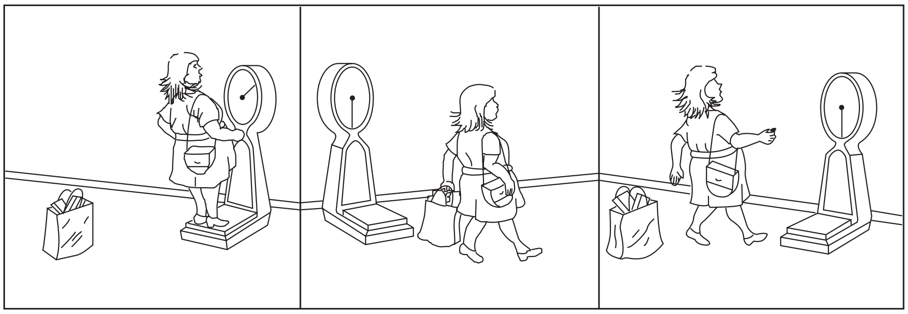
Arithmetic
1. Sam had three pieces of candy and Joe gave him four more. How many pieces of candy did Sam have all together?
2. If two buttons cost fifteen cents, what will be the cost of a dozen buttons?

Similarities
1. In what way are a saw and a hammer alike?
2. In what way are an hour and a week alike?

Vocabulary
This test consists simply of asking, "What is a ________?" or "What does ________mean?" The words cover a wide range of difficulty.

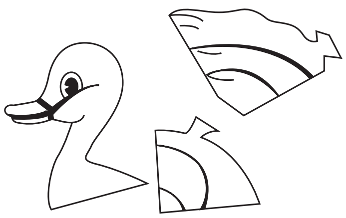
PERFORMANCE SCALE

Picture Arrangement



I want you to arrange these pictures in the right order so they tell a story that makes sense. Work as quickly as you can. Tell me when you have finished.

Object Assembly



Put this one together as quickly as you can.

Source: Simulated items similar to those in the Wechsler Intelligence Scale for Children: Third Edition. Copyright © 1991 by the Psychological Corporation, a Harcourt Assessment Company. Reproduced by permission. All rights reserved. "Wechsler Intelligence Scale for Children" and "WISC-III" are registered trademarks of The Psychological Corporation.

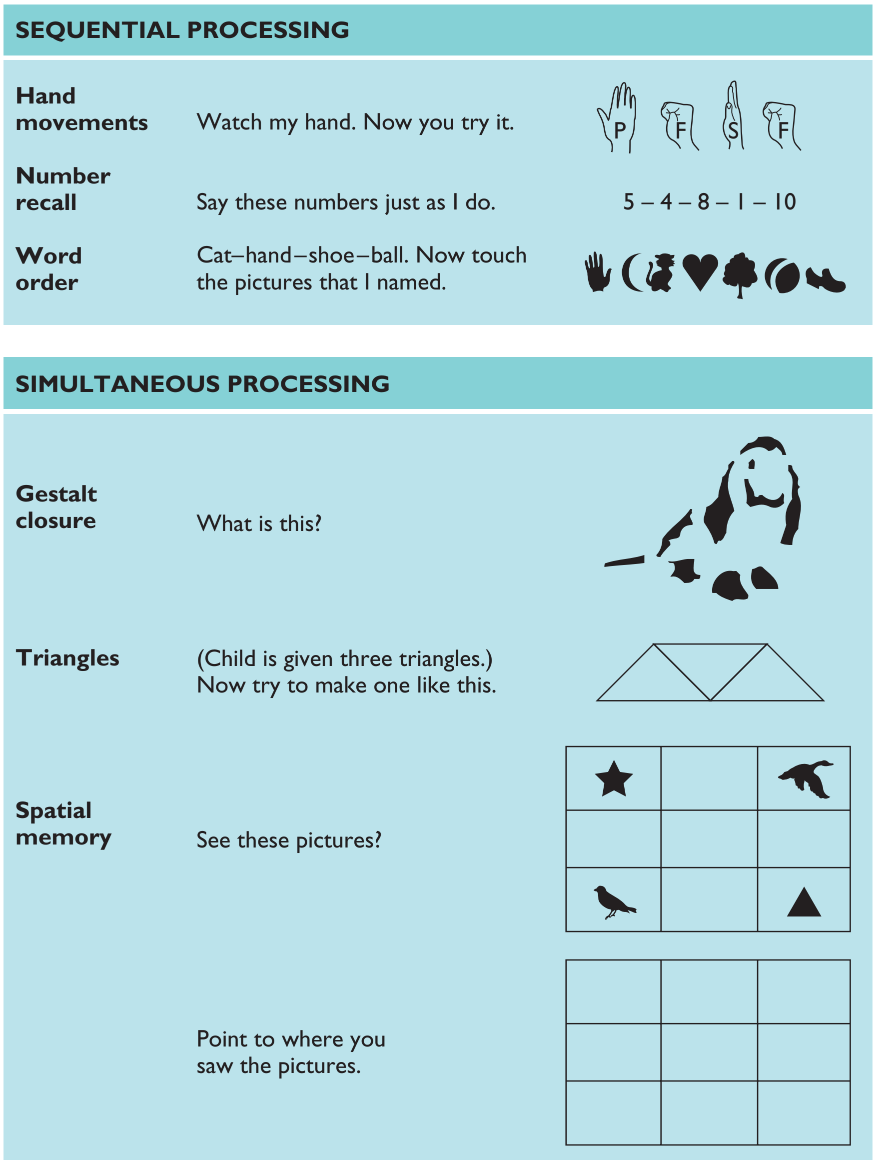
Stability and Prediction

Intelligence tests were first developed with the goal of predicting children's future functioning. Binet, you recall, was asked to design a tool that would anticipate children's achievement in school. Those who followed with other theories and assessment tools for measuring intelligence likewise assumed, either explicitly or implicitly, that scores on the tests would forecast the individual's successes or failures in some areas of life. Moreover, many (although not all) psychologists assumed "intelligence" is a quality people carry with them over the whole life span. They believed, in other words, that IQ scores would show continuity and stability.

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 362

FIGURE 10.4
Sample Items from the Kaufman Assessment Battery for Children

The K-ABC contains a Sequential and a Simultaneous Processing Scale. One goal of this test is to assess intelligence apart from the specific content children already have learned.



Source: Kaufman & Kaufman, 1983.

The Stability of IQ If intelligence is a reasonably invariant characteristic, a child tested repeatedly at various ages should obtain approximately the same IQ scores. In one major longitudinal research project, the Berkeley Growth Study, a group of children was given intelligence tests every year from infancy through adulthood. The correlations between the scores obtained during the early school years and scores at ages seventeen and eighteen years were generally high; the correlation between IQ scores at ages seven and eighteen years, for example, was .80 (Jones & Bayley, 1941; Pinneau, 1961). Even though the results point to a moderate degree of stability, however, about half of the sample showed differences of 10 points or more when IQ in the early school years was compared with IQ in adolescence.

In another extensive project, the Fels Longitudinal Study, the stability of intelligence was assessed from the preschool years to early adulthood. Although correlations for scores were high when the ages were adjacent, they were much lower as the years between testing increased; the correlation between IQ score at ages three and four years, for example, was .83, but dropped to .46 between ages three and twelve years. Furthermore, as in the Berkeley data, individual children frequently showed dramatic changes in scores—sometimes as much as 40 points—between ages two and seventeen years (McCall, Appelbaum, & Hogarty, 1973; Sontag, Baker, & Nelson, 1958). Taken together, the results of these two major longitudinal studies suggest that for many children, IQ scores can be stable, especially if the two test times are close together, but large fluctuations in individual scores are also possible.

Why do the scores of some children shift so dramatically? The presence or absence of family stress can be a factor. Children in the Berkeley study who showed significant declines in IQ often experienced a dramatic alteration in life experience, such as loss of a parent or a serious illness (Honzik, Macfarlane, & Allen, 1948). Similarly, a more recent longitudinal study found a relationship between IQ scores and the number of environmental risk factors to which a child is exposed (Sameroff et al., 1993). As children matured from ages four to thirteen years, those with lower IQ scores also experienced a greater number of risks, factors such as unemployment of a parent, physical illness of a family member, or absence of the father from the household. The child's personality attributes or parental interaction styles can also play a role. In the Fels study, children who showed gains in IQ were described as independent, competitive in academics, and self-initiating. In addition, the parents of these children encouraged intellectual achievement and used a discipline style that emphasized moderation and explanation. In contrast, children whose IQ scores decreased with age had parents who were overly restrictive or permissive in discipline style (McCall et al., 1973). Qualities of a parent's personality, a parent's style of interaction with the child, and the type of home environment provided can contribute to instability in IQ scores (Pianta & Egeland, 1994). This body of studies suggests that IQ scores can be vulnerable to environmental influences that can affect the child's performance on a test at a given point in time or, more broadly, his or her motivation to achieve in the intellectual domain.

KEY THEME
Nature/Nurture

The Stability of Infant Intelligence In general, studies conducted prior to the 1990s have found that correlations between scores on infant intelligence tests and IQ scores in later childhood were low (Kopp & McCall, 1980; McCall, Hogarty, & Hurlburt, 1972). One review of studies measuring IQ at age one year and again at ages three through six years found that the average correlation was only .14 (Fagan & Singer, 1983). In another review, Nancy Bayley (1949) reported essentially no relationships between scores obtained in the first four years of life and those obtained in young adulthood. Only when children reached age five years were correlations of .60 seen with adult scores (see Figure 10.5).

How can we explain these results? One possibility, of course, is that there is no such thing as a general intelligence factor (or *g*) or that, if it exists, it is not a stable trait. Another possibility is that intelligence in infancy differs qualitatively from intelligence in later years, implying that intellectual development is discontinuous. One problem in drawing any conclusions is that the types of skills measured by infant intelligence tests are very different from those measured by tests such as the Stanford-Binet and WISC-III. Recall, for example, some of the items from the Bayley Scales of Infant Development, many of which center on the child's sensory and motor accomplishments: the ability to roll over, reach, or jump on one foot. We have little reason to believe the infant's skill in these areas should be related to the verbal, memory, and problem-solving skills measured by traditional IQ tests for older children.

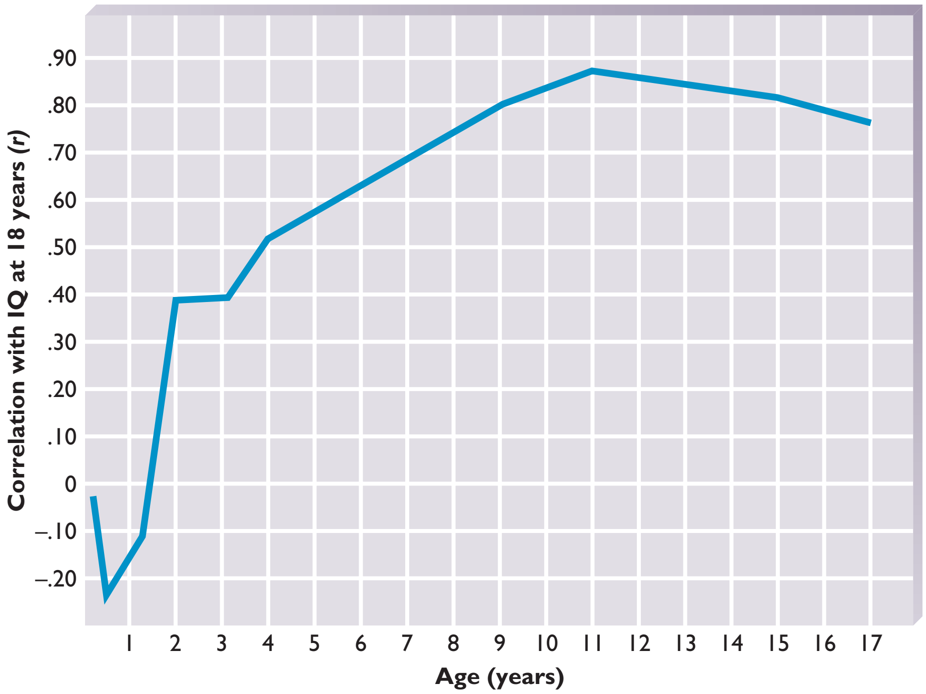
KEY THEME
Continuity/Discontinuity

As we saw with the Fagen Test of Infant Intelligence, however, some components of infants' information-processing capabilities remain constant over a span of years and are related to IQ scores in later childhood. Several researchers have reported strong relationships among recognition memory, speed of habituation, and visual reaction time measured during infancy and IQ up to age eleven years (Bornstein & Sigman, 1986; Dougherty & Haith, 1997; McCall & Carriger, 1993; Rose & Feldman, 1995, 1997). These results suggest that mental development may be more continuous than developmental psychologists previously thought. In addition, certain fundamental cognitive skills such as visual recognition memory and intermodal perception (discussed in the chapter titled "Basic Learning and Perception") seem to stay

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 364

FIGURE 10.5
Is Intelligence Stable over Time?

The graph shows the correlation between IQ scores obtained in infancy and childhood and IQ scores at age eighteen years. Note that IQ scores obtained before age four years are poor predictors of subsequent IQ.



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quite stable within individual children as they progress from infancy through childhood (Rose et al., 1997, 1998); it may be that these skills somehow play a specific role in other higher-order mental processes that are usually associated with intelligence.

● **The Predictive Utility of IQ Tests** What do IQ tests predict? IQ tests do a good job of telling us which children will be successful in school and which will have difficulties. Most studies have found that the correlations between intelligence tests and measures of educational achievement average about .50, with the correlations slightly higher for elementary school children than for high school or college students (Brody & Brody, 1976; Jensen, 1980). In addition, the correlations are strongest with academic subjects that emphasize verbal skills, such as reading (Horn & Packard, 1985). One reason IQ scores predict school achievement so successfully is that many of the skills assessed in intelligence tests overlap with the skills essential to educational success. Verbal fluency, the ability to solve arithmetic problems, and rote memory, some of the abilities IQ tests measure, are part of most children's school routines. Thus IQ tests predict best exactly what Binet originally designed them to foretell.

Do IQ tests predict any developmental outcomes other than school success? IQ scores are related to job status during adulthood, according to one research program. In his longitudinal study of children with IQs of 140 or higher, Lewis Terman (Terman, 1925; Terman & Oden, 1959) found that many of these exceptionally bright individuals eventually became scientists, executives, and college faculty members. As usual, however, we must be cautious about how we interpret correlational data. As we saw earlier, IQ scores are strongly related to educational achievement. They are also related to how many years an individual will actually spend in school (Neisser et al., 1996). It may be that occupational success is the result of education and not a direct outcome of IQ (Ceci & Williams, 1997; Fulker & Eysenck, 1979; Jencks, 1972).

Aside from these relationships, do IQ scores predict other measures of success in life? Social scientists disagree. According to some, IQ scores predict economic status in adulthood (Herrnstein & Murray, 1994); others claim that IQ scores do not necessarily forecast the amount of money an individual earns, physical or mental health,

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 365

job satisfaction, or general life satisfaction (Lewis, 1983; McClelland, 1973; Sternberg, 1995). The debate abounds with disagreements about the proper use of statistical techniques as well as whether various measures of IQ are valid (Fraser, 1995). Suffice it to say that this topic has strong roots in the nature-nurture controversy; generally, advocates of a nature position believe intelligence is a stable trait that affects later developmental outcomes, whereas those who favor a nurture position believe intelligence is malleable depending on the quality of a child's experiences.

Research Applied to Education

Interpreting IQ Test Scores

The day seemed to drag on forever. Son Van Nguyen must have looked at the clock a hundred times before the 3:00 P.M. dismissal bell finally rang. He trudged slowly toward the school counselor's office to meet his family; they would be discussing his test results with the school psychologist. As he entered the office, he saw his parents already seated, silent and looking as apprehensive as he felt.

After a brief greeting, the school psychologist launched into a description of the test Son had taken. Then she suddenly stopped.

"Do your parents understand English?" she asked.

"No," he replied softly.

"I should have realized that. Can you translate my comments for them?"

"I can try," responded Son as his confidence slowly resurfaced. "I often have to do that for my parents."

"The main thing you should tell them is that you did very well on many parts of the test." Son was visibly relieved. Maybe he had at least some intelligence, he thought.

The psychologist continued, "You just need to continue to work on your English and . . ."

"I borrowed some books from the library," interrupted Son as he pulled one from his backpack. "See? This one is all about Christopher Columbus." He stopped, looking up sheepishly as he realized he had not waited for the psychologist to finish.

"That's terrific!" she laughed. "Now can you please tell your parents what I said?"

Because of the controversy surrounding IQ tests—which (if any) tests are most valid, for example—and because scores on IQ tests can fluctuate markedly for any individual child, many psychologists advocate that educators and parents use caution when interpreting test scores. Here are several important aspects of testing to keep in mind:

A number of factors can affect a child's performance on an IQ test, including unfamiliarity with the adult administering the test and language and cultural barriers that may interfere with the child's performance. Therefore, IQ scores must be interpreted with caution.

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 366

1. *Recognize that a child may obtain a low score on a given test because of poor motivation, anxiety about taking a test, unfamiliarity with the English language, or vastly different cultural experiences.* Psychologists who administer tests are trained to try to make the child feel comfortable, but it may be impossible to make him or her feel completely free of stress under the usual test-taking conditions: a separate, perhaps strange room, an unfamiliar adult, lots of questions with little feedback about the answers. Moreover, barriers created by language and cultural differences may be difficult to remove. These issues are addressed later in this chapter when we discuss cultural differences in IQ scores.

2. *Avoid labeling a child on the basis of an IQ score as an "underachiever" or a "slow learner," because this practice creates its own set of risks.* For example, teachers and parents may lower expectations of that child, a phenomenon that can, in turn, further lower her achievement. This is an example of a "self-fulfilling prophecy."

3. *Be aware that IQ test scores usually do not have direct implications for specific remedial education practices or instructional techniques.* The assignment of a child to a particular reading group or math skill level has less to do with the number the child received on an IQ test than with his successes or failures on various class assignments and observations of his behavior and problem-solving strategies in the classroom (Boehm, 1985; Bruer, 1994). In other words, optimizing performance in and out of the classroom, regardless of the scores on intelligence tests, should remain the primary goal of teachers and parents.

These caveats do not necessarily mean IQ tests are useless. They may give a clinician a good sense of the child's pattern of strengths and weaknesses, can assist in the diagnosis of learning problems, and give other clinical insights. However, care must be taken not to focus on the single number—the IQ score. Instead, school and clinical psychologists should use multiple sources of information about the child's level of functioning, including observations of classroom behaviors and personal history (Prifitera, Weiss, & Saklofske, 1998; Weinberg, 1989).

FOR YOUR REVIEW

- What assumptions do psychologists make about the distribution of IQ scores in the population?
- How is giftedness defined? What are the unique ways in which gifted individuals process information? What are the behavioral characteristics of gifted children?
- How is mental retardation defined? What are its causes? What are the unique ways in which these children process information?
- What are the major tests that have been used to assess intelligence in infants and children? What are the major features of each in terms of how they measure intelligence?
- What does research reveal about the stability of IQ? What kinds of outcomes do IQ scores predict?
- What cautions should be kept in mind when interpreting IQ scores?

Factors Related to Intelligence

KEY THEME
Nature/Nurture

In the chapter titled "Genetics and Heredity," we saw that genetics can influence intelligence. Chromosomal abnormalities and single-gene effects such as fragile X syndrome, Down syndrome, and PKU can have profound consequences for the child's intellectual growth. The higher correlations among IQ scores of identical twins reared

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 367

apart compared with fraternal twins or nontwin siblings reared in the same environment and the strong correlations between IQs of adopted children and their biological parents also suggest a role for heredity. In fact, researchers have recently claimed to have located a specific gene associated with *g*, the general intelligence factor (Chorney et al., 1998). A particular allele on chromosome 6 was found to appear more frequently in very bright children than in children of average intellectual ability.

Yet even if we agree that genetic differences contribute, perhaps even substantially, to the child's intellectual competence, it would be a mistake to conclude that IQ scores are not influenced by environmental experiences (Angoff, 1988; Scarr, 1981). Consider two traits very strongly influenced by heredity: physical height and the presence of the trait for PKU. In each instance, the presence of the genotype bears a great resemblance to the phenotype. Yet it is also true that environmental factors can influence the eventual outcome for the child. Recall the discussion of secular trends in physical height in the chapter titled "Brain, Motor Skill, and Physical Development." Recall also from the chapter titled "Genetics and Heredity" that dietary modifications for infants born with PKU can result in nearly normal mental development. In each case, a highly canalized human characteristic is modified by the environment. Moreover, studies of early brain development demonstrate the critical role of experiences in how neurons form connections with one another. Individuals may differ in how readily neurons respond to experience, but the environment is still essential to understanding their eventual abilities (Garlick, 2002).

Consider also the phenomenon called the "Flynn effect." Across twenty countries in North America, Europe, and Asia, IQ scores have risen about 15 points every thirty years on culture-fair tests such as the Raven Progressive Matrices (Flynn, 1998, 1999). Perhaps better nutrition, increased access to schooling, or greater availability of technology (which may foster certain cognitive skills) are responsible (Neisser, 1998). By the same token, it would be difficult to argue for a genetic basis for these shifts in scores; large-scale changes in hereditary patterns occur across much longer time spans. Thus the ever-present role of the environment is an important factor to keep in mind as we discuss the roots of intelligence.

What factors are especially important in shaping the child's intellectual attainments? We begin by examining group differences in IQ scores, findings that have provided much of the backdrop for the nature-nurture debate. Next, we examine those elements of the child's home experience that may be crucial to mental growth as well as the role of the sociocultural environment in shaping specific mental skills. Finally, we consider the impact of early intervention programs on the intellectual attainment of children from culturally different backgrounds. In each case we will see that there are many conditions, even given the contributions of heredity, under which intelligence is not fixed but modified by the timing, extent, and range of environmental experiences.

Group Differences in IQ Scores

Children from different socioeconomic and ethnic backgrounds do not perform equally well on traditional IQ tests. One well-established finding is that African American children in the United States typically score 15 points lower than Caucasian children on tests such as the Stanford-Binet and the WISC (Jensen, 1980; Loehlin, Lindzey, & Spuhler, 1975). Another finding is that children from lower socioeconomic classes obtain lower IQ scores than those from middle and upper classes (Deutsch, Katz, & Jensen, 1968; Lesser, Fifer, & Clark, 1965). Of the many hypotheses put forward about the sources of these differences, some have rekindled the nature-nurture debate and others focus on the validity of IQ tests for children who are members of minority and lower socioeconomic groups.

KEY THEME
Nature/Nurture

● **Race, IQ, and Nature Versus Nurture** In 1969, Arthur Jensen published a paper suggesting that racial differences in IQ scores could, in large part, be accounted for by heredity. According to Jensen, there is a high degree of *heritability* in IQ; that is, about 80 percent of the variation in IQ scores in the population could be explained by genetic variation. He argued that because racial and ethnic subgroups within the population tend not to marry outside their groups, African American–Caucasian differences in IQ scores have a strong genetic component.

Jensen's propositions created a storm of controversy, one that has reemerged as a result of similar claims made more recently by Richard Herrnstein and Charles Murray (1994). One of the most immediate criticisms of Jensen's argument (which has also been applied to its modern-day counterpart) was that *within-group* estimates of heritability cannot be used to explain *between-group* differences in performance. Even if the heritability of IQ were .80 for both Caucasian and African American populations (actually the heritability estimates for IQ were derived solely from samples of Caucasian children and their families), other factors, such as differences in the environmental experiences of each group, could not be ruled out in explaining racial differences in IQ scores (Loehlin et al., 1975). For example, a 15-point difference in IQ could still arise if most Caucasian children grew up in enriched environments and most African American children experienced environments that did not promote optimal intellectual development.

A **cross-fostering study** by Sandra Scarr and Richard Weinberg (1976, 1978, 1983) that examined children who were raised in environments markedly different from those of their biological families demonstrated just how this effect might take place. In their transracial adoption study, Scarr and Weinberg selected 101 Caucasian middle-class families that had adopted African American children, most of whom were under one year of age at the time of adoption. Many of these families also had biological children of their own. The adoptive families were highly educated, were above average in occupational status and income, and had high IQ scores. The biological families of the adopted children had lower educational levels and lower-status occupations. Scarr and Weinberg found that the average IQ among the African American adopted children was 106, higher than the average score of both African American children and those in the general population. The researchers argued that because the adopted children were raised in environments that exposed them to Caucasian culture and the verbal and cognitive skills customarily assessed in IQ tests, they performed better than African American children with similar genetic backgrounds who did not have that experience. At the same time, however, the IQs of the adopted children were more strongly correlated with the educational levels of their biological parents ($r = 0.36$) than with the IQs of their adoptive parents ($r = 0.19$). Thus the role of heredity cannot be ruled out either.

Many researchers reject a genetic explanation of racial differences in IQ as too simplistic. We saw in the chapter titled "Genetics and Heredity" that heredity and environment interact in complex ways to produce varied developmental outcomes; neither by itself is sufficient to explain most human behaviors. In fact, because an individual's genotype influences the type of environment he or she will experience, heritability estimates may actually include environmental effects (Dickens & Flynn, 2001). Furthermore, in the United States race is a variable confounded by the other variables of social class, educational achievement, educational opportunities, and income. All of these factors can contribute to the types of learning experiences young children undergo. Parents with greater financial resources can provide the books, toys, and other materials that stimulate intellectual growth. Moreover, families with economic stability are likely to experience less stress than economically unstable families, a factor that can be related to intellectual performance, as we saw earlier in this chapter. Finally, a recent study shows that heritability estimates can vary depending on family background variables. For families in which parents were well educated, heritability of verbal IQ for children was estimated to be .74, whereas when parents were poorly educated, the heritability estimate was .26 (Rowe, Jacobson, & Van den Oord, 1999). Rather than settling the nature-nurture question, then, racial differences in IQ have served to highlight the complexity of interactions among variables associated with intelligence.

cross-fostering study Research study in which children are reared in environments that differ from those of their biological parents.

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KEY THEME
Sociocultural Influence

● **Test Bias** A major hypothesis put forth to account for group differences in IQ scores is based on the notion of **test bias.** According to this view, the content of traditional tests is unfamiliar to children from some social or cultural backgrounds. In other words, traditional psychometric tests are not *culturally fair*. Recall the dilemma Son Van Nguyen faced at the beginning of this chapter and the erroneous conclusion he drew about his own intelligence based on his failure to define *inscription* and to answer the question "Who discovered America?" Unfortunately, his IQ test score may reflect the same conclusion. Individuals who have not encountered such specific information in their own cultural experiences will fail those items and score lower on many intelligence tests (Fagen & Holland, 2002).

What happens when tests that are more culturally fair are administered to children from varied sociocultural backgrounds? The research findings are mixed. In the chapter titled "Language," you were introduced to the Raven Progressive Matrices, a nonverbal test of reasoning ability that is assumed to contain minimal cultural bias. Caucasian children still score significantly higher on this test than African American children do (Jensen, 1980). Yet when another culturally fair test, the Kaufman Assessment Battery, was administered to children of different cultural backgrounds, the difference in test scores between Caucasian and African American children was smaller than when tests such as the WISC were given (Kaufman, Kamphaus, & Kaufman, 1985).

Finally, there are questions about whether minority children have the same experiences with, and attitudes toward, taking tests that majority children do. Some of the skills required to perform well on standardized tests include understanding directions, considering all response alternatives before selecting one, and attending to one item at a time (Oakland, 1982). Minority children may lack this basic "savvy" regarding how to take tests. Because most tests do not permit examiners to be flexible in administering them, they may underestimate minority children's skills (Miller-Jones, 1989). Moreover, minority children may score lower simply because they do not see the point of performing well or have not acquired the same drive to achieve in academic settings that is part of the majority culture (Gruen, Ottinger, & Zigler, 1970; Zigler & Butterfield, 1968). For some, IQ tests may even represent a part of the majority culture that is to be rejected outright (Ogbu, 1994). Still another factor to consider is the extent to which children are accustomed to having questions asked of them by adults. Greenfield (1997) points out that in Asian, African, and Latino cultures, children are expected not to speak to adults but to listen to them and respect their authority. By answering questions posed by an adult, the child may be violating cultural norms.

Not all researchers are convinced that test bias and motivational factors play a large part in explaining the lower IQ scores of certain groups of children (Jensen, 1980). Even for the skeptics, however, these ideas have highlighted the importance of structuring test situations so that *all* children are given the opportunity to display their best performance.

● **Stereotype Threat** How an individual thinks about his or her abilities in relation to negative stereotypes about gender or race can affect performance on different tasks, a concept called **stereotype threat**. This phenomenon has been demonstrated among adults: African American individuals initially primed to think that an upcoming test would assess their abilities scored lower on a challenging verbal test than did Caucasian individuals. However, there was no difference in performance when the groups were given instructions that did not emphasize ability testing (Steele & Aronson, 1995). Similar findings have been reported with upper and lower elementary and middle school Asian American girls given a standardized math test. Right before taking the test, each girl colored a picture that activated stereotypes about either "girls" or "Asians." A third group colored a neutral landscape scene. Figure 10.6 shows the performance of each of the groups on the math component of the Iowa Test of Basic Skills. For the youngest and oldest age groups, activating stereotypes about girls resulted in lower math test scores, whereas activating stereotypes about ethnicity resulted in higher scores (Ambady et al., 2001). (It is unclear why upper elementary

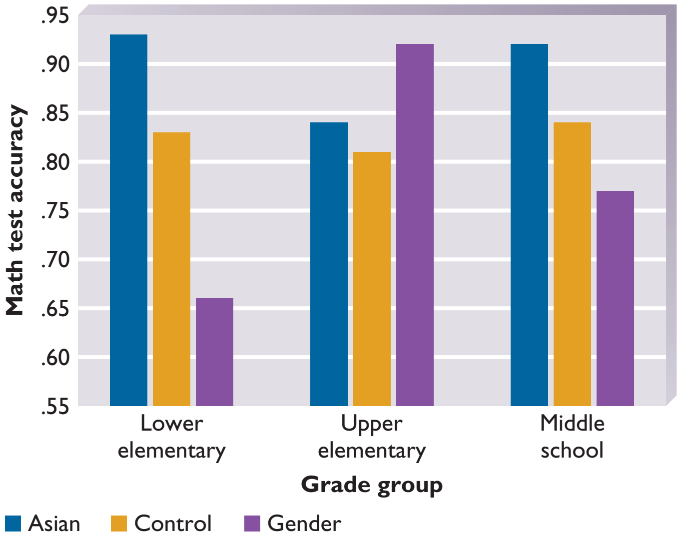
test bias Idea that the content of traditional standardized tests does not adequately measure the competencies of children from diverse cultural backgrounds.

stereotype threat The psychological impact of negative social stereotypes in an individual.

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 370

FIGURE 10.6
Stereotype Threat and Test Performance

In a study of lower and upper elementary and middle school Asian American girls, Nalini Ambady and her colleagues found that activation of gender stereotypes resulted in lower math test scores but that activation of ethnic stereotypes resulted in higher scores at least for the youngest and oldest groups. These findings suggest that it is important to consider the phenomenon of stereotype threat in evaluating ethnic differences in intelligence test scores.



Source: Ambady et al., 2001.

students did not fit this pattern of performance.) Results such as these suggest that stereotype threat may be an important factor in interpreting racial and ethnic group differences in IQ scores.

The Role of Early Experiences

KEY THEME
Nature/Nurture

The generally lower performance of children from minority groups and lower socioeconomic classes on IQ tests has prompted many researchers to take a closer look at how interactions in the home, early experiences in preschool programs, and the values of the larger culture might affect intellectual development. Research has generally revealed that certain aspects of adult-child interactions are related to higher scores on IQ tests.

● **The HOME Inventory** In 1970, an ambitious project got under way in Little Rock, Arkansas. Initiated by Bettye Caldwell and her associates (Caldwell & Bradley, 1978), the goal of the project was to identify characteristics of the young child's environment that might be related to later competence, including intellectual achievement. A sample of infants and their parents was recruited for a longitudinal study that would last eleven years.

The *Home Observation for Measurement of the Environment (HOME)* inventory was designed to measure a number of characteristics of the child's home surroundings, including the quality of caregiver-child interactions, the availability of objects and activities to stimulate the child, and the types of experiences family members provide to nurture the child's development (see Table 10.3 for the subscales and some sample items). Researchers collected data for the inventory through interviews and direct observations in the children's homes and gave children in the sample standard intelligence and school achievement tests.

The results identified several key features of the home environment as being related to subsequent IQ (Bradley, 1989). Significant correlations were found among measures of the home environment taken at age twelve months and children's IQ scores at ages three and four-and-a-half years. Particularly important were scales that measured parental emotional and verbal responsivity to the child, the availability of appropriate play materials, and parental involvement with the child (Bradley & Caldwell, 1976; Elardo, Bradley, & Caldwell, 1975). In addition, HOME scores at age two years were significantly related to language competencies at age three years (Elardo, Bradley, & Caldwell, 1977). The same three scales on the HOME inventory were especially related to the children's linguistic competence. A follow-up of these children

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 371

TABLE 10.3
Subscales of the Home Observation for Measurement of the Environment (HOME)

The HOME Inventory assesses several features of the home environment. Subscales 1, 4, and 5 were found to be significantly correlated with the child's later IQ and language competence.

(1) Emotional and verbal responsivity of mother
Sample item: Mother caresses or kisses child at least once during visit.

(2) Avoidance of restriction and punishment
Sample item: Mother does not interfere with child's actions or restrict child's movements more than three times during visit.

(3) Organization of physical and temporal environment
Sample item: Child's play environment appears safe and free of hazards.

(4) Provision of appropriate play materials
Sample item: Mother provides toys or interesting activities for child during interview.

(5) Maternal involvement with child
Sample item: Mother tends to keep child within visual range and to look at the child often.

(6) Opportunities for variety in daily stimulation
Sample item: Child eats at least one meal per day with mother and father.

Source: Adapted from Elardo & Bradley, 1981.

showed that parental involvement and availability of toys at age two years were significantly related to school achievement at age eleven years (Bradley, 1989).

KEY THEME
Interaction Among Domains

This series of studies shows that important processes occur between children and their parents early in life that can have long-lasting implications for future intellectual achievement. For one thing, children who have responsive parents may develop a sense of control over their environments, and their resulting general socioemotional health may facilitate intellectual growth. In addition, the opportunity to play with toys may provide contexts for children to learn problem-solving skills from their parents, as well as the chance to develop knowledge from direct manipulation of the play materials. Language development is also enhanced because verbal interactions with parents during play and at other times teach children the properties of spoken speech (Bradley & Caldwell, 1984). One project demonstrated that when mothers provided an environment rich in learning experiences such as those described in the HOME studies, the difference in IQ scores between African American and Caucasian children dropped by 28 percent (Brooks-Gunn, Klebanov, & Duncan, 1996).

Examining Research Methods

Using Correlations to Test Models of Causality

The HOME studies must be interpreted with caution because, as with any correlational research that uncovers relationships, we do not necessarily know the direction of influence. Parental responsiveness may have been responsible for children's IQ scores. But it is also possible that intelligent infants may have engendered more parental responsiveness and involvement simply because of their greater exploration of the environment or advanced verbal skills.

Some of these difficulties in interpretation are addressed with sophisticated statistical techniques, such as *structural equation modeling,* that allow researchers to evaluate hypotheses about the directions of influence in correlational relationships. Although the mathematical details of these approaches are beyond the scope of the present discussion, a study by Gottfried, Fleming, and Gottfried (1998) concerning the effects of the home environment on school-related motivation serves to illustrate the general tactics involved.

In their study, Gottfried and colleagues (1998) tested the prediction that a cognitively stimulating home environment would have a positive impact on children's academic *intrinsic motivation*—the tendency to be curious, interested, and persistent in

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 372

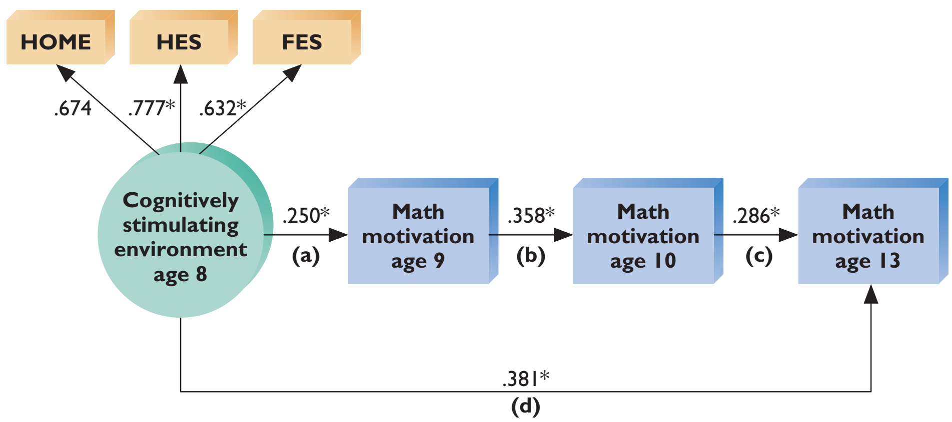
school-related tasks. When children in the sample were eight years old, extensive information was collected on their home environments by using a portion of the HOME inventory, as well as two other measures, the Home Environment Survey (HES) and the Family Environment Survey (FES). These latter two measures assessed parental encouragement of learning, educational stimulation, and involvement with the child. Some sample items from these scales are, "Does your child have access to a real musical instrument?" and the true-or-false item, "Family members often go to the library." Children were tested on the Children's Academic Intrinsic Motivation Inventory at ages nine, ten, and thirteen for reading, social studies, science, math, and "school in general." This test assesses the extent to which children enjoy learning, seek out challenging tasks, show curiosity, and display an orientation toward mastering tasks. Of special interest, of course, was whether measures of the home environment predicted children's motivation scores. We will focus here on children's motivation scores for math.

In structural equation modeling, the researcher usually draws a diagram, called a *path diagram,* that illustrates the predicted pattern of cause-and-effect relationships among the variables. An important assumption in this technique is that the connections among variables are set out before the researcher has the opportunity to inspect the results. If you look at Figure 10.7 (and ignore the numbers for now), you can see that the path diagram indicates that the home environment is expected to predict math motivation; the arrows indicate the direction of suspected causality. Specifically, the researchers predicted the relationships designated in (a), (b), and (c). Notice also that the dimension of interest to the researchers, a "cognitively stimulating home environment," is denoted by a circle. The reason is that it is an underlying psychological construct that is not measured directly. It is approximated by a combination of the variables in the small squares, the specific measures of the home environment obtained by the researchers. The variable in the circle is seen as causing the scores on the different home environment measures to take on their specific values. How would the diagram look if, in contrast, motivation levels in children were hypothesized to be responsible for different levels of stimulation in the home?

Next, the "goodness-of-fit" of the model is tested statistically. In Figure 10.7, the results are indicated by the numbers along each arrow, which are called *path coefficients.* Similar to correlation coefficients, the numbers indicate how much of a change in the variable at the start of an arrow is associated with a change at the end of an arrow. As you can see by the starred (statistically significant) numbers, the results supported the idea that home environment predicted math motivation at age nine and that math motivation scores at successive ages were also related. (A secondary level of the statistical analysis also showed that the home environment predicted math motivation at age thirteen, depicted as (d) in the path diagram.) In addition, another statistical test indicated that the overall pattern of the data fit the predicted model.

FIGURE 10.7
An Example of Structural Equation Modeling

This diagram shows the causal relationship between the home environment and math motivation predicted by Gottfried, Fleming, and Gottfried (1998). The direction of the arrows shows that a cognitively stimulating home environment, as measured by the HOME inventory, the Home Environment Survey (HES), and the Family Environment Survey (FES), was thought to predict math motivation. The starred path coefficients show that the data are consistent with the predictions. Structural equation modeling allows researchers to come closer to understanding causal relations than simple correlational studies do.



Source: Adapted from Gottfried, Fleming, & Gottfried, 1998.

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 373

An important caution about structural equation modeling is that because the analyses are essentially correlational, we can still not be absolutely sure that one variable or set of variables causes another to occur. What other cautions about correlational research might also apply to these results? What is the only research approach by which confidence about causality can be established? Could such an approach be used in the situation being examined by Gottfried and colleagues? Despite the limitations we are suggesting, however, structural equation modeling allows researchers to come closer to understanding causal relations than simple correlational studies do.

Gottfried, Fleming, and Gottfried's (1998) study did not directly explore the impact of home environment on IQ, but it does suggest a methodology that could be useful in untangling difficulties in interpreting research on this topic. How would you design such a study?

KEY THEME
Nature/Nurture

● **Early Intervention Programs** During the 1960s, the idea of compensatory education became popular in the United States. Researchers wanted to see whether the poor performance of children from lower socioeconomic classes on IQ and achievement tests could improve if the children received the kinds of cognitive stimulation presumably available to middle-class children. If compensatory education programs worked, the idea that IQ is malleable or modifiable by experience would receive strong support, and a genetic explanation of class and race differences in IQ would be less tenable.

Today, interest in early education is further spurred by the belief that experiences during the first three or four years of life are crucial for optimal brain development. Because we now understand that neurotransmitter functioning, synaptic formation, and gene activation are influenced by environmental conditions, there is greater urgency to provide optimal learning environments for young children (Shore, 1997).

The first federally funded program for compensatory education was Project Head Start, begun in the 1960s as a preschool enrichment program for "underprivileged children." The program includes nutritional and medical assistance, as well as a structured educational program designed to provide cognitive stimulation. The first evaluations of Head Start were disappointing. In 1969, the Westinghouse Learning Corporation/Ohio University report compared the intellectual development of about four thousand children from similar backgrounds, half of whom had participated in the first Head Start programs around the country and half of whom did not participate. Essentially no differences were found in the intellectual performance of

One example of an early intervention program is Project Head Start, a federal program designed to provide nutritional and medical assistance, as well as school readiness skills, to children growing up in poverty. Children who attend Head Start show gains in some measures of educational achievement and at least short-term increases in IQ scores.

307673_ch_10.qxd pp4 2/26/03 12:50 PM Page 374

the two groups; both remained below the norms for their age groups. This evaluation, however, has been criticized on a number of grounds, including the fact that the evaluation was done prematurely, just barely after the program got off the ground.

SEE FOR YOURSELF
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Evaluating Head Start

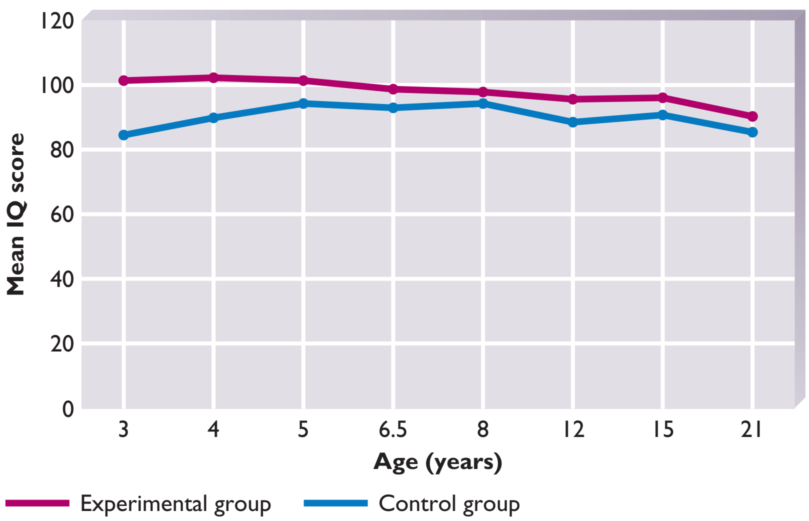
Subsequent evaluations of Head Start have yielded more optimistic results. The Head Start Evaluation, Synthesis, and Utilization Project was an attempt to summarize all research on the impact of Head Start (McKey et al., 1985). This review concluded that Head Start produced significant effects on the intellectual performance of program participants, at least for the short term. Head Start children performed well in the first year or two after they started elementary school, showing average gains of 10 points in IQ score, but the effects of the program faded in subsequent years.

Another important early intervention project, the Carolina Abecedarian Project, begun in 1972, aimed to prevent the lower intellectual functioning of children at risk (Ramey & Campbell, 1981; Ramey, Lee, & Burchinal, 1989). A sample of 121 low-income, pregnant women with low educational achievement and low IQ scores (an average of 84) was selected. Once the infants were born, roughly half were assigned to the experimental group and half to the control group. Infants in the experimental group received medical care, nutritional supplements, and a structured program of day care that emphasized the development of cognitive, language, social, and motor skills. In addition, the researchers provided a toy-lending library and a home visiting program, as well as parent support groups. During the first year, few differences on Bayley scores were found between infants in the experimental and control groups. From age eighteen months onward, however, the IQs of the experimental group consistently exceeded those of the control group, even when the children reached young adulthood (see Figure 10.8) (Campbell & Ramey, 1994; Campbell et al., 2001). Yet some researchers remain pessimistic about the significance of these findings. For example, Herman Spitz (1986) pointed out that by age five years, the differences between the experimental and control groups diminished to an average of only 7 points. Also, scores for the experimental group never really increased (Spitz, 1999). Therefore, say the critics, the effects of this intensive intervention were not substantial.

An important issue concerns why the initial gains of Head Start and Abecedarian children "washed out" in successive years. Perhaps early intervention is not enough to overcome the pervasive and continuing effects of poverty and understimulating environments on children as they advance into the school years. Perhaps, too, IQ scores are not the best indicators of the impact of Head Start and other early intervention programs. One collaborative study of the effects of eleven early intervention programs showed that children who had participated were less likely than nonparticipants to be assigned to special education classes, less likely to be "held back" in grade, and more likely to cite their school achievements as a source of pride (Lazar &

FIGURE 10.8
Early Intervention and IQ

Children who participated in the Abecedarian Project from infancy have been followed longitudinally through early adulthood. As the graph shows, compared with a control group, participants in this program had higher IQ scores at each test time, suggesting a modest but long-term impact of intensive early intervention.



Source: Campbell et al., 2001.

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Darlington, 1982). Edward Zigler, a key figure in the formulation of Project Head Start, and his colleagues have also found that Head Start children show notable gains in social competence (Zigler & Berman, 1983; Zigler & Trickett, 1978). Perhaps these multifaceted outcomes are just as important as gains in IQ scores.

Craig and Sharon Ramey (1998), pioneers in the Abecedarian Project, suggest that in order to be effective, early intervention programs need to target children early in development, include substantial contact with children and families who participate, and provide direct learning experiences for children. Programs should also provide a broad array of services, including health and social services, as well as transportation. Finally, in order to have long-lasting impact, continuous intervention and support should take place beyond the preschool years.

The Child's Sociocultural Environment

KEY THEME
Sociocultural Influence

Children from different cultural backgrounds often display unique patterns of intellectual abilities. For example, the Inuit people of the Arctic region show exceptional visual-spatial skills compared with those of United States residents (Berry, 1966; Vernon, 1966). How does the larger culture within which the child lives influence his or her pattern of mental abilities?

The role of culture in intellectual development may be examined in terms of activities and behaviors essential for adaptation and survival. The Inuits depend on hunting and gathering in their native terrain, activities that require the ability to perceive small changes in large, expansive fields of vision; in this context, the prominence of their visual-spatial skills is understandable. Similarly, as we saw in the chapter titled "Cognition: Piaget and Vygotsky," Mexican children with extensive experience in making clay pottery were found to be more advanced on a Piagetian measure of intelligence, the conservation of quantity task, than children without experience in pottery making (Price-Williams, Gordon, & Ramirez, 1969). Intensive practice in specialized skills that are an integral part of one's cultural experience can heighten "intelligence" in those domains.

The degree to which culture emphasizes formal schooling can also influence patterns of intellectual activity. Cross-cultural studies have shown that children with formal education are more likely to use mnemonic strategies to learn lists of words and to classify objects according to a consistent rule (Sharp, Cole, & Lave, 1979; Wagner, 1978). Although memory and classification performance, the dependent measures in

The child's sociocultural environment can influence specific patterns of intellectual skills. For example, among the Inuits, superior visual-spatial skills may be tied to that culture's emphasis on hunting in large, expansive terrains.

307673_ch_10.qxd pp4 2/26/03 12:51 PM Page 376

these studies, are not explicit indices of intelligence, they are cognitive skills that are frequently embedded in psychometric tests. Moreover, if intelligence is assumed to be reflected in IQ scores, children may learn specific skills in school that enable them to do well on intelligence tests (Ceci, 1991). Performing on a time-limited test, understanding and following directions, and being able to consider a number of response alternatives are all general test-taking skills that children are likely to absorb in school. Furthermore, the answers to specific questions found on intelligence tests, such as "Who discovered America?" or "What is the distance from New York to Los Angeles?" are usually learned in school.

Finally, cultures may differ in the ways intelligent behavior is conceptualized. For example, Latino immigrants place a high value on behaviors that are socially respectful and correct (Reese et al., 1995). Humility and personal self-knowledge are emphasized in certain Chinese traditions (Yang & Sternberg, 1997). Even in our own society, new theories describe notions such as "emotional intelligence," the ability to read and respond to the feelings of others, as well as to understand and regulate one's own emotions (Goleman, 1995; Mayer & Salovey, 1997). Children growing up in societies that promote concepts such as these may be encouraged to develop in ways that differ from those of cultures in which cognitive and academic skills are viewed as the exclusive components of intelligence.

FOR YOUR REVIEW

- What are the complexities involved in trying to assess the contributions of heredity to group differences in IQ?
- How might concepts like test bias and stereotype threat play a part in explaining group differences in IQ?
- Which specific aspects of the home environment are related to subsequent IQ scores in children?
- How do techniques like structural equation modeling help to address questions of causal relationships among variables?
- What has research revealed about the effects of early intervention programs for children? What factors are most important in promoting successful outcomes?
- How does the child's sociocultural environment influence intellectual abilities? What are some specific examples of this influence?

CHAPTER RECAP

Summary of Developmental Themes

Nature/Nurture ***What roles do nature and nurture play in the development of intelligence?***

The nature-nurture debate becomes an especially thorny issue in the matter of intelligence. Few psychologists would dispute that heredity plays a role in the child's intellectual development. For example, early individual differences in the speed of infant habituation and recognition memory may signal differences in some aspects of later intellectual functioning. In addition, genetic effects such as Down syndrome and the high correlations between IQ scores of identical twins reared apart suggest a role for "nature." Yet research also shows that children's early experiences within the home, together with the intellectual skills touted by the larger culture, modulate how their genetic blueprints unfold.

Sociocultural Influence ***How does the sociocultural context influence the development of intelligence?***

Culture broadly influences the kinds of skills that its members value and nurture and that are believed to constitute "intelligence." Is speed of executing tasks important? Are good visual-spatial or verbal skills essential for successful adaptation to the environment? A culture's demands and expectations frame the way intelligent behavior will be defined in the first place. From the narrower perspective of performance on standardized IQ tests, children who have experiences consistent with the knowledge tapped by test items will perform well, whereas those with more impoverished backgrounds will be at a disadvantage. Other sociocultural factors often associated with social class, such as parental emphasis on intellectual achievement or the amount of emotional stress within the family system, can also impinge on IQ test performance.

■ **Child's Active Role** ***How does the child play an active role in the development of intelligence?***

Traditional psychometric theories have rarely assumed that the child plays an active role in affecting her intelligence. However, the information-processing perspective has focused on executive control skills, the child's ability to monitor his own cognitive processes, and other cognitive activities as significant contributors to intellectual development.

■ **Continuity/Discontinuity** ***Is the development of intelligence continuous or discontinuous?***

Some would argue that intelligence does not really develop at all, that it is a stable, relatively unchanging, inborn human characteristic. Information-processing theorists, in contrast, see intelligence as largely the by-product of normal, continuous developmental processes wherein the child learns more complex relations among stimuli in the surrounding world and becomes capable of more sophisticated cognitive processing with age.

■ **Individual Differences** ***How prominent are individual differences in the development of intelligence?***

From the psychometric perspective, the concept of intelligence is rooted in the assumption that individual differences exist in performance on certain mental tasks. Other theories, particularly Gardner's theory of multiple intelligences, stress the patterns of strength and weakness a given individual shows across a spectrum of domains. Studies of how the environment influences intelligence also suggest that an individual's score on an IQ test can be a function of the specific parenting practices she or he has experienced or other elements of the childhood environment.

■ **Interaction Among Domains** ***How does the development of intelligence interact with development in other domains?***

Children who obtain high scores on intelligence tests are more likely to be successful in school and, as adults, to hold high-status jobs and be productive in those jobs. Thus, to some extent, IQ scores can predict certain aspects of success in life. According to more recent theoretical perspectives, the child's experiences in various domains can also influence intelligence. For example, in Gardner's theory of multiple intelligences, bodily-kinesthetic intelligence can be fostered through athletic experiences, and interpersonal intelligence can grow through extensive social experience.

Summary of Topics

What Is Intelligence?

- Definitions of intelligence vary in two major ways: (1) whether intelligence is seen as a global characteristic or as a set of separate abilities and (2) whether the emphasis is on the products or the processes of intelligent behavior.

Psychometric Approaches

- The *psychometric model* of intelligence emphasizes individual differences in test scores.
- Two historically important ideas were those of Spearman, who conceptualized a general intelligence factor called *g*, and Thurstone, who believed in seven primary mental abilities.
- In Cattell and Horn's view, intelligence could be seen as having two components: *fluid intelligence*, which was free of cultural influence, and *crystallized intelligence*, which referred to culturally derived skills. Fluid intelligence shows an earlier developmental decline than crystallized intelligence.

Information-Processing Approaches

- Information-processing models focus on the mental activities of individuals as they engage in problem solving. Speed of processing and working memory capacity are two information-processing activities thought to be involved in intelligence.
- Sternberg's *triarchic theory* points to (1) the ability to adapt to the environment, (2) the ability to encode, combine, and compare stimuli, and (3) the ability to deal with novelty and to automatize as components of intelligence.
- Gardner's theory of multiple intelligences states that individuals can differ in discrete skill areas such as language, music, mathematics, spatial perception, physical activities, personal awareness, social interaction, or nature.

Measuring Intelligence

- IQ scores are normally distributed in the population. The mean IQ is 100 and the standard deviation is 15.
- Individuals who fall beyond two standard deviations from the mean are considered to be exceptional. They may be categorized as either gifted or mentally retarded.

Standardized Tests of Intelligence

- Intelligence is usually expressed in terms of the intelligence quotient, or IQ score.
- IQ tests are designed by being administered to large groups of individuals to assess norms of performance and to establish the validity and reliability of the test.
- Two tests of intelligence for infants are the Bayley Scales of Infant Development and the Fagan Test of Infant Intelligence. Both are generally used to identify children who are at risk for developmental delays.
- School-age children are most frequently tested with the Stanford-Binet Intelligence Scales or the Wechsler Intelligence Scale for Children–III (WISC-III). These tests are based on the psychometric model and assess a range of verbal, visual-spatial, quantitative, and problem-solving skills. The Kaufman Assessment Battery (K-ABC) focuses more on children's mental processing skills.

Stability and Prediction

- For many children, IQ scores are stable over time, especially after age five years, although individual children can show dramatic fluctuations.
- Studies of infant attention and memory show that there are some developmental continuities in mental abilities.
- IQ scores generally predict academic success but are not necessarily related to other measures of life satisfaction.

Factors Related to Intelligence

- Intelligence is the result of the complex interplay between heredity and environment.

Group Differences in IQ Scores

- Social class and racial differences in IQ scores illustrate the difficulty of drawing simple conclusions about the sources of intelligence. One problem is that estimates of heritability do not necessarily explain between-group differences in scores.
- *Cross-fostering studies* of children who were raised in environments that differ from those of their biological parents indicate that IQ scores rise in enriched environments but that scores are still more strongly related to educational levels of biological parents than to IQ levels of adoptive parents.
- *Test bias*, the idea that the content of IQ tests may not be fair to children from different cultural backgrounds, can help to explain group differences in IQ scores. Other factors in the testing situation may also interfere with children's optimal performance.
- *Stereotype threat*, the negative psychological impact of being sensitized to a stereotype about gender or ethnicity, has been linked to diminished performance on standardized tests.

The Role of Early Experiences

- Studies using the HOME Inventory show that several factors in the child's home environment are related to higher IQ scores. Particularly important are parental responsiveness to the child, provision of appropriate play materials, and parental involvement with the child.
- Evaluations of the effectiveness of early intervention programs such as Head Start and the Abecedarian Project show intellectual gains by children who have participated. However, the increases shown by Head Start children often fade after a few years. Critics of the Abecedarian Project say that increases in IQ scores are modest at best. Some researchers argue that more intensive and continuous intervention is necessary to produce more dramatic outcomes.

The Child's Sociocultural Environment

- Children have been observed to display different patterns of intellectual skills depending on the environment in which they are raised, probably because of the intensive practice they receive in those domains.
- Formal schooling influences the development of cognitive skills such as memory and classification.
- Cultures differ in the ways they conceptualize intelligence. For example, some give greater priority to social respectfulness, whereas others emphasize the importance of personal knowledge.