

Testing and Individual Differences

Our society believes that intelligence is very important; in fact, intelligence tests are used to decide what schools people may attend, what jobs they are qualified for, and whether or not they are capable or brilliant. Interestingly, psychologists generally cannot agree on what exactly intelligence is or an effective way that it can be measured. Experimental psychologist E.G. Boring once famously declared, "Intelligence is what intelligence tests measure." If that were the only meaning of intelligence, no one but psychologists would care about it. Broadly defined, **intelligence** involves the capacity to acquire knowledge, reason effectively, and adapt to one's surroundings by utilizing a combination of inherited abilities (nature) and learned experiences (nurture). Intelligence may be described as a collection of separate abilities or as one significant factor. The study of intelligence is closely related to the field of **psychometrics**, or the scientific study of using mathematical or numerical methods to measure psychological variables by creating reliable and valid tests. Psychometrics involves the use of a mathematical concept called **factor analysis**, which utilizes statistics to reduce the number of variables by placing them in clusters of related items. This technique can be used to determine groups of similar variables on a test to determine if an individual's score on a measure of intelligence is related to one type of ability (factor) or many. In regard to intelligence it is important that you are able to describe the main theories, the history of testing, and the elements of good test construction.

Intelligence Theories

As psychologists have researched intelligence, a variety of different theories have been proposed to explain how intelligence can be defined and potentially measured. The theories differ in terms of how they explain the overall concept. Some theories describe intelligence as one type of ability; others describe intelligence as being comprised of several different abilities. Psychologists ultimately disagree as to whether intelligence is a single function or several different abilities. The major theories of intelligence, both historical and contemporary, that are required for the AP Psychology exam are outlined below.

Spearman's Two-Factor Theory of Intelligence

Utilizing factor analysis, **Charles Spearman** created the **two-factor theory** of intelligence that is comprised of both a main **general factor (g-factor)** that represents an individual's overall ability and several other **specific abilities (s-factors)** that are needed for certain types of cognitive tasks. Spearman believed that the g-factor was of greater importance and was the best predictor of intellectual ability. Some modern psychologists still support the idea of a single general factor for intelligence that can be measured on some IQ tests and can be used as a predictor of academic success. However, a downfall of using general intelligence is that the score focuses mainly on cognitive abilities and does not measure other important types of abilities.

Thurstone's Primary Mental Abilities

L.L. Thurstone disagreed with Spearman and believed that intelligence is not dependent on one general factor, but on several primary mental abilities. He considered the idea of a single general intelligence to be too narrow a concept for the wide range of human talents and identified a total of seven different **primary mental abilities**—verbal comprehension (vocabulary), verbal fluency, inductive reasoning, spatial visualization, number computation, memory recall, and perceptual speed. Based on Thurstone's idea of the existence of several specific types of intelligences, J.P. Guilford identified over 100 separate and measurable mental abilities. The advantage of a multifactor theory is the identification of specific mental abilities, which is useful in education because it can help discover areas in which students may need assistance, such as math or reading, in order to be successful.

Gardner's Multiple Intelligences

Another multiple factor theory was proposed by **Howard Gardner**; his theory originally consisted of seven intelligences that exist independently of each other. Currently there are eight **multiple intelligences**—verbal-linguistic, logical-mathematical, spatial, musical, bodily-kinesthetic, interpersonal, intrapersonal, and naturalist with the possibility of more to come. Although these intelligences are independent, they are often used together to solve complicated problems. Gardner gathered evidence by examining the effects on specific intelligences resulting from damage to particular brain areas and testing prodigies and savants. An advantage to Gardner's theory is that it includes other types of intelligence not measured on traditional IQ tests. However, it is difficult

to identify how many specialized intelligences exist and to devise an accurate method of measuring them. There is also skepticism regarding how bodily-kinesthetic can be labeled as a mental ability, as opposed to a talent.

STUDY TIP

Be able to distinguish between Howard Gardner's intrapersonal and interpersonal intelligences.

- *Intrapersonal intelligence* refers to an individual's level of self-awareness, including an understanding of one's own emotions, behaviors, and cognitions.
- *Interpersonal intelligence* refers to an individual's level of understanding the emotions and motivations of others in order to form positive relationships and work effectively with others. To remember *interpersonal*, think of an interstate that connects two cities.

Sternberg's Triarchic Theory of Intelligence

Robert Sternberg, another multifactor theorist, identifies three sets of mental abilities—practical, analytical, and creative intelligence. **Practical intelligence** refers to the realistic and useful thinking abilities that enable a person to cope with and thrive in their environment. **Analytical intelligence** is the logical reasoning typically measured on traditional IQ tests. Finally, **creative intelligence** is the inventive problem-solving abilities required to generate new ideas and learn from experience. This theory differentiates between what is commonly referred to as “book smarts” (analytical) and “street smarts” (practical). To remember the three parts of Sternberg's triarchic theory of intelligence, use the acronym PAC (practical, analytical, and creative).

Two Types of Intelligence

Raymond Cattell divided general intelligence into two different types—fluid and crystallized intelligence. **Fluid intelligence** involves the rapid processing of information and memory span needed to solve new types of problems and make new associations and analogies with existing knowledge. **Crystallized intelligence** involves knowledge acquired over the lifespan, including vocabulary, verbal skills, cultural knowledge, and factual information. With old age, fluid intelligence tends to decrease, but crystallized intelligence remains steady or even increases with old age.

Emotional Intelligence

Peter Salovey and John Mayer first introduced the idea of emotional intelligence. **Emotional intelligence** is the ability to recognize emotion in others and in oneself and incorporate knowledge about emotion into reasoning and thought processes. Emotionally intelligent individuals are capable of managing their own emotions and are better at expressing empathy. This concept was popularized by Daniel Goleman and is now taught in many schools and companies. Psychologists agree that individuals who possess the attributes associated with emotional intelligence are better prepared for success in personal relationships and the world of work, but many believe that this does not constitute a separate type of intelligence. A major criticism of this theory is that emotional intelligence assessments may in fact do little more than measure personality traits.

STUDY TIP

Be able to compare and contrast historic and contemporary theories of intelligence, including the two-factor (Spearman), primary mental abilities (Thurstone), multiple intelligences (Gardner), and the triarchic theory of intelligence (Sternberg).

History of Intelligence Tests

One of the earliest attempts at determining intelligence was the use of **phrenology**, or the study of how bumps on an individual's head indicated personality traits, skills, and intelligence. Other early efforts searched for a strong correlation between brain size and intelligence, but these efforts were unsuccessful. **Sir Francis Galton**, a cousin of Darwin and pioneer in psychometrics, introduced the idea that intelligence was hereditary because intelligent individuals often had intelligent children. As a nativist, Galton examined differences in inherited intelligence by utilizing statistical methods. He attempted to measure intelligence by testing the basic sensory and motor abilities of individuals; he included reaction time, sensory ability, and memory, but was unable to determine any significant conclusions.

Modern intelligence testing began with the development of the first instrument to measure intellectual ability in France during the early 1900s. **Alfred Binet** and Theodore Simon were hired by the French Ministry of Education to devise a method to determine which students were unable to succeed in regular classrooms, in order to

arrange for them to be placed in special schools. Unlike Galton, who measured intelligence in terms of sensory and motor abilities, Binet and Simon created a test that evaluated children in terms of reasoning and comprehension tasks. Binet introduced a new concept, **mental age** or the score on an IQ test that indicates the typical age group an individual's score represents. Mental age provided a framework for comparing individuals, and Binet inferred that children with cognitive disabilities would have scores more typical of a child who was younger. Based on this concept of mental age, Binet created the first intelligence test that was used to evaluate mental abilities.

The concept of **intelligence quotient (IQ)** was created by William Stern to provide a specific score, indicating the level of intelligence in a particular individual, which enabled comparisons to be made between individuals of different ages. Stern's formula for IQ is mental age divided by chronological age multiplied by 100. This type of IQ score is called a *ratio IQ*. If mental and chronological ages are equivalent, the individual is said to have an average IQ, which is 100. Individuals who have a mental age that is greater than their chronological age have above-average IQs. The major flaw in the traditional IQ formula is that it is not effective for creating ratios in older individuals. Modern IQ scores are not determined by using Stern's formula and are instead based on comparing individual performance to a pretested group and establishing norms. The modern IQ formula is called a *deviation IQ* and is obtained by dividing an individual's score on the IQ test by the average test score of individuals their same age in a pretested group and then multiplying that result by 100.

STUDY TIP

Be able to compute a ratio IQ for a simple example: $IQ = (\text{mental age}/\text{chronological age}) \times 100$. Also, be aware that a modern IQ score is based on comparing an individual's test score to a pretested group (deviation IQ).

Lewis Terman, a psychologist and professor at Stanford University, translated and revised the original intelligence test created by Binet for use in the United States. This test initially used the ratio IQ formula and was renamed the **Stanford-Binet** test. The Stanford-Binet test is known for its high reliability and predictive value. It is very accurate in terms of predicting future academic achievement and may be best thought of as a measure of scholastic aptitude or achievement. The original version of the Stanford-Binet test has been revised multiple times, and the current Stanford-Binet Intelligence Scale is widely used today to assess intelligence and cognitive abilities for individuals

ranging from two to eighty-nine years of age. In addition, scores are now based on comparisons to pretested groups resulting in a deviation IQ score.

David Wechsler criticized the Stanford-Binet test because it was too heavily focused on verbal skills. Wechsler designed a set of intelligence tests that were capable of measuring cognitive skills and evaluating individuals with lower verbal abilities for overall intelligence. Currently the Wechsler Intelligence Scales include separate tests for adults (WAIS), children (WISC), and preschoolers (WPPSI). Wechsler's scales include both **verbal and performance subscales** and measure a variety of abilities through the use of eleven subtests. The verbal subscale includes tests on general information, comprehension, arithmetic reasoning, digit span, and vocabulary. The performance subscale includes tests on digit-symbol substitution, picture completion, block design, picture arrangement, and object assembly. Final test results are broken into three subscale scores: verbal, performance, and the total. The separation of subscale scores allows for areas of weakness to be easily identified. The three scores are then converted into deviation IQ scores, with the mean set at 100 and a standard deviation of 15.

Measuring Intelligence

Intelligence is not the same as IQ. Intelligence is a complex concept whose exact meaning psychologists continue to debate. An IQ, or **intelligence quotient**, on the other hand, is a specific score on an intelligence test that may or may not be an accurate measure of the cognitive capabilities of that particular individual. If intelligence is the same as academic achievement, then an IQ is an excellent way to measure intelligence because IQ test scores are usually positively correlated with school grades. Intelligence tests are separated into two general categories in terms of measuring cognitive abilities. **Achievement tests** are intelligence tests created for the purpose of determining the level of knowledge an individual has regarding a particular subject or skill that has resulted from learning or education. For example, after completing the AP Psychology course, students take the Advanced Placement exam in psychology, which is an achievement test, to determine how much material has been learned. **Aptitude tests** are assessments that are designed to predict the success of an individual by evaluating his or her level of skill on a variety of general abilities necessary for success in academic or career environments. Typically aptitude tests measure abilities such as mathematical calculation, language ability, and reasoning. Intelligence tests like the Stanford-Binet or Wechsler Scales are aptitude assessments created to determine if an individual has the potential to learn based on the possession of basic skills. Other examples of aptitude tests include the SAT and ACT exams, both of which are utilized to determine if students have the skills

required for success in college or, in other words, predict college success. As measures of aptitude SAT and ACT scores are checked against college grades to make sure that those scores correlate with future academic achievement. In reality, college entrance exams measure both aptitude (likelihood of college success) and achievement (accumulated knowledge based on high school course work.) It is important to realize, however, that the line between achievement and aptitude tests is unclear.

Intelligence tests may be given individually or in group settings. **Individual tests** are given to the person by a psychologist trained in the administration of the test in a one-on-one setting. Individual tests are more time-consuming and expensive than group tests, but they provide an opportunity for the test administrator to work closely with the examinee and develop a stronger understanding of their cognitive processes. The Stanford-Binet and Weschler Intelligence Scales are both administered individually. Because of the costs associated with individualized testing, many intelligence tests are now given as **group tests** in which large numbers of examinees take the same test at the same time under standardized conditions. Group tests allow for easier scoring and require little training to administer, but it is difficult to gain detailed information about specific thought processes because there is no relationship between the administrator and test taker. Sometimes intelligence tests are created to measure the speed of processing. In **power tests**, abilities are measured under testing conditions involving little or no time pressure, and in **speed tests** examinees' scores are based in part on how quickly they solve the problems presented.

Test Construction

The accuracy of conclusions based on the results of intelligence tests is directly related to the quality of their design. Psychometricians base test construction on standardization and the utilization of norms. It is important to note that psychometricians are not only interested in creating intelligence tests, but also generating useful measurement devices for other psychological variables, including personality traits. In order to be prepared for the AP Psychology exam, you will need to be able to differentiate between different types of reliability and validity and understand how tests are standardized.

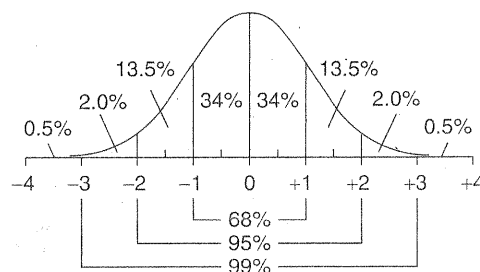
Standardization

One aspect involved in test construction includes creating a standardized test that ensures uniformity of procedures and establishes reliability and validity. During the

administration of the assessment, **standardization** would require that the procedures be kept the same. For example, standardized national tests like the AP Psychology exam use the same directions, time frames, and scoring rubrics for all individuals taking the exam. Standardization of procedures eliminates potential confounding variables and ensures, to the extent that it is possible, that no individuals have an advantage over others due to testing conditions. **Standardized tests** are created after they are first provided to a large pretested group to determine norms. **Norms** indicate typical scores for a pretested group that allows for the comparison of an individual test subject with the larger group. For example, the SAT, which is a standardized test, has a mean of 500 and a standard deviation of 100, enabling the comparison of individual scores to the larger group. The results of both the pretested group and the actual test subjects are analyzed for reliability and validity based on the procedures explained later in the chapter.

Once norms have been established they often form normal distributions as in the case of intelligence tests. **Normal distributions (curves)** create bell-shaped curves in which the mean, median, and mode are equivalent and located at the center of the distribution and have a predictable distribution of scores. In a normal distribution, approximately 68 percent of scores fall within one standard deviation of the mean, 95 percent of scores fall within two standard deviations of the mean, and 99 percent of scores fall within three standard deviations of the mean. In a normal distribution, standard deviations are measured in z-scores. Positive z-scores indicate standard deviations above the mean, and negative z-scores represent standard deviations below the mean. Therefore, based on the percentages of a normal distribution, approximately 68 percent of all scores will fall between a z-score of -1 and a z-score of $+1$. IQ scores form a normal distribution with an average score of 100 and a standard deviation of 15, this means that 68 percent of all scores fall between 85 and 115. The z-scores and their associated percentages are indicated in Figure 13.1.

Figure 13.1. Normal Distribution



The diagram above illustrates the percentages of scores in a normal distribution that fall within specific z-scores. Percentile rank for any score in a normal distribution can be computed using this diagram, as long as the mean and standard deviation are provided. The nature of normal distributions makes it simple to determine the percentile rank of any individual test taker, as long as the mean and standard deviation of the distribution of scores have been identified. **Percentile rank** refers to the percentage of scores equal to or below a specific score in a distribution. Different standardized tests will have different means and different standard deviations that can be used to determine percentile rank for scores within that distribution—see Table 13.1. In terms of most intelligence tests, the mean is 100 and the standard deviation is 15. Therefore, if an individual scored 100 on an intelligence assessment, that person would be at the 50th percentile, which means that 50 percent of the tested sample scored at or below the test score of 100. The steps in determining percentile rank are provided in Table 13.1, along with an example for identifying the percentile rank for an IQ score of 115.

DID YOU KNOW?

In 2010, over 177,000 students took the AP Psychology exam. The mean score was 3.11; the standard deviation was 1.42.

Table 13.1. Determining Percentile Rank

Steps to Determine Percentile Rank	Example for IQ Percentile Rank (Score of 115)
Determine the mean located at the center of the normal distribution.	The mean for IQ is 100.
Identify the test score associated with each z-score based on the standard deviation of the distribution.	Each z-score is equivalent to 15 points for IQ. A score of 115 is located at $Z+1$.
Percentages of individuals in the ranges of the normal curve can be seen in Figure 13.1 and include: $Z-1 = 34\%$ $Z+1 = 34\%$ $Z-2 = 13.5\%$ $Z+2 = 13.5\%$ $Z-3 = 2\%$ $Z+3 = 2\%$	A total of 34% of the scores in the distribution fall between the mean (100) and $Z+1$ (115).
Determine the percentile rank of the particular score that needs to be identified by adding the percentages of the scores to the left of the particular score in the normal distribution. Note: the mean score will always be 50% of the distribution.	The mean score in the distribution is 50% of the scores, plus the percentage of $Z+1$, which is 34% ($50 + 34$), creating a total of 84% of scores falling at or below an IQ score of 115. Therefore, an IQ score of 115 is at the 84 th percentile.

Reliability

An important aspect of constructing intelligence tests or other types of assessments is ensuring reliability. **Reliability** refers to the consistency or repeatability of a particular assessment. There are a variety of methods for checking the reliability of an assessment, and they are explained in Table 13.2.

Table 13.2. Tests for Reliability

Test	Definition	Example
Split-half Reliability	Comparing the scores on one half of the test to the scores on the other half of the test. If a strong positive correlation is found between scores on the two halves of the test, it is said to be split-half reliable. <i>Note:</i> Split-half reliability involves giving the test only <i>one</i> time.	Alan is given a test designed to measure his current stress level, and, if his stress level is low on both odd- and even-numbered questions, the assessment demonstrates split-half reliability because it is consistent.
Test-retest Reliability	Comparing the scores of the <i>same</i> individual who takes the <i>same</i> exact test on <i>two</i> different occasions. If a strong positive correlation is found between the scores on both occasions, the test is said to be test-retest reliable and indicates the stability of the measurement tool. A major problem with test-retest reliability for achievement or aptitude tests can be practice effects.	Karlee is given a personality test that reveals she is very high in the trait of extraversion. If the personality assessment has test-retest reliability Karlee will have the <i>same</i> or a very similar score if she takes the exact <i>same</i> test two weeks later.
Alternate-forms Reliability	Comparing the results of two different but equivalent versions of a test given to subjects. If a strong positive correlation is found between the scores on the two different versions of the test, it is said to have alternate-forms reliability, which means that the two versions are equivalent. The use of alternate-forms eliminates practice effects.	The ACT is considered to have alternate-forms reliability if there is a strong positive correlation between the distribution of scores on version A and version B or if individuals who take both versions receive similar scores.
Interrater Reliability	Comparing the scores given by two different examiners of the same individual test subject. If both examiners give the <i>same</i> subject the <i>same</i> score, the testing instrument is considered to be interrater reliable. Interrater reliability is often important in determining if subjective data collected through observation is consistent, regardless of whom is recording the behavior of the subjects.	Kathee is interviewed by two separate clinical psychologists who both arrive at the same diagnosis based on the criteria listed in the <i>DSM-IV TR</i> . Because both examiners using the same testing tool arrived at the same conclusion, the <i>DSM-IV TR</i> would be considered interrater-reliable.

Validity

In addition to being consistent and repeatable (reliable), tests used by psychologists to measure intelligence or other variables must be valid. **Validity** refers to the accuracy of the test or measurement instrument being used. It is possible for a test to be reliable, but not valid, which would mean that every time an individual took the assessment she or she will receive the same inaccurate results. Various methods exist to assess the validity of a particular assessment tool; they are explained in Table 13.3.

Table 13.3. Common Types of Validity

Type	Definition	Example
Face Validity	The extent to which the material on a test appears on the surface to accurately measure what it intends to measure. Face validity is determined either by a non-expert or an expert who gives only a quick evaluation of the test.	A psychology teacher who is asked to evaluate the accuracy of the art history final exam could provide face validity only because the teacher does not have experience in the field.
Content Validity	The extent to which a test accurately measures the entire breadth of the subject it is intended to measure. For example, an ACT math test that included only geometry questions would lack content validity because it does not include other areas within the domain of math, such as algebra.	Because specific phobias are defined in the <i>DSM-IV TR</i> as requiring seven specific criteria, a diagnostic test for specific phobias would need to include questions related to all seven criteria in order to have content validity.
Construct Validity	The extent to which a test accurately measures the abstract theoretical idea (construct) or skill it is intended to measure. Constructs include ideas that are often difficult to define operationally, such as intelligence or personality traits.	If an intelligence test actually measures cognitive abilities and not a different theoretical idea (construct) such as language ability or cultural knowledge, it has construct validity.
Criterion Validity	Scores on a particular test that are positively correlated with scores on another existing and well-established test (criterion) of the same skill, trait, or ability.	Dr. Taber created a depression-screening instrument, and individuals who scored high on her test also scored high on the well-known Beck's Depression Inventory indicating criterion validity.
Predictive Validity	The extent to which a test score forecasts (predicts) future behaviors or results.	If high scores on the Stanford-Binet Intelligence Scale are strongly positively correlated with academic success or high GPA, the Stanford-Binet can be said to have high predictive validity.

Selecting testing instruments for research that are both reliable and valid is a critical part of the research process for psychologists who study intelligence and cognitive abilities. Since achievement tests and aptitude tests have different uses, they are validated in different ways. An achievement test is evaluated for content validity, while aptitude tests are compared to other tests or indicators of the same behavior in order to determine criterion validity. For example, an aptitude test might be designed to predict college performance. Therefore, its scores would be checked against college grades to make sure that those scores correlated with the examinee's future academic achievement.

Extremes of Intelligence

Intelligence test scores create normal distributions, and almost all individuals fall within two standard deviations of the mean (95 percent of the population). Psychologists, however, are interested in studying both extremes, including cognitively disabled individuals on the low end of the distribution and gifted individuals on the high end. Because intelligence tests identify where individuals fall on the cognitive continuum, they can be highly controversial and at times have been misused. IQ test scores, especially on the low end, can lead to negative stereotypes or create self-fulfilling prophecies. It is important to remember that an IQ score is not the only gauge of cognitive ability and that IQ tests often do not reveal all types of intelligence.

Cognitive Disability

Individuals with cognitive disabilities are classified as belonging to one of four levels of mental retardation, according to the current diagnostic manual published by the American Psychiatric Association. A new edition of the manual is currently being produced, and when the revised version is released, it is likely that the classification of mental retardation will be changed to cognitive or intellectual disability (due to the stigma associated with the term *retardation*). **Mental retardation** refers to individuals at the lower extreme of intelligence and is generally determined by IQ tests and problems coping with the basic demands of independent living. An IQ score of less than 70 is considered cognitively disabled, but enormous diversity in terms of ability is present among the four levels—mild, moderate, severe, and profound (see Table 13.4). Altogether, the four levels of cognitive disability make up about one

percent of the population. Each of the four levels is explained in greater detail in the chart below.

Table 13.4. Classification Levels of Cognitive Disability

Level	IQ	Characteristics
Mild 85% of cognitively disabled individuals	50–70	<ul style="list-style-type: none"> • Eligible as children and teens for special education in school which is beneficial for social and vocational skills. • Capable of developing academic skills at approximately a sixth-grade level. • Adults in this group can achieve independence and occupational success, although they may need help with social and financial problems.
Moderate 10% of cognitively disabled individuals	35–50	<ul style="list-style-type: none"> • During childhood, special classes that emphasize self-care instead of academic achievement are beneficial. • Capable of developing academic skills ranging from approximately a second- to fourth-grade level. • Adults in this group are able to succeed at unskilled or routine jobs, often in sheltered workshops, and most are dependent on their families.
Severe 4% of cognitively disabled individuals	20–35	<ul style="list-style-type: none"> • Individuals at this level are mostly institutionalized and require a controlled environment. • With prolonged training, may develop limited speech and the ability to take care of their basic needs.
Profound 1% of cognitively disabled individuals	Below 20	<ul style="list-style-type: none"> • Individuals at this level require total supervision and care for their entire lives. • Language ability is extremely limited, and there are severe physical and motor impairments.

The most common cause of cognitive disability is **Down syndrome**, which accounts for 10 to 20 percent of all moderately to severely disabled children. This chromosomal disorder is caused by a genetic abnormality involving an additional chromosome on the twenty-first pair. Children with Down syndrome seldom have an IQ above 50, and many have specific physical abnormalities. Two additional genetic causes of cognitive disability, Phenylketonuria (PKU) and fragile X syndrome, are discussed further in the biological psychology chapter. Cognitive disability can also be attributed to exposure to teratogens, such as in the case of **fetal alcohol syndrome**, which results when the mother drinks alcohol in excess during pregnancy.

Autistic spectrum disorder refers to a range of permanent developmental disorders that are diagnosed in childhood, including autism and Asperger's syndrome. Autism is a developmental disorder that results in difficulties with communication and social interactions. The exact cause of this disease is unknown, but researchers suspect a genetic link. Additionally, some scientists believe that the difficulties autistic children have in terms of empathy and social relations may be due to a deficiency in mirror neurons. **Savant syndrome** is a rare condition marked by an island of brilliance in relation to limited cognitive abilities. A savant is someone who is diagnosed as cognitively disabled or with a developmental disorder such as autism, but the savant also displays an exceptional skill in a limited domain such as music, art, math, or calculating dates. Obsessive fixations on particular topics and memorization of trivia can also be present.

DID YOU KNOW?

As the Academy-Award winning lead actor in the 1988 movie *Rain Man*, Dustin Hoffman met with and researched a number of savants, including the real "Rain Man," Kim Peek. Kim, who passed away in December 2009, had an encyclopedic memory and could recite facts about world and American history, the Bible, sports, geography, the space program, popular culture, current events, and music and literature as well as do calendar calculations (including a person's day of birth, present year's birthday, and the year and date the person would turn 65 years old so he or she could retire) and list the area code, ZIP code, and television stations for any locale. Some other remarkable savants—and well worth an Internet search—include Leslie Lemke, Alonzo Clemons, Daniel Tammet, and Brittany Maier.

Giftedness

On the other side of the spectrum are gifted children. Although **gifted** is commonly defined as children who have an IQ over 130, the term *gifted* is also used to refer to individuals who have special talents, creativity, or leadership ability. In 1926, **Lewis Terman** published his book, *Genetic Studies of Genius*, a longitudinal study of one thousand gifted children possessing IQ scores greater than 140 whom he sometimes referred to as *Terman's Termites*. Contrary to the stereotypical expectations of the period that gifted children would become maladjusted, Terman found that children with high IQs grew up to be well-adjusted adults who achieved significantly higher levels of professional success and reported high levels of happiness and physical health.

Creativity and Intelligence

Creativity and intelligence are not the same thing, but creativity, like intelligence, is a difficult concept to define. Psychologists observed that creativity is influenced by personality and encouraged by a receptive, as opposed to critical, attitude toward new ideas. Modern cognitive psychologists define **creativity** as cognitive processes resulting in original and useful ideas.

Many aspects of creativity cannot be measured on intelligence tests, and creating reliable and valid measures of creativity have proved difficult. Tests of **divergent thinking**, or the ability to generate a variety of solutions to one problem, are a common psychological method of measuring creativity. Questions for **convergent thinking**, or thought processes that are designed to produce just one end result, are not generally used during creative thinking, but are often included on intelligence tests. The question of whether or not a creative person must also be intelligent remains. Once IQ reaches a certain level, correlations between creativity with intelligence test scores are fairly low. An intelligent person would naturally have more information at his or her disposal to use creatively, but the secret of creativity seems to be that there is something unique about how creative individuals think that distinguishes them from others with similar levels of intelligence.

Intelligence Controversies

Does intelligence remain stable throughout the lifespan? As was previously noted, during old age there is a difference between fluid and crystallized intelligence, but psychologists also wonder if intelligence is stable earlier in life. In general, two variables affect IQ stability: the interval of time between the initial test and retest, and the subject's age. The shorter the interval between test and retest, the more stable the IQ will be. Also, the older a person is at the time of the initial IQ test, the more stable that IQ will be. Intelligence changes dramatically during childhood, and the greatest changes occur early. The difference in the intellectual capacity of a three-year-old and a four-year-old is much greater than the difference between a fifteen-year-old and a sixteen-year-old. In general, however, IQ scores are fairly stable measures after the age of approximately seven. The purpose of determining the stability of an individual's IQ is to anticipate problems one might encounter during intellectual development. Then it is often possible to develop intervention programs and change that person's intellectual future.

Another vigorous debate in the field of intelligence is the source of intellectual abilities. Psychologists agree that both genetic and biological factors (nature) and environmental influences (nurture) contribute to differences among individuals regarding intelligence. Evidence for the influence of genetics on intelligence is typically generated by twin, family, and adoption studies which result in heritability measurements. **Heritability** is a mathematical measure that indicates the estimated amount of variation among individuals that is related to genes translated into a percentage. Biological factors that can have a negative effect on individual intelligence include genetic disorders such as Down syndrome, Phenylketonuria (PKU), and fragile X syndrome.

Environmental factors also contribute significantly to differences among individuals in terms of intelligence. Evidence supporting the influence of nurture on IQ comes from poverty studies and research comparing how intelligence is impacted by the addition of an enriched environment. Factors that may influence the development of intelligence include intellectual advantage (such as a house full of books), parental concern with a child's educational achievement or general welfare, environmental change (such as attending summer school), or that the child is developing more quickly than normal. External or environmental factors that are known to have a negative effect on intelligence are problems with exposure to teratogens during pregnancy, physical trauma and illness, drastic changes in the family (such as divorce, loss of parents, adoption or a foster home), and lack of opportunity. The **Flynn effect** is a recently discovered phenomenon that demonstrates that the average IQ has been rising dramatically over successive generations. Most researchers believe that the Flynn effect must be the result of environmental factors because the time period over which the changes have been noticed is much too short for evolution within the gene pool to have occurred.

Group Differences and Bias

Misconceptions about the relationship between heredity and intelligence have caused pain for millions of people. In the United States alone, Americans of Irish, Italian, Jewish, Chinese, and African descent and women have all been accused of being less intelligent than white men. These individuals have been denied jobs, education, and legal rights in part because of these claims. It is true that, in the United States, the IQ scores of certain groups are, on average, lower than other groups. However, the range of IQ for European Americans and other groups is actually the same; every race contains genius. The mean IQ difference has no meaning for specific individuals, only the distribution of scores for the entire population. The problem with comparing

different racial or gender groups is that IQ tests have traditionally been developed for only one population: relatively affluent Americans of white European ancestry. IQ tests may be measuring cultural similarity and rules for white affluent Americans as well as intelligence.

Cultural Bias

Psychologists are concerned that intelligence tests might be unfair because individuals who belong to particular ethnic groups score lower on tests because they do not possess enough of an understanding of the dominant culture; thus some questions are unclear. Equally important is the fact that some cultures may have very different interpretations about what intelligence consists of. There seems to be no question that IQ tests, achievement tests, and aptitude tests are culturally biased. The mere fact that a person needs to have good English skills to do well on them is evidence of cultural bias. Standardized intelligence tests that require language skills are the most likely to be culturally biased. For example, the cultural bias of the Wechsler exam is most noticeable on the verbal sections. Although intelligence tests are excellent at evaluating language skills required for success, they do not measure levels of creativity, persistence, or relationship skills that are also necessary for success.

A **culture-fair test** is one that is designed to allow all individuals, regardless of culture, the opportunity to perform equally well. The advantage of developing a culture-fair test to be used across cultures is that it would be possible to measure innate abilities, such as Spearman's general intellectual ability. Psychologists have tried to develop culture-fair tests by first eliminating the problem of different languages and either translating the test or removing language altogether. In addition, psychologists have paid particular attention to speed of performance. In some cultures and rural environments, the tempo of life is slower and there is less emphasis on finishing tests quickly. Thus, culture-fair tests often allow longer time limits and give no credit for fast performance, while traditional tests typically have rigid time restrictions and may be scored according to the total number of items completed. The most important way that culture-fair tests differ is in test content. Many tests are culturally biased because they require the subject to be familiar with objects that are absent in their culture, or that have different uses or values. For example, a person raised with the British game of cricket would assume that a baseball bat is used for hitting balls on the ground and perhaps fail a portion of a test that was developed in the United States. The idea of being able to design an intelligence test that is completely **culture-free** may be out of reach, and perhaps a culture-relevant test is more appropriate. A **culture-relevant test** focuses on skills and knowledge that

are specific and important to a particular culture and would be administered only to members of the culture for which it was designed.

Gender Bias

Males and females typically score equally on measures of general intelligence; however, they differ in their scores regarding specific abilities. Males, on average, may score higher on tasks that involve visual-spatial skills, mathematical calculations, and some motor skills. Females, on average, tend to score higher on tasks of verbal ability, reading comprehension, spelling, and speed of processing for recall of semantic information. It must be noted that these average differences apply only to the group, not specific individuals. There is actually a greater average difference within genders than there is between genders. When conducting research regarding group differences, researchers need to be cautioned about the impact of stereotype threat. **Stereotype threat** happens when an individual's belief that negative stereotypes will be used by others to rate his or her performance results in the individual experiencing anxiety that leads to low performance. For example, if a girl is led to believe, either directly or indirectly, that girls are unable to perform well in math and is then given a math test, she may do poorly, due to anxiety caused by this expectation.