61-2 What's the difference between achievement and aptitude tests?

- *Achievement tests* are designed to assess what you have learned.
- *Aptitude tests* are designed to predict what you can learn.
- The *WAIS (Wechsler Adult Intelligence Scale)*, an aptitude test, is the most widely used intelligence test for adults.

61-3 What are standardization and the normal curve?

- *Standardization* establishes a basis for meaningful score comparisons by giving a test to a representative sample of future test-takers.
- The distribution of test scores often forms a *normal* (bell-shaped) *curve* around the central average score, with fewer and fewer scores at the extremes.

61-4 What are reliability and validity?

- *Reliability* is the extent to which a test yields consistent results (on two halves of the test, or when people are retested).
- *Validity* is the extent to which a test measures or predicts what it is supposed to.
  - A test has *content validity* if it samples the pertinent behavior (as a driving test measures driving ability).
  - It has *predictive validity* if it predicts a behavior it was designed to predict. (Aptitude tests have predictive ability if they can predict future achievements.)

Multiple-Choice Questions

1. A test-developer defines uniform testing procedures and meaningful scores by comparison with the performance of a pretested group. Which of the following best describes this process?
   a. Reliability testing
   b. Validation
   c. Content validation
   d. Standardization
   e. Predictive validity

2. Which of the following best describes the extent to which a test yields consistent results upon retesting?
   a. Content validity
   b. Validity
   c. Reliability
   d. Predictive validity
   e. Normal curve

3. Which of the following can be used to demonstrate that only about 2 percent of the population scores are at least two standard deviations above the mean on an intelligence test?
   a. Reliability test
   b. Aptitude test
   c. Predictive validity test
   d. Test-retest procedure
   e. Normal curve

Practice FRQs

1. What are the fundamental differences between achievement and aptitude tests?

2. Name and briefly describe the three essential principals of test construction.
(3 points)

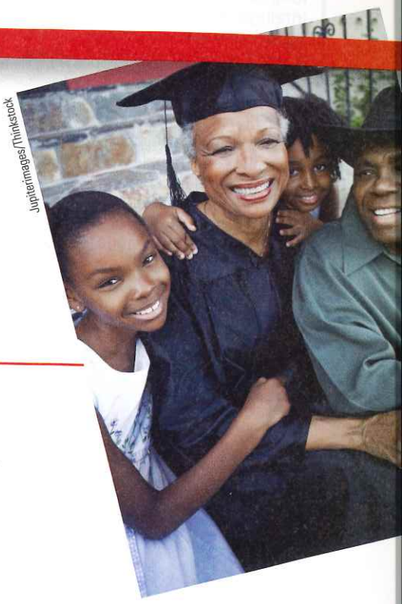
Answer

1 point: Achievement tests are designed to assess what a person has learned.

1 point: An aptitude test is designed to predict a person's future performance.

Module 62

The Dynamics of Intelligence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Module Learning Objectives

62-1 Describe the stability of intelligence scores over the life span.

62-2 Describe the traits of those at the low and high intelligence extremes.

We now can address some age-old questions about the dynamics of human intelligence—about its stability over the life span, and about the extremes of intelligence.

Stability or Change?

62-1 How stable are intelligence scores over the life span?

If we retested people periodically throughout their lives, would their intelligence scores be stable? Let's first explore the stability of mental abilities in later life.

Aging and Intelligence

What happens to our broader intellectual muscles as we age? Do they gradually decline, as does our body strength (even if relative intellectual and muscular strength in later life is predictable from childhood)? Or do they remain constant? The quest for answers to these questions illustrates psychology's self-correcting process. This research developed in phases.

PHASE I: CROSS-SECTIONAL EVIDENCE FOR INTELLECTUAL DECLINE

In *cross-sectional studies,* researchers at one point in time test and compare people of various ages. In such studies, researchers have consistently found that older adults give fewer correct answers on intelligence tests than do younger adults. WAIS-creator, David Wechsler (1972) therefore concluded that "the decline of mental ability with age is part of the general [aging] process of the organism as a whole." For a long time, this rather dismal view went unchallenged. Many corporations established mandatory retirement policies, assuming the companies would benefit by replacing aging workers with younger, presumably more capable, employees. As "everyone knows," you can't teach an old dog new tricks.

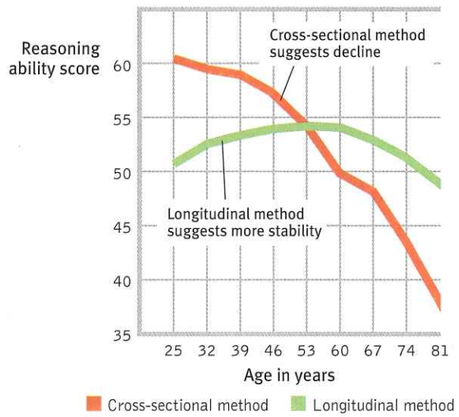
PHASE II: LONGITUDINAL EVIDENCE FOR INTELLECTUAL STABILITY

After colleges in the 1920s began giving intelligence tests to entering students, several psychologists saw their chance to study intelligence *longitudinally.* They retested the same **cohort**—the same group of people—over a period of years (Schaie & Geiwitz, 1982). What they found was a surprise: Until late in life, intelligence remained stable (**FIGURE 62.1** on the next page). On some tests, it even increased.

cohort a group of people from a given time period.

Figure 62.1

Cross-sectional versus longitudinal testing of intelligence at various ages In this test of one type of verbal intelligence (inductive reasoning), the cross-sectional method produced declining scores with age. The longitudinal method (in which the same people were retested over a period of years) produced a slight rise in scores well into adulthood. (Adapted from Schaie, 1994.)



How then are we to account for the cross-sectional findings? In retrospect, researchers saw the problem. When cross-sectional studies compared 70-year-olds and 30-year-olds, they compared people not only of two different ages but of two different eras. They compared generally less-educated people (born, say, in the early 1900s) with better-educated people (born after 1950), people raised in large families with people raised in smaller families, people growing up in less affluent families with people raised in more affluent families.

With this more optimistic view, the myth that intelligence sharply declines with age was laid to rest. At age 70, John Rock developed the birth control pill. At age 81—and 17 years from the end of his college football coaching career—Amos Alonzo Stagg was named coach of the year. At age 89, architect Frank Lloyd Wright designed New York City's Guggenheim Museum. As "everyone knows," given good health you're never too old to learn.

PHASE III: IT ALL DEPENDS

With "everyone knowing" two different and opposing facts about age and intelligence, something was clearly wrong. As it turns out, longitudinal studies have their own potential pitfalls. Those who survive to the end of longitudinal studies may be bright, healthy people whose intelligence is least likely to decline. (Perhaps people who died younger and were removed from the study had declining intelligence.) Adjusting for the loss of participants, as did a study following more than 2000 people over age 75 in Cambridge, England, reveals a steeper intelligence decline, especially after 85 (Brayne et al., 1999).

Research is further complicated by the finding that intelligence is not a single trait, but rather several distinct abilities. Intelligence tests that assess speed of thinking may place older adults at a disadvantage because of their slower neural processing. Meeting old friends on the street, names rise to the mind's surface more slowly—"like air bubbles in molasses," said David Lykken (1999). But slower processing need not mean less intelligence. In four studies in which players were given 15 minutes to complete *New York Times* crossword puzzles, the highest average performance was achieved by adults in their fifties, sixties, and seventies (Salthouse, 2004). "Wisdom" tests assessing "expert knowledge about life in general and good judgment and advice about how to conduct oneself in the face of complex, uncertain circumstances" also suggested that older adults more than hold their own on such tasks (Baltes et al., 1993, 1994, 1999).

So the answers to our age-and-intelligence questions depend on what we assess and how we assess it. **Crystallized intelligence**—our accumulated knowledge as reflected in vocabulary and analogies tests—*increases* up to old age. **Fluid intelligence**—our ability to reason speedily and abstractly, as when solving novel logic problems—*decreases* beginning in the twenties and thirties, slowly up to age 75 or so, then more rapidly, especially after age 85 (Cattell, 1963; Horn, 1982; Salthouse, 2009). With age we lose and we win. We lose recall memory and processing speed, but we gain vocabulary knowledge (**FIGURE 62.2**). Our decisions also become less distorted by negative emotions such as anxiety, depression, and anger (Blanchard-Fields, 2007; Carstensen & Mikels, 2005). And despite their lesser fluid intelligence, older adults also show increased social reasoning, such as by taking multiple perspectives, appreciating knowledge limits, and thus offering helpful wisdom in times of social conflict (Grossman et al., 2010).

FYI

Like older people, older gorillas process information more slowly (Anderson et al., 2005).

"Knowledge is knowing a tomato is a fruit; wisdom is not putting it in a fruit salad." -Anonymous

crystallized intelligence our accumulated knowledge and verbal skills; tends to increase with age.

fluid intelligence our ability to reason speedily and abstractly; tends to decrease during late adulthood.

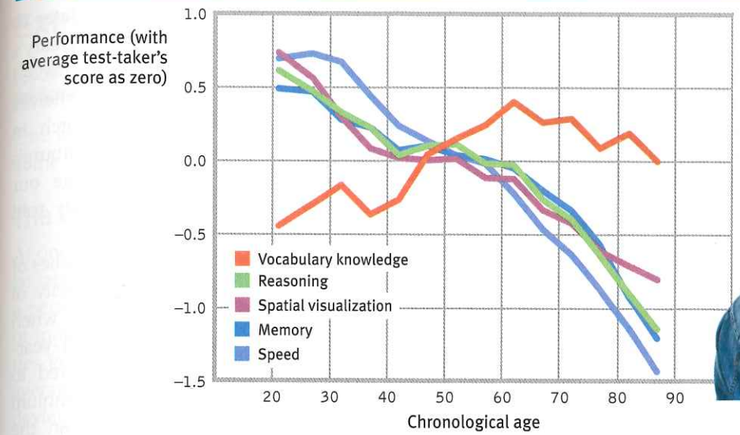


Figure 62.2

With age we lose and we win Research reveals that word power grows with age, while fluid intelligence dimensions decline (Salthouse, 2010b).

Ann Baldwin/Shutterstock

These cognitive differences help explain why older adults are less likely to embrace new technologies (Charness & Boot, 2009). In 2010, only 31 percent of Americans ages 65 and older had broadband Internet at home, compared with 80 percent of adults under 30 (Pew, 2010). The age-related cognitive differences also help explain some curious findings about creativity. Mathematicians and scientists produce much of their most creative work during their late twenties or early thirties. In literature, history, and philosophy, people tend to produce their best work in their forties, fifties, and beyond—after accumulating more knowledge (Simonton, 1988, 1990). Poets, for example, who depend on fluid intelligence, reach their peak output earlier than prose authors, who need a deeper knowledge reservoir. This finding holds in every major literary tradition, for both living and dead languages.

"In youth we learn, in age we understand." -Marie Von Ebner-Eschenbach, *Aphorisms*, 1883

Stability Over the Life Span

Now what about the stability of intelligence scores early in life? Except for extremely impaired or very precocious children, casual observation and intelligence tests before age 3 only modestly predict children's future aptitudes (Humphreys & Davey, 1988; Tasbihsazan et al., 2003). For example, children who are early talkers—speaking in sentences typical of 3-year-olds by age 20 months—are not especially likely to be reading by age 4½ (Crain-Thoreson & Dale, 1992). (A better predictor of early reading is having parents who have read lots of stories to their child.) Even Albert Einstein was slow in learning to talk (Quasha, 1980).

By age 4, however, children's performance on intelligence tests begins to predict their adolescent and adult scores. The consistency of scores over time increases with the age of the child. The remarkable stability of aptitude scores by late adolescence is seen in a U.S. Educational Testing Service® study of 23,000 students who took the SAT® exam and then later took the GRE® (Angoff, 1988). On either test, verbal scores correlated only modestly with math scores—revealing that these two aptitudes are distinct. Yet scores on the SAT® exam verbal test correlated +.86 with the scores on the GRE® verbal tests taken four to five years later. An equally astonishing +.86 correlation occurred between the two math tests. Given the time lapse and differing educational experiences of these 23,000 students, the stability of their aptitude scores is remarkable.

Ian Deary and his colleagues (2004, 2009) set a record for long-term follow-up. Their amazing longitudinal studies have been enabled by their country, Scotland, doing something that no nation has done before or since. On June 1, 1932, essentially every child in the country who had been born in 1921—87,498 children around age 11—was given an intelligence test. The aim was to identify working-class children who would benefit from

"My dear Adele, I am 4 years old and I can read any English book. I can say all the Latin substantives and adjectives and active verbs besides 52 lines of Latin poetry." -Francis Galton, letter to his sister, 1827

FYI

Ironically, SAT® exam and GRE® scores correlate better with each other than either does with its intended criterion, school achievement. Thus, their reliability far exceeds their predictive validity. If either test was much affected by coaching, luck, or how one feels on the test day (as so many people believe), such reliability would be impossible.

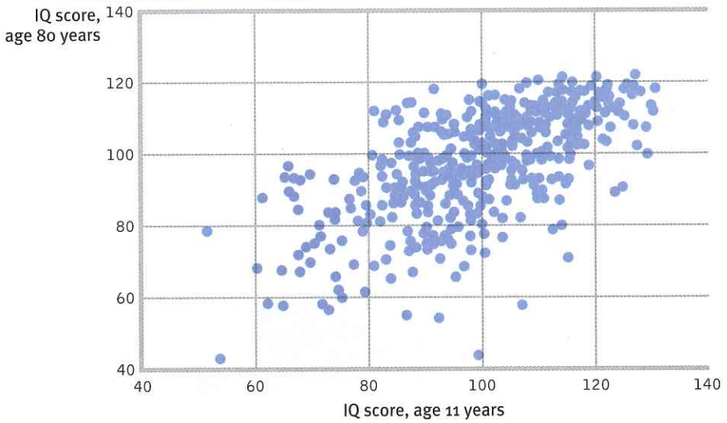


Figure 62.3
Intelligence endures When Ian Deary and his colleagues (2004) retested 80-year-old Scots, using an intelligence test they had taken as 11-year-olds, their scores across seven decades correlated +.66. (When 207 survivors were again retested at age 87, the correlation with their age 11 scores was +.51 [Gow et al., 2011].)

"Whether you live to collect your old-age pension depends in part on your IQ at age 11."
-Ian Deary, "Intelligence, Health, and Death," 2005

further education. Sixty-five years later to the day, Patricia Whalley, the wife of Deary's co-worker, Lawrence Whalley, discovered the test results on dusty storeroom shelves at the Scottish Council for Research in Education, not far from Deary's Edinburgh University office. "This will change our lives," Deary replied when Whalley told him the news.

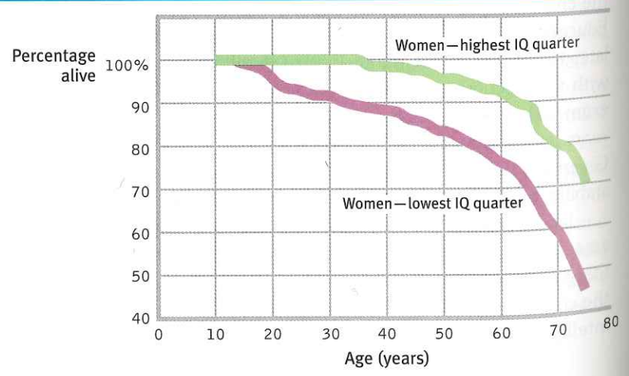
And so it has, with dozens of studies of the stability and the predictive capacity of these early test results. For example, when the intelligence test administered to 11-year-old Scots in 1932 was readministered to 542 survivors as turn-of-the-millennium 80-year-olds, the correlation between the two sets of scores—after almost 70 years of varied life experiences—was striking (**FIGURE 62.3**). A later study that followed Scots born in 1936 from ages 11 to 70 confirmed the remarkable stability of intelligence, independent of life circumstance (Johnson et al., 2010).

High-scoring 11-year-olds also were more likely to be living independently as 77-year-olds and were less likely to have suffered the cognitive erosion of Alzheimer's disease (Starr et al., 2000; Whalley et al., 2000). Among girls scoring in the highest 25 percent, 70 percent were still alive at age 76—as were only 45 percent of those scoring in the lowest 25 percent (**FIGURE 62.4**). (World War II prematurely ended the lives of many of the male test-takers.) Follow-up studies with other large samples confirm the phenomenon: More intelligent children and adults live healthier and longer (Deary et al., 2008, 2010; Der et al., 2009; Weiss et al., 2009). One study that followed 93 nuns found that those exhibiting less verbal ability in essays written when entering convents in their teens were more at risk for Alzheimer's disease after age 75 (Snowdon et al., 1996).

Pause a moment: Have you any ideas why more intelligent people might live longer? Deary (2008) reports four possible explanations:

1. Intelligence facilitates more education, better jobs, and a healthier environment.
2. Intelligence encourages healthy living: less smoking, better diet, more exercise.
3. Prenatal events or early childhood illnesses might have influenced both intelligence and health.
4. A "well-wired body," as evidenced by fast reaction speeds, perhaps fosters both intelligence and longevity.

Figure 62.4
Living smart Women scoring in the highest 25 percent on the Scottish national intelligence test at age 11 tended to live longer than those who scored in the lowest 25 percent. (From Whalley & Deary, 2001.)



Extremes of Intelligence

62-2 What are the traits of those at the low and high intelligence extremes?

One way to glimpse the validity and significance of any test is to compare people who score at the two extremes of the normal curve. The two groups should differ noticeably, and they do.

The Low Extreme

At one extreme of the normal curve are those with unusually low intelligence test scores. To be labeled as having an **intellectual disability** (formerly referred to as *mental retardation*), a person must have both a low test score and difficulty adapting to the normal demands of independent living. American Association on Intellectual and Developmental Disabilities guidelines specify performance that is approximately two standard deviations below average (Schalock et al., 2010). For an intelligence test with 100 as average and a standard deviation of 15, that means (allowing for some variation in one's test score) an IQ of approximately 70 or below. The second criterion is a comparable limitation in adaptive behavior as expressed in

- *conceptual skills,* such as language, literacy, and concepts of money, time, and number,
- *social skills,* such as interpersonal skills, social responsibility, and the ability to follow basic rules and laws and avoid being victimized, and
- *practical skills,* such as daily personal care, occupational skill, and travel and health care.

intellectual disability a condition of limited mental ability, indicated by an intelligence score of 70 or below and difficulty in adapting to the demands of life. (Formerly referred to as *mental retardation*.)

Down syndrome a condition of mild to severe intellectual disability and associated physical disorders caused by an extra copy of chromosome 21.

Intellectual disability is a developmental condition that is apparent before age 18, sometimes with a known physical cause. **Down syndrome,** for example, is a disorder of varying severity caused by an extra chromosome 21 in the person's genetic makeup.

Consider one reason why people diagnosed with a mild intellectual disability—those just below the 70 score—might be better able to live independently today than many decades ago, when they were institutionalized. Recall that, thanks to the Flynn effect, the tests have been periodically restandardized. As that happened, individuals who scored near 70 on earlier tests suddenly lost about 6 IQ points. Two people with the same ability level could thus be classified differently, depending on when they were tested (Kanaya et al., 2003; Reynolds et al., 2010). As the boundary shifts, more people become eligible for special education and for Social Security payments for those with an intellectual disability. And in the United States (one of only a few industrialized countries with the death penalty), fewer people are eligible for execution—the U.S. Supreme Court ruled in 2002 that the execution of people with an intellectual disability is "cruel and unusual punishment." For people near that score of 70, intelligence testing can be a high-stakes competition. And so it was for Teresa Lewis, a "dependant personality" with limited intellect, who was executed by the state of Virginia in 2010. Lewis, whose reported IQ score was 72, reportedly agreed to a plot in which two men killed her husband and stepson in exchange for a split of a life insurance payout (Eckholm, 2010). If only she had scored 69.


Reuters/Claudia Daut

Mainstreaming in Chile Most Chilean children with Down syndrome attend separate schools for children with special needs. However, this boy is a student at the Altamira School, where children with differing abilities share the classrooms.

The High Extreme

In one famous project begun in 1921, Lewis Terman studied more than 1500 California schoolchildren with IQ scores over 135. Contrary to the popular notion that intellectually gifted children are frequently maladjusted, Terman's high-scoring children, like those in later studies, were healthy, well-adjusted, and unusually successful academically (Koenen et al., 2009; Lubinski, 2009a; Stanley, 1997). When restudied over the next seven decades, most people in Terman's group (the "Termites") had attained high levels of education (Austin et al., 2002; Holahan & Sears, 1995). They included many doctors, lawyers, professors, scientists, and writers, but no Nobel Prize winners.

FYI
Terman did test two future Nobel laureates in physics but they failed to score above his gifted sample cutoff (Hulbert, 2005).

JOE KLAMAR/AFP/Getty Images

The extremes of intelligence
Moshe Kai Cavalin completed his third college degree by the time he was 14, when the math major graduated from UCLA. According to his mother, he first picked up a college textbook and started reading it at age 2.

"Joining Mensa means that you are a genius. . . . I worried about the arbitrary 132 cutoff point, until I met someone with an IQ of 131 and, honestly, he was a bit slow on the uptake." -Comedian Steve Martin, 1997

A more recent study of precocious youths who aced the math SAT® exam at age 13—by scoring in the top quarter of 1 percent of their age group—were at age 33 twice as likely to have patents as were those in the bottom quarter of the top 1 percent (Wai et al., 2005). Compared with the math aces, 13-year-olds scoring high on verbal aptitude were more likely to have become humanities professors or written a novel (Park et al., 2007). About 1 percent of Americans earn doctorates. But among those scoring in the top 1 in 10,000—on the mere two-hour SAT® at age 12 or 13—more than half have done so (Lubinski, 2009b).

These whiz kids remind me of Jean Piaget, who by age 15 was publishing scientific articles on mollusks and who went on to become the twentieth century's most famous developmental psychologist (Hunt, 1993). Children with extraordinary academic gifts are sometimes more isolated, introverted, and in their own worlds (Winner, 2000). But most thrive.

Is there a gifted education program at your school? There are critics who question many of the assumptions of currently popular "talented and gifted child" programs, such as the belief that only 3 to 5 percent of children are gifted and that it pays to identify and "track" these special few—segregating them in special classes and giving them academic enrichment not available to their peers. Critics note that tracking by aptitude sometimes creates a self-fulfilling prophecy: Those implicitly labeled "ungifted" may be influenced to become so (Lipsey & Wilson, 1993; Slavin & Braddock, 1993). Denying lower-ability students opportunities for enriched education can widen the achievement gap between ability groups and increase their social isolation from one another (Carnegie, 1989; Stevenson & Lee, 1990). Because minority and low-income youth are more often placed in lower academic groups, tracking can also promote segregation and prejudice—hardly, note critics, a healthy preparation for working and living in a multicultural society.

Critics and proponents of gifted education do, however, agree on this: Children have differing gifts, whether at math, verbal reasoning, art, or social leadership. Educating children as if all were alike is as naive as assuming that giftedness is something, like blue eyes, that you either have or do not have. One need not hang labels on children to affirm their special talents and to challenge them all at the frontiers of their own ability and understanding. By providing *appropriate developmental placement* suited to each child's talents, we can promote both equity and excellence for all (Colangelo et al., 2004; Lubinski & Benbow, 2000; Sternberg & Grigorenko, 2000).

Before You Move On

ASK YOURSELF
How do you feel about mainstreaming children of all ability levels in the same classroom? What evidence are you using to support your view?

TEST YOURSELF
The Smiths have enrolled their 2-year-old son in a special program that promises to assess his IQ and, if he places in the top 5 percent of test-takers, to create a plan that will guarantee his admission to a top university at age 18. Why is this endeavor of questionable value?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 62 Review

62-1 How stable are intelligence scores over the life span?

- Cross-sectional studies (comparing people of different ages) and longitudinal studies (retesting the same *cohort* over a period of years) have shown that *fluid intelligence* declines in older adults, in part because neural processing slows. *Crystallized intelligence* tends to increase.
- The stability of intelligence test scores increases with age.
  - At age 4, scores fluctuate somewhat but begin to predict adolescent and adult scores.
  - By early adolescence, scores are very stable and predictive.

62-2 What are the traits of those at the low and high intelligence extremes?

- An intelligence test score of or below 70 is one diagnostic criterion for the diagnosis of *intellectual disability* (others are limited conceptual, social, and practical skills). People with this diagnosis vary from near-normal to requiring constant aid and supervision.
- *Down syndrome* is a developmental disorder caused by an extra copy of chromosome 21.
- High-scoring people tend to be healthy and well-adjusted, as well as unusually successful academically.
  - Schools sometimes "track" such children, separating them from students with lower scores. Such programs can become self-fulfilling prophecies as both groups live up to—or down to—others' perceptions and expectations.

Multiple-Choice Questions

1. Which of the following is a longitudinal study?
   a. Researchers test the intelligence of all the students in a high school.
   b. Intelligence tests are given to the residents of a nursing home.
   c. Researchers randomly select 50 students from a high school with 2000 students. The 50 students are given intelligence tests.
   d. A group of college juniors is given an extensive battery of tests over a period of 2 days.
   e. A group of kindergartners is given an intelligence test. They are retested every other year for 30 years.

2. Which of the following best represents crystallized intelligence?
   a. Jake can solve math word problems quickly.
   b. Grandpa Milt is good at crossword puzzles.
   c. Aliyah has a knack for training dogs.
   d. Anna writes creative computer programs.
   e. Heng bakes excellent chocolate chip cookies.

3. Who conducted a famous study of high IQ children?
   a. Lewis Terman
   b. David Wechsler
   c. Robert Sternberg
   d. Howard Gardner
   e. Alfred Binet

4. Intellectual disability is defined by both IQ and which of the following?
   a. Chronological age
   b. Mental age
   c. Adaptive ability
   d. Physical condition
   e. Heritability

Practice FRQs

1. Name and describe the two main types of evidence used to determine whether there is an intellectual decline as people age.

Answer
2 *points:* Cross-sectional evidence, which comes from studies that examine several age groups at once.

2 *points:* Longitudinal evidence, which comes from studies that examine the same group of people over a long period of time.

2. Explain three reasons why more intelligent people might live longer.

(3 points)