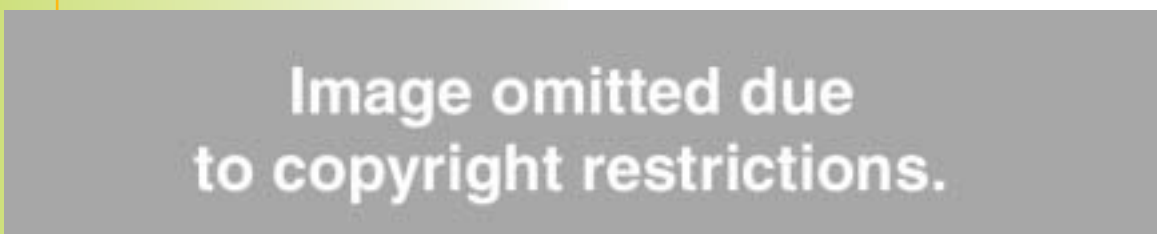
7 Intelligence, Cognition, and Language



Imagine being able to explore Einstein's genius today. Well, that dream is a reality for Canadian researchers at McMaster University. Although Einstein died in 1955 at the age of 76, his legacy in physics and math continues today—and so does his brain. It is Einstein's brain that is the focus of interest for neuroscientist Dr. Sandra Witelson. Einstein's brain was removed and carefully cut into sections during an autopsy shortly after his death. The pathologist who did the autopsy, Dr. Thomas Harvey, still retains most of the pieces of the brain in his lab in Wichita, Kansas ("Have brain," 1999). Some of the brain, however, has travelled extensively and has been examined by medical and psychological researchers.

Most recently, Dr. Witelson examined Einstein's brain to see if the physical brain would reveal anything about his genius. In her preliminary work she noted some unique characteristics. For example, the portion of the brain associated with mathematics was wider in Einstein's brain than it is for most brains (Chang, 2000). The brain also has a different shape. One area in the middle of the brain, the inferior parietal lobes, has a shortened groove where most people have

a long groove running from the back to the front. Interestingly, it is this area of the brain that is often associated with higher-level thinking—such as that involved in mathematics. Researchers believe that this shortened groove might have allowed the neurons in that area to work together more easily and to make more interconnections (Chang, 2000). Although no one is saying that it is just the anatomy that accounts for the intelligence of Einstein, it is interesting that there seems to be some physical evidence that matches his extraordinary abilities.

There is more to intelligence than simple anatomy. As yet, our knowledge of the anatomical differences between geniuses and ordinary people is quite primitive. In many ways we are limited in our ability to pick out those few people who will, through their innovation, creativity, or brilliance, change all of our lives. For example, many highly prominent people tested poorly in school. Among them are Thomas Edison, Winston Churchill, whose teachers thought he was mentally limited, and Albert Einstein, who was labelled a dunce in math. These examples show us how important it is to understand the breadth of intelligence and intelligent thinking.

In this chapter we will explore intelligence, thinking skills, creativity, and language. You will learn about the nature of intelligence and how it is measured. Where does our intelligence come from—our genes, or experiences provided by our environment, or both? We will look at people who are mentally gifted and those who are mentally disabled. Then we will consider how we think and examine the approaches we use to solve problems. Finally, we will explore language.

First, let us ask the most obvious question: What is intelligence? A recent task force of experts from the American Psychological Association defined intelligence as an individual's "ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, and to overcome obstacles by taking thought" (Neisser et al., 1996, p. 77)

The Nature of Intelligence

Is intelligence a single trait or capability? Is it many capabilities unrelated to each other? Or is it something in between? As you might expect, there are many different points of view about the nature of intelligence.

LINK IT!

www.educ.drake.edu/romig/cogito/intelligence.html
Brain and mind

www2.psy.mq.edu.au/~tbates/104/104-theories.html
Major Descriptive Theories of Intelligence

The Search for Factors Underlying Intelligence

What factors underlie intelligence, according to Spearman, Thurstone, and Guilford?

Are there certain common factors that underlie intelligence? If so, what might they be?

Spearman and General Intelligence: The g Factor

English psychologist Charles Spearman (1863–1945) observed that people who are bright in one area are usually bright in other areas as well. In other words, they tend to be generally intelligent. Spearman (1927) came to believe that intelligence involves a general ability, or ***g* factor**, that underlies all intellectual functions.

Spearman arrived at his "*g* theory" when he found that there were positive relationships between scores on the subtests of intelligence tests. People who score high on one subtest tend to score high on the other subtests. Spearman theorized that this positive relationship between the scores on the subtests meant that the tests were measuring something in common—that general ability was being expressed to some degree in all of them. This, according to Spearman, was evidence of the *g* factor—general intelligence. The influence of Spearman's thinking can be seen in the intelligence tests, such as the Stanford-Binet, that yield one IQ score to indicate the level of general intelligence.

But some of the correlations between subtests are higher than others. If the *g* factor alone defined the whole of what intelligence tests measure, then all of the correlations would be nearly perfect. Because they are not, some other abilities in addition to the *g* factor must be present. These other abilities Spearman named "*s* factors" for specific abilities. Spearman concluded that intelligence tests tap an individual's *g* factor, or general intelligence, and a number of *s* factors, or specific intellectual abilities.

Thurstone's Primary Mental Abilities: Primarily Seven

Louis L. Thurstone (1938), another early researcher in testing, rejected Spearman's notion of general ability, or *g* factor. After analyzing the scores of a large number of people on some 50 separate ability tests, Thurstone identified seven **primary mental abilities**: verbal comprehension, numerical ability, spatial relations, perceptual speed, word fluency, memory, and reasoning. He maintained that all intellectual activities involve one or more of these primary mental abilities. Thurstone and his wife, Thelma G. Thurstone, developed their Primary Mental Abilities Tests to measure these seven abilities.

The Thurstones believed that a single IQ score obscured more than it revealed. They suggested that a profile showing relative strengths and weaknesses on the seven primary abilities would provide a more accurate picture of a person's mental ability.

Guilford's Structure of Intellect: A Mental House with 180 Rooms

Still another effort to shed light on the nature of intelligence was J.P. Guilford's **structure of intellect**. In 1967, Guilford proposed that the structure of intelligence has three dimensions: mental operations, contents, and products.

When we think, we perform a mental operation or activity. According to Guilford's theory, the mental operation can be cognition, memory, evaluation, divergent production, or convergent production. But we can't think in a vacuum; we must think *about* something. The something we think about, Guilford called "contents," which can be visual, auditory, figural, symbolic, semantic, or behavioural. The result of bringing some mental activity to bear on some contents is a "product."

Guilford (1967) hypothesized that there are 120 different intellectual abilities, depending on how the different operations, contents, and products are combined in a task. Shortly before his death, Guilford (1988) expanded his theory so that there were 180 abilities, and he divided the operation of memory into two categories: memory recording and memory retention.

Intelligence: More Than One Type?

What types of intelligence did Gardner and Sternberg identify?

Some theorists, instead of searching for the factors that underlie intelligence, propose that there are different types of intelligence. For example, some researchers distinguish between two types of intelligence (Horn, 1982). *Crystallized intelligence* refers to verbal ability and accumulated knowledge, whereas *fluid intelligence* refers to abstract reasoning and mental flexibility. Some theorists have made very refined distinctions in the types of intelligence we have. Two such modern theorists are Howard Gardner and Robert Sternberg.

g factor: Spearman's term for a general intellectual ability that underlies all mental operations to some degree.

primary mental abilities: According to Thurstone, seven relatively distinct abilities that singularly or in combination are involved in all intellectual activities.

structure of intellect: The model proposed by Guilford consisting of 180 different intellectual abilities, which involve all of the possible combinations of the three dimensions of intellect—mental operations, contents, and products.

Gardner's Theory of Multiple Intelligences: Seven Frames of Mind

Howard Gardner (1983) denies the existence of a *g* factor—a general intellectual ability. Instead he proposes seven forms of intelligence, which he declares are independent and of equal importance. Gardner's multiple intelligences are as follows:

1. *Linguistic*—language skills
2. *Logical/mathematical*—math and quantitative skills
3. *Musical*
4. *Spatial*—skills used by painters, sculptors, and architects to manipulate and create forms
5. *Bodily kinesthetic*—body control necessary in athletics, and skill and dexterity in handling objects
6. *Interpersonal*—understanding the behaviour and reading the moods, desires, and intentions of others
7. *Intrapersonal*—understanding one's own feelings and behaviour

Gardner (1983) developed his theory of multiple intelligences after studying patients with different types of brain damage that affected some forms of intelligence but left others intact. He also studied reports of "idiot savants"—individuals who possess a strange combination of mental disability and unusual talent or ability. Finally, he considered how various abilities and skills have been valued differently in other cultures and periods of history.

Gardner's theory "has enjoyed wide popularity, especially among educators, but Gardner's ideas are based more on reasoning and intuition than on the results of empirical studies" (Aiken, 1997, p. 196). Recently his theory has been expanded to include other intelligences, such as "naturalistic" intelligence. His theory is criticized by those who do not believe that all seven frames of mind are of equal value in education and in life. For example, Robert Sternberg (1985b) contends that "the multiple intelligences might better be referred to as multiple talents" (p. 1114). He asks whether an adult who is tone-deaf and has no sense of rhythm can be considered mentally limited in the same way as another person who has never developed any verbal skills. But Sternberg is not merely a critic; he has developed his own theory of intelligence.

Sternberg's Triarchic Theory of Intelligence: The Big Three

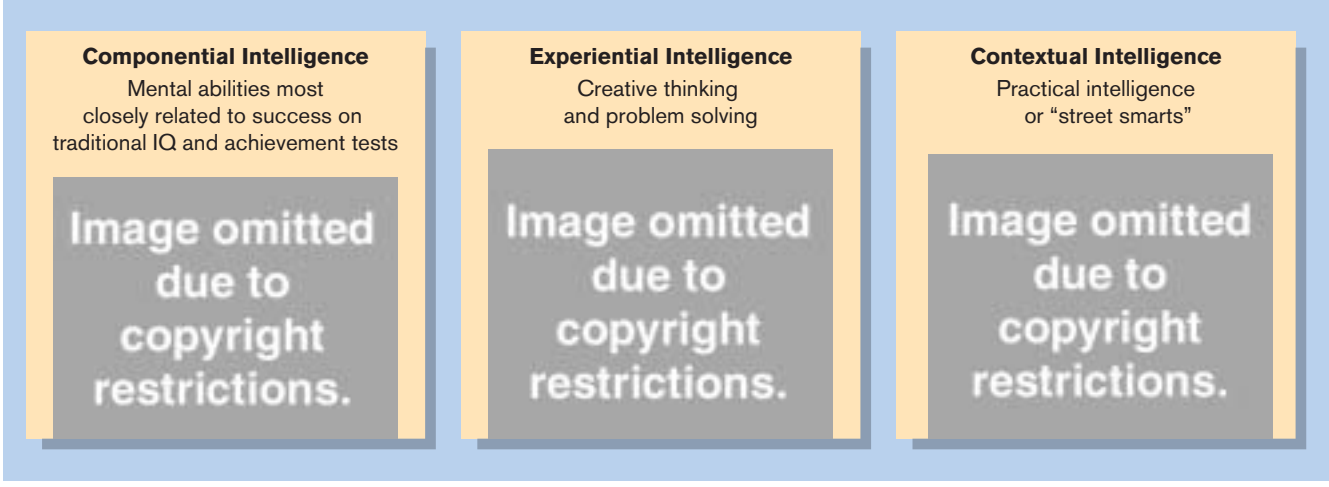
Sternberg uses the information-processing approach to understanding intelligence. This approach involves a step-by-step analysis of the cognitive processes people employ as they acquire knowledge and use it to solve problems.

Though now a respected theorist and researcher in the area of intelligence, Sternberg admits that when he was young he never did well on traditional intelligence tests. "I really stunk on IQ tests. I was just ter-

FIGURE 7.1

Sternberg's Triarchic Theory of Intelligence

According to Sternberg, there are three types of intelligence: componential, experiential, and contextual.



rible," he says (Trotter, 1986, p. 56). Believing that he possessed more intellectual power than conventional intelligence tests revealed, he made up an intelligence test of his own—the Sternberg Test of Mental Abilities—when he was in junior high school.

Sternberg (1985a, 1986b) has formulated a **triarchic theory of intelligence**, which, as the term *triarchic* implies, proposes that intelligence consists of three main parts: the componential, the experiential, and the contextual (see Figure 7.1). The first part, the *componential,* refers to the mental abilities that are most closely related to success on conventional IQ and achievement tests. He maintains that traditional intelligence tests tap only the componential, or analytical, aspect of intelligence.

The second part, the *experiential,* encompasses creativity and insight, although creativity has not yielded easily to conventional measurement efforts. The third leg of the triarchic model is *contextual* or practical intelligence, which some might equate with common sense or "street smarts." People with high contextual intelligence are survivors who capitalize on their strengths and compensate for their weaknesses. They adapt well to their environment, or change the environment to improve their success, or find a new environment. People who have succeeded in spite of hardships and adverse circumstances probably have a great deal of contextual intelligence. Sternberg and his colleagues (1995) maintain that testing both academic and practical intelligence yields more accurate predictions about real-world performance than relying on either kind alone.

You have now read several competing explanations of how intelligence is structured and how intellectual processes work. But even before a workable definition of intelligence was formulated, attempts were made to measure intelligence.

Measuring Intelligence

Alfred Binet and the First Successful Intelligence Test

What was Binet's major contribution to psychology?

The first successful effort to measure intelligence resulted not from a theoretical approach but as a practical means of solving a problem. The Ministry of Public Instruction in Paris was trying to find some objective means of identifying children's intelligence. The ministry wanted to ensure that average or brighter children would not be wrongly assigned to special classes and that children of limited ability would not be subjected to the regular program of instruction. In 1903 a commission was formed to study the problem. One of its members was French psychologist Alfred Binet (1857–1911).

Alfred Binet

triarchic theory of intelligence: Sternberg's theory that intelligence consists of three parts—the componential, the contextual, and the experiential.

Remember It!

Theories of Intelligence

Match the theorist with the theory of intelligence.

1) triarchic theory of intelligence
2) seven primary mental abilities
3) structure of intellect
4) the *g* factor

a. Spearman
b. Thurstone
c. Guilford
d. Sternberg
e. Gardner

Answers: 1) d 2) b 3) c 4) a

With the help of his colleague, psychiatrist Theodore Simon, he began testing the schoolchildren of Paris. They used a wide variety of tests, some of which Binet had tried with his own daughters. They kept only those test items that discriminated well between older and younger children. Binet and Simon published their intelligence scale in 1905 and revised it in 1908 and again in 1911. The Binet-Simon Intelligence Scale was an immediate success in most Western countries.

Test items on the scale were structured according to increasing difficulty, with the easiest item first and each succeeding item more difficult than the last. Children went as far as they could, and then their progress was compared with that of others of the same age. A child with the mental ability of a normal five-year-old was said to have a mental level of five. (Binet and Simon used the term *mental level*, but since then the term *mental age* has been used instead.) Binet established the concept that mental disability and mental superiority are based on the difference between chronological age (one's actual age) and mental age. An eight-year-old with a mental age of eight is normal or average. An eight-year-old with a mental age of five is mentally deficient, whereas an eight-year-old with a mental age of eleven is mentally superior.

LINK IT!

www.yorku.ca/dept/psych/classics/Binet/binet1.htm
Text of Binet's New Methods for the Diagnosis of the Intellectual Achievements of Subnormals (1905)

The Intelligence Quotient, or IQ

What does IQ mean, and how was it originally calculated?

Binet believed that children with a mental age two years below chronological age were disabled and should be placed in special education classes. But there was a flaw in his thinking: a four-year-old with a mental age of two is far more retarded than a 12-year-old with a mental age of 10. How could a similar degree of retardation at different ages be expressed?

German psychologist William Stern (1914) came up with the answer. In 1912 he devised a simple formula for calculating intelligence—the **intelligence quotient**, or **IQ**. He divided a child's mental age by his or her chronological age. This formula was revised later by Lewis Terman who eliminated the decimal and multiplied by 100:

Here's how IQ is calculated:

$$\frac{\text{Mental age}}{\text{Chronological age}} \times 100 = \text{IQ}$$

Here is how some IQs for 10-year-olds would be calculated:

$$\frac{14}{10} \times 100 = 1.40 \times 100 = \text{IQ } 140 \text{ (superior IQ)}$$

$$\frac{10}{10} \times 100 = 1.00 \times 100 = \text{IQ } 100 \text{ (normal IQ)}$$

$$\frac{6}{10} \times 100 = 0.60 \times 100 = \text{IQ } 60 \text{ (below normal IQ)}$$

It is interesting to note that Binet and his partner Simon were totally against the use of IQ scores. They believed that trying to represent human intelligence with a single number was impossible and that doing so was not only misleading but dangerous (Hothersall, 1984).

Intelligence Testing in North America

The Stanford-Binet Intelligence Scale

What is the Stanford-Binet Intelligence Scale?

Henry H. Goddard translated the Binet-Simon scales of 1908 and 1911 into English. Lewis M. Terman of Stanford University in California published a thorough revision of the Binet-Simon scale in 1916. Terman established new **norms**—standards based on the scores of a large number of people and used as bases for comparison. Terman's revision, known as the **Stanford-Binet Intelligence Scale**, was the first test to make use of Stern's IQ score (von Mayrhauser, 1992). Within two-and-a-half years, four million children had taken the test.

The Stanford-Binet is an individually administered IQ test developed for persons aged 2 to 23. Last revised in 1986, it now contains four subscales: verbal reasoning, quantitative reasoning, abstract visual reasoning, and short-term memory. An overall IQ score is derived from scores on the four subscales. The Stanford-Binet is highly regarded and correlates well with achievement test scores (Laurent et al., 1992).

LINK IT!

www.abacon.com/slavin/t26.html
The Modern Stanford-Binet Intelligence Scale

Intelligence Testing for Adults

It quickly became obvious that the Stanford-Binet Intelligence Scale was not useful for testing adults. The original IQ formula could not be applied to adults because at a certain age, maturity in intelligence is reached, as it is for height and for other physical characteristics. According to the original IQ formula, a 40-year-old who scored the same on an IQ test as the average 20-year-old would be mentally disabled, with an IQ of only 50. Obviously, something went wrong when the formula was applied to adults. Today we still use the term IQ; however, for adults, IQ is a **deviation score** calculated by comparing an individual's score with scores of others of the *same age* on whom the test's norms were formed. The deviation score is one of the contributions of David Wechsler, another pioneer in mental testing.

The Wechsler Intelligence Tests

What did Wechsler's tests provide that the Stanford-Binet did not?

In 1939 David Wechsler developed the first successful individual intelligence test for people aged 16 and older. The original test has been revised, restandardized, and renamed the **Wechsler Adult Intelligence Scale (WAIS-R)** and is now one of the most common psychological tests. The test contains both verbal and performance (nonverbal) subtests, which yield separate verbal and performance IQ scores as well as an overall IQ score. This test is a departure from the Stanford-Binet, which yields just one IQ score.

Wechsler also published the Wechsler Intelligence Scale for Children (WISC), as well as the Wechsler Preschool and Primary Scale of Intelligence (WPPSI), which has established norms for children aged four to six and a half.

The latest revision, the WISC III, was tested for Canadian populations. Researchers tested shorter alternative scoring frameworks in order to reduce testing times for subjects. The General Ability Index (GAI) is a good alternative system that is appropriate for Canadian children (Weiss et al., 1999). The WPPSI was also tested for Canadian children. Researchers found it appropriate when the whole scale was used to make assessments. Canadian children showed much greater variability, which would make them less accurate in assessing performance (French et al., 2000).

Group Intelligence Tests

Administering individual intelligence tests such as the Stanford-Binet and the Wechsler is expensive and time-consuming. The tests must be administered to one individual at a time by a psychologist or other qualified testing professional. When large numbers of people must be tested in a short period of time on a limited budget, individual IQ testing is out of the question. A number of widely used group intelligence tests now exist, such as the California Test of Mental Maturity, the Canadian Cognitive Abilities Test, and the Otis-Lennon Mental Ability Test. You may have taken one or more of these tests, all of which are good. But not all tests are created equal, as we will see in the following discussion.

Requirements of Good Tests: Reliability, Validity, and Standardization

What is meant by the terms *reliability, validity,* and *standardization*?

If your watch gains six minutes one day and loses three or four minutes the next day, it is not reliable. You want a watch that you can rely on to give the correct time day after day. Like a watch, an

intelligence quotient (IQ): An index of intelligence originally derived by dividing mental age by chronological age and then multiplying by 100.

norms: Standards based on the range of test scores of a large group of people who are selected to provide the bases of comparison for those who will take the test later.

Stanford-Binet Intelligence Scale: An individually administered IQ test for those aged 2 to 23; Lewis Terman's adaptation of the Binet-Simon Scale.

deviation score: A test score calculated by comparing an individual's score with the scores of others of the same age on whom the test's norms were formed.

Wechsler Adult Intelligence Scale (WAIS-R): An individual intelligence test for adults that yields separate verbal and performance (non-verbal) IQ scores as well as an overall IQ score.

intelligence test must have **reliability**; the test must consistently yield nearly the same scores when the same people are retested on the same test or an alternative form of the test. The higher the correlation between the two scores, the more reliable the test. A correlation coefficient of 1.0 would indicate perfect reliability. Most widely used tests, such as the Stanford-Binet and Wechsler tests, boast high reliabilities of about .90.

Even highly reliable tests are worthless if they are not valid. A test has **validity** if it measures what it is intended to measure. For example, a thermometer is a valid instrument for measuring temperature; a bathroom scale is valid for measuring weight. But no matter how reliable your bathroom scale is, it will not take your temperature. It is valid only for weighing.

Once a test is proven to be valid and reliable, the next requirement is for **standardization**. There must be standard procedures for administering and scoring the test. Exactly the same directions must be given, whether written or oral, and the same amount of time must be allowed for every test taker. But even more important, standardization involves establishing norms by which all scores are interpreted. The creators of a test standardize it by administering it to a large sample of people representative of those who will be taking the test in the future. The group's scores are analyzed, and then the average score, standard deviation, percentile rankings, and other measures are computed. These comparative scores become the norms, which are used as the standard against which all other test takers will be measured.

The Range of Intelligence

What are the ranges of IQ scores that are considered average, superior, and in the range of mental disability?

When large populations are measured on mental characteristics such as intelligence or on physical characteristics such as height or weight, the test scores or results usually conform to the bell-shaped distribution known as the *normal curve.* Most of the scores cluster around the mean (average). The farther the scores deviate, or move away, from the mean, above *or* below, the fewer people there are (see Figure 7.2).

The average IQ test score for all people in the same age group is arbitrarily assigned a value of 100. On the Wechsler intelligence tests, about 50 percent of all scores fall in the average range, between 90 and 110. About 68 percent fall between 85 and 115, and about 95 percent fall between 70 and 130. About 2 percent of the scores are above 130, which is considered superior, and about 2 percent fall below 70, in the range of mental disability.

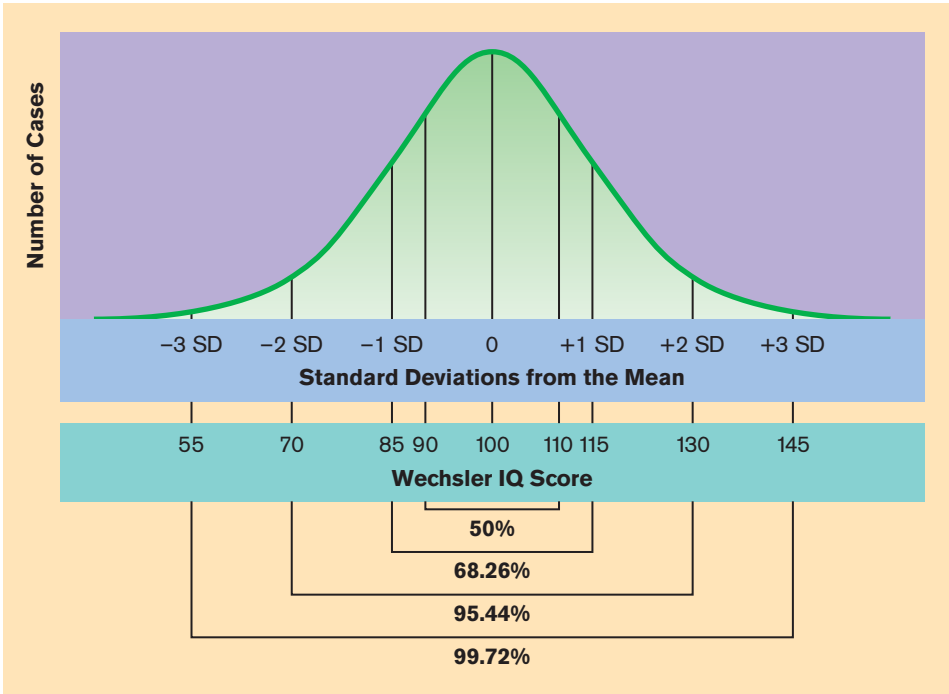


FIGURE 7.2

The Normal Curve **When a large number of test scores are compiled, they are typically distributed in a normal (bell-shaped) curve. On the Wechsler scales, the average or mean IQ score is set at 100. As the figure shows, about 68 percent of the scores fall between 15 IQ points (1 standard deviation) above and below 100 (from 85 to 115), and about 95.5 percent of the scores fall between 30 points (2 standard deviations) above and below 100 (from 70 to 130).**

Terman's Study of Gifted People: 1528 Geniuses and How They Grew

According to the Terman study, how do gifted people differ from the general population?

In 1921 Lewis M. Terman began a **longitudinal study**, now a classic, in which 1528 gifted students were measured at different ages throughout their lives. The 857 males and 671 females were students who had unusually high IQs on the Stanford-Binet, ranging from 135 to 200, with a mean (or average) of 151. Terman assumed the Stanford-Binet was "a measure of innate intelligence" and that IQ was fixed at birth (Cravens, 1992).

Terman's early findings ended the myth that mentally superior people are more likely to be physically inferior. Terman's gifted participants excelled in almost all of the abilities he studied—intellectual, physical, emotional, moral, and social. Terman also exploded many other myths about mentally gifted people (Terman & Oden, 1947). For example, you may have heard the saying that there is a thin line between genius and madness. Actually, Terman's gifted group enjoyed better mental health than the general population. Also, they were more likely to be successful in the real, practical world than their less mentally gifted peers.

The Terman study continues today, with most of the participants in their 80s. Shneidman (1989) states its basic findings of the study—that "an unusual mind, a vigorous body, and a relatively well-adjusted personality are not at all incompatible" (p. 687).

Who Is Gifted?

In the early 1920s, the term *giftedness* was used to describe those with IQs in the upper 2 or 3 percent of the population. Since that time, the term has been expanded to include both the exceptionally creative and those excelling in the visual or performing arts.

Traditionally, special programs for gifted people have involved either acceleration or enrichment. Acceleration programs enable students to progress at a rate that is consistent with their abilities; students may skip grades, progress through subject matter more quickly, or enter university early. Enrichment programs broaden or extend students' knowledge in foreign languages, music appreciation, and the like, or develop more advanced thinking skills.

People with Mental Disabilities

What two criteria must a person meet to be classified as mentally disabled?

At the opposite end of the continuum from the intellectually gifted are the 2 percent of Canadians whose IQ scores place them in the range of **mental disability.** People are not classified as mentally disabled unless their IQ is below 70 and they find it very hard to care for themselves and relate to others (Grossman, 1983). Individuals with IQs ranging from 55 to 70 are considered mildly disabled; from 40 to 55, moderately disabled; from 25 to 40, severely disabled; and below 25, profoundly disabled. Table 7.1 shows the level of functioning expected for various categories of mental disability.

Before the late 1960s, mentally disabled children were educated almost exclusively in special schools. Since then there has been a movement toward **mainstreaming**, which involves educating mentally disabled students in regular schools, often in classes with "abled" students.

Some mentally disabled individuals may have exceptional abilities in a narrow area of accomplishment. This is known as *savant syndrome* (also referred to as "splinter skills"), and it allows individuals to excel in one area such as arithmetic, memory tasks, music, art, or sculpture (Miller, 1999).

reliability: The ability of a test to yield nearly the same score each time a person takes the test or an alternative form of the test.

validity: The ability of a test to measure what it is intended to measure.

standardization: The establishment of norms for comparing the scores of people who will take the test in the future; administering tests using a prescribed procedure.

longitudinal study: A type of developmental study in which the same group of participants is followed and measured at different ages.

mental disability: Subnormal intelligence reflected by an IQ below 70 and by adaptive functioning severely deficient for one's age.

mainstreaming: Educating mentally disabled students in regular rather than special schools by placing them in regular classes for part of the day or having special classrooms in regular schools.

TABLE 7.2

Mental Disability as Measured on the Wechsler Scales

Classification	IQ Range	Percentage of Mentally Disabled People	Characteristics of Disabled Persons at Each Level
Mild	55–70	90%	Are able to grasp learning skills up to Grade 6 level; may become self-supporting and can be profitably employed in various occupations.
Moderate	40–55	6%	Probably are not able to grasp more than Grade 2 academic skills but can learn self-help skills and some social and occupational skills; may work in sheltered workshops.
Severe	25–40	3%	Can be trained in basic health habits; can learn to communicate verbally; learn through repetitive habit training.
Profound	Below 25	1%	Rudimentary motor development; may learn very limited self-help skills.

Remember It!

Measuring Intelligence

1. The first valid intelligence test was the
   a. Stanford-Binet.
   b. Binet-Simon.
   c. Wechsler.
   d. Terman.
2. According to Stern's formula, what is the IQ of a child with a mental age of 12 and a chronological age of 8?
   a. 75
   b. 150
   c. 125
   d. 100
3. The Stanford-Binet and Wechsler intelligence tests must be administered individually rather than in groups. (true/false)
4. Wechsler developed intelligence tests for adults and children. (true/false)
5. The largest percentage of people taking an IQ test will score in the range from
   a. 80 to 100.
   b. 90 to 109.
   c. 100 to 130.
   d. 65 to 90.
6. In his study of gifted people, Terman found that mentally superior individuals tend to be physically smaller and weaker. (true/false)
7. People are considered mentally disabled if they are clearly deficient in adaptive functioning and their IQ is below
   a. 100.
   b. 90.
   c. 80.
   d. 70.
8. A test that measures what it claims to measure has _____; a test that gives consistent results has _____.
   a. reliability; validity
   b. equivalence; reliability
   c. validity; reliability
   d. objectivity; validity

Answers: 1. a 2. b 3. true 4. true 5. b 6. false 7. d 8. c

The IQ Controversy: Brainy Dispute

The Uses and Abuses of Intelligence Tests

Since Binet's time, intelligence testing has become a major growth industry. Virtually every college and university student in Canada has taken one or more intelligence or aptitude tests. And many people have come to believe that an IQ score gives a precise indication of a person's intellectual capacity, ability, or potential.

Intelligence Test Scores: Can They Predict Success and Failure?

What do intelligence tests predict well?

What can intelligence tests really tell us? IQ scores are fairly good predictors of academic achievement and success in school. Both the Stanford-Binet Intelligence Scale and the Canadian Cognitive Abilities Test correlate highly with school grades. This is not surprising, since these scales test the same things as schoolwork—verbal and test-taking ability. But IQ tests and aptitude tests are far from infallible.

Another important question is whether there is a high correlation between IQ and success in real life. While it is true that people in the professions (doctors, dentists, lawyers) tend to have higher IQs than people in lower-status occupations, the exact relationship between IQ score and occupational status is not clearly understood. Nevertheless, intelligence scores are related to a wide range of social outcomes including job performance, income, social status, and years of education completed (Neisser et al., 1996).

The Abuses of Intelligence Tests: Making Too Much of a Single Number

What are some of the abuses of intelligence tests?

Abuses occur when people are judged solely on their scores on intelligence tests. Intelligence tests do not measure attitude and motivation, which are critical ingredients of success. Many people who probably should not be are admitted to schools; but more important, many people are denied admission to schools who could profit from them and possibly make significant contributions to society.

Many poor and minority children (particularly those for whom English is a second language) and visually impaired or hearing-impaired children have been placed into special education programs. IQ tests predicted that they were not mentally able to profit from regular classroom instruction. There would be no problem with this if tests were unfailingly accurate. But in fact they are not.

Many people maintain that IQ tests are designed for the white middle class and that other groups are at a disadvantage when they are assessed with these tests. For example, Native populations often score lower on IQ tests (Darou, 1992). Attempts have been made to develop **culture-fair intelligence tests**. Such tests are designed to minimize cultural bias; the questions do not penalize individuals whose cultural experience or language differs from that of the urban middle or upper classes. See Figure 7.3 for an example of the type of test item found on a culture-fair test.

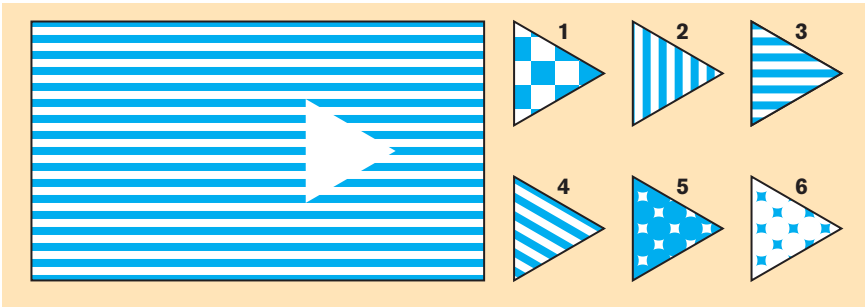


FIGURE 7.3

An Example of a Test Item on a Culture-Fair Test **This culture-fair test item does not penalize test takers whose language or cultural experiences differ from those of the urban middle or upper classes. Participants are to select, from the six samples on the right, the patch that would complete the pattern. Patch number 3 is the correct answer. (Adapted from the Raven Standard Progressive Matrices Test.)**

culture-fair intelligence test: An intelligence test designed to minimize cultural bias by using questions that will not penalize individuals whose culture or language differs from that of the urban middle or upper class.

The Nature–Nurture Controversy: Battle of the Centuries

How does the nature–nurture controversy apply to intelligence?

The most vocal area of disagreement concerning intelligence has been the **nature–nurture controversy**, the debate over whether intelligence is primarily the result of heredity or environment. Most psychologists today agree that both nature and nurture contribute to intelligence, but they continue to debate the proportions.

Behavioural Genetics: Investigating Nature and Nurture

What is behavioural genetics, and what are the primary methods used in the field today?

Behavioural genetics is a field of research that investigates the relative effects of heredity and environment on behaviour and ability (Plomin et al., 1997). Two of the primary methods used by behavioural geneticists are the twin study method—first used by Galton (1875) in his studies of heredity—and the adoption method.

In the **twin study method**, researchers study **identical twins** (monozygotic twins) and **fraternal twins** (dizygotic twins) to determine how much they resemble each other on a variety of characteristics. *Identical* twins have exactly the same genes: a single sperm cell of the father fertilizes a single egg of the mother, forming a cell that then splits to form two human beings—"carbon copies." *Fraternal* twins are no more alike genetically than other siblings born to the same parents: two separate sperm cells fertilize two separate eggs that happen to be released at the same time during ovulation.

Twins who are raised together, whether identical or fraternal, have similar environments. If identical twins raised together are found to be more alike than fraternal twins on a certain trait, that trait is assumed to be more influenced by heredity. If identical and fraternal twins from similar environments do not differ on a trait, that trait is assumed to be influenced more by environment. The term **heritability** refers to the index of the degree to which a characteristic is estimated to be influenced by heredity. Figure 7.4 shows estimates of the contribution of genetic and environmental factors to intelligence.

Behavioural geneticists also use the **adoption method** and conduct longitudinal studies of children adopted shortly after birth. By comparing their abilities and personality traits with those of the adoptive family members with whom they live and with those of their biological parents (whom they may never

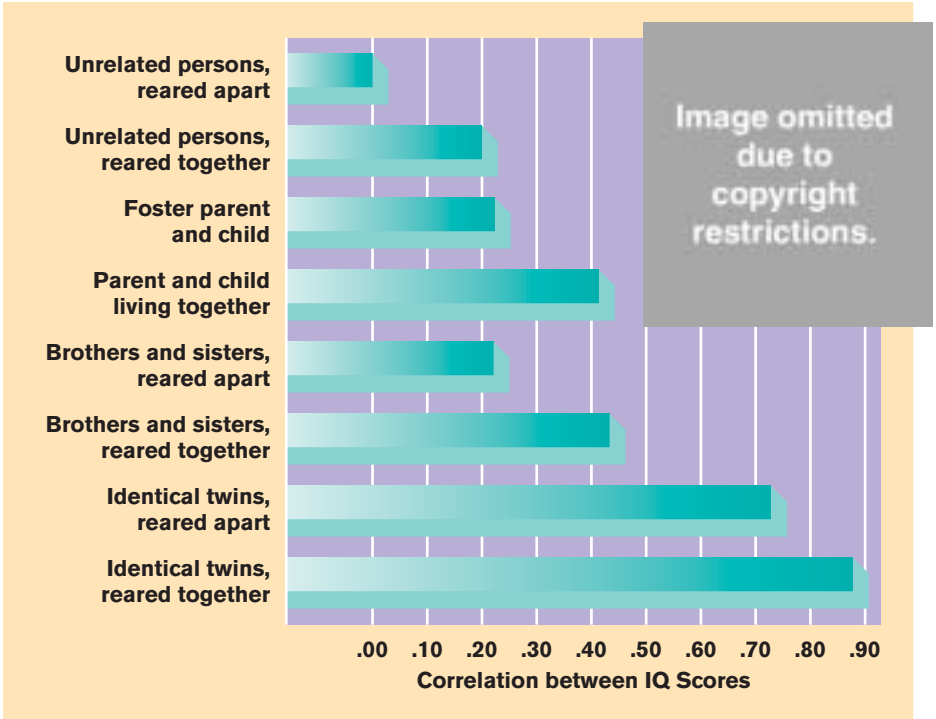


FIGURE 7.4
Correlations between the IQ Scores of Persons with Various Relationships **The more closely related two individuals are, the more similar their IQ scores tend to be. Thus, there is a strong genetic contribution to intelligence. (Based on data from Bouchard & McGue, 1981; Erlenmeyer-Kimling & Jarvik, 1963.)**

have met), researchers can disentangle the effects of heredity and environment (Plomin et al., 1988).

A Natural Experiment: Identical Twins Reared Apart

How do twin studies support the view that intelligence is inherited?

Probably the best way to assess the relative contributions of heredity and environment is to study identical twins who have been separated at birth and raised apart. When separated twins are found to have strikingly similar traits, it is assumed that heredity has been a major contributor. When separated twins differ on a given trait, the influence of the environment is thought to be greater.

Since 1979 researchers headed by Thomas Bouchard have studied some 60 pairs of fraternal twins and 80 pairs of identical twins who were reared apart. They conclude that *"general intelligence or IQ is strongly affected by genetic factors"* (1990, p. 227). Bouchard (1997) reports that various types of twin studies have consistently revealed heritability estimates to be .60 to .70 for intelligence, indicating that 60 to 70 percent of the variation in IQ can be attributed to genetic factors. Not all researchers agree with Bouchard's estimate. Having combined data from a number of twin studies, Plomin and colleagues (1994) estimate heritability for general intelligence to be .52 and other larger studies seem to concur with Plomin's estimates (McClearn et al., 1997).

Psychologists who consider environmental factors to be the chief contributors to differences in intelligence take issue with Bouchard's findings. They maintain that most separated identical twins are raised by adoptive parents who have been matched as closely as possible to the biological parents. This fact, the critics say, could account for the similarities in IQ. In response to their critics, Bouchard (1997) points out that studies comparing non-biologically related siblings reared in the same home reveal that IQ correlations are close to zero by the time the participants reach adolescence.

Adoption studies reveal that children adopted shortly after birth have IQs closer to their biological than to their adoptive parents' IQs. The family environment influences IQ early in life, but that influence seems to diminish; as participants reach adulthood, it is the genes that are most closely correlated with IQ (Loehlin et al., 1988, 1989; McCartney et al., 1990; Plomin & Rende, 1991). Bouchard and others (1990) assert that "although parents may be able to affect their children's rate of cognitive skill acquisition, they may have relatively little influence on the ultimate level attained" (p. 225). But does this mean that the degree to which intelligence is inherited is the degree to which it is absolutely fixed and immune to environmental intervention?

Intelligence: Is It Fixed or Changeable?

What kinds of evidence suggest that IQ is changeable rather than fixed?

Probably the most important issue in intelligence is whether IQ is fixed or changeable. There is little doubt that the great similarity in intelligence scores between identical twins reared apart makes a strong case that genetics is a powerful influence. But even Bouchard and his colleagues (1990, 1997) admit that only a few of the identical twins studied were raised in impoverished environments or by illiterate parents. Consequently, they caution against trying to generalize their findings to people raised in disadvantaged environments. Moreover, they point out that their findings do not argue that IQ cannot be enhanced in a more optimal environment.

Several studies indicate that IQ test scores are not fixed but can be modified with an enriched environ-

nature–nurture controversy: The debate over whether intelligence and other traits are primarily the result of heredity or environment.

behavioural genetics: A field of research that investigates the relative effects of heredity and environment on behaviour and ability.

twin study method: Studying identical and fraternal twins to determine the relative effects of heredity and environment on a variety of characteristics.

identical twins: Twins with identical genes; monozygotic twins.

fraternal twins: Twins who are no more alike genetically than ordinary brothers and sisters; dizygotic twins.

heritability: An index of the degree to which a characteristic is estimated to be influenced by heredity.

adoption method: A method researchers use to study the relative effects of heredity and environment on behaviour and ability in children who are adopted shortly after birth, by comparing them with their biological and adoptive parents.

ment. More than two decades ago, Sandra Scarr and Richard Weinberg (1976) studied 130 black and interracial children who had been adopted by highly educated, upper-middle-class white families; 99 of the children had been adopted in the first year of life. The adoptees were fully exposed to middle-class cultural experiences and vocabulary, the "culture of the tests and the school" (p. 737).

How did the children perform on IQ and achievement tests? For these children, the average 15-point black–white IQ gap was bridged by an enriched environment. Instead of an average IQ score of 90 (which would have been expected had they been reared by their biological parents), these adoptees had an average IQ of 106.3. And their achievement test scores were slightly *above* the national average. Studies in France also show that IQ scores and achievement are substantially higher when children from lower-class environments are adopted by middle- and upper-middle-class families (Duyme, 1988; Schiff & Lewontin, 1986). Zajonc and Mullaly (1997) suggest that the gains might be due to the fact that family size has decreased over the decades. First- and second-born children tend to do better on intelligence and achievement tests than those born later in larger families. With the decrease in family size, there has been a naturally corresponding increase in the proportion of first- and second-born children.

Other evidence also suggests that environmental factors have a strong influence on IQ scores. In industrialized countries all over the world there have been huge IQ gains over the past 50 years. These IQ gains are known as the *Flynn effect,* after James Flynn, who analyzed 73 studies involving some 7 500 participants ranging in age from 12 to 48. He found that "every Binet and Wechsler sample from 1932 to 1978 has performed better than its predecessor" (1987b, p. 225). The gain, about one-third of an IQ point per year (three points per decade), has been continuing for 50 years. That is, average IQ in industrial nations is currently about 15 IQ points, or one standard deviation, higher than 50 years ago.

In regard to the black–white IQ gap among American adults, Flynn (1987b) asserts that "the environmental advantage whites enjoy over blacks is similar to what whites (adults) of today enjoy over their own parents or grandparents of 50 years ago" (p. 226).

Drastic changes in the environment can have major effects on intelligence. For example, malnutrition, especially early in life, can harm intellectual development (Brown & Pollitt, 1996).

Race and IQ: The Controversial Views

What are Jensen's and Herrnstein and Murray's controversial views on race and IQ?

Some studies over the past several decades have reported that, on average, blacks score about 15 points lower than whites on standardized IQ tests (Herrnstein & Murray, 1994; Jensen, 1985; Loehlin et al., 1975). In 1969 Arthur Jensen published an article in the *Harvard Educational Review* in which he attributed the IQ gap to genetic factors. He also maintained that because heredity is such a strong influence on intelligence, environment cannot make a significant difference. Jensen's views on race and intelligence sent a shock wave through the scientific community.

In a similar vein, a Canadian researcher, J. Philippe Rushton, argued that races could be ranked in order of intelligence, with Asians being the highest, followed by whites, and then blacks. His conclusions are based on differences in head circumference, brain size, and estimated cranial space (Rushton, 1991, 1992). This argument has been challenged by other researchers who question the methodology of the research, the accuracy of the measurements, and whether the studies actually test intelligence. Active among Rushton's critics are Guelph University researchers Michael Peters (1995a, 1995b) and Andrew Winston (1996).

A book called *The Bell Curve* (1994) is the most recent fuel for this same controversy. The authors, Herrnstein and Murray, argue that more than any other factor, IQ explains how those at the top rungs of society got there and why those on the lower rungs remain there. For the authors, IQ is primarily genetic and cannot be changed by environmental interventions.

Jensen's views and those of Rushton and Herrnstein and Murray run counter to the beliefs of those who argue that an enriched, stimulating environment can overcome the deficits of poverty and cultural disadvantage and thus reduce or wipe out the IQ deficit.

IS THE GAP DUE TO RACE ALONE? If average IQ differences were genetically determined by race, then the mean IQ scores of mixed-race individuals should fall somewhere between the mean scores for blacks and whites. But studies over the decades have not

Remember It!

IQ Controversies

1. IQ tests are good predictors of success in school. (true/false)
2. What field of research investigates the relative effects of heredity and environment on behaviour and ability?
   a. genetics
   b. behavioural genetics
   c. biology
   d. physiology
3. Twin studies suggest that environment is a stronger factor than heredity in shaping IQ differences. (true/false)
4. Jensen and Herrnstein and Murray maintain that the black–white IQ gap is due primarily to
   a. genetics.
   b. environment.
   c. discrimination.
   d. racism.
5. Several adoption studies have revealed that when infants from disadvantaged environments are adopted by middle- and upper-middle-class parents, their IQ scores are raised about 15 points. (true/false)

Answers: 1. true 2. b 3. false 4. a 5. true

found such a relationship between IQ and mixed ancestry. Among the earliest such research was a study by Witty and Jenkins (1936), who reported no relationship between test scores and white ancestry as reported by blacks. Other studies showed that blacks whose blood types were identical to those most commonly found in whites did not score higher than blacks with other blood types (Loehlin et al., 1973; Scarr et al., 1977).

At the end of World War II, American soldiers stationed in Germany, both black and white, fathered thousands of children with German women. Fifteen years later, Eyeferth (1961) randomly selected samples of these children (183 with black fathers and 83 with white fathers). The mean IQs of the two groups were virtually identical. Having a white father conferred no measurable IQ advantage at all.

LINK IT!

www.mugu.com/cgi-bin/Upstream/Issues/bell-curve/index.html
Materials Relating to the Book The Bell Curve

webusers.anet-stl.com/~civil/bellcurveillustration2.html
Compilation of Web sites and scholarly articles on The Bell Curve

Emotional Intelligence

Daniel Goleman (1995) claims that success in life is more markedly influenced by emotional intelligence than by IQ. **Emotional intelligence** refers to a set of capabilities that are separate from IQ but necessary for success in life—in the workplace, in intimate personal relations, and in social interactions. Goleman (1995) has extended the work of Peter Salovey and John Mayer (1990; Mayer & Salovey, 1993, 1995, 1997), who first introduced the concept of emotional intelligence.

Personal Components of Emotional Intelligence

What are the personal components of emotional intelligence?

The foundation of emotional intelligence is self-knowledge. It involves an awareness of emotions, an ability to manage those emotions, and self-motivation.

Awareness of our own emotions—recognizing and acknowledging feelings as they happen—is at the very heart of emotional intelligence. It means being aware

emotional intelligence: A type of intelligence that includes an awareness of and an ability to manage one's own emotions, the ability to motivate oneself, empathy, and the ability to handle relationships successfully.

not only of our moods, but of thoughts about those moods, as well. Those who are able to monitor their feelings as they arise are more likely to be able to manage them rather than being ruled by them.

Managing emotions does not mean suppressing them, any more than it means giving free rein to every feeling and impulse. To manage emotions is to express them in an appropriate manner and not let them run out of control. For example, if not tempered with reason, uncontrolled anger can lead to rage and violence. People high in emotional intelligence have learned how to regulate their moods and not let anger, boredom, or depression ruin their day (or their lives). You manage your emotions when you do something to cheer yourself up, soothe your own hurts, reassure yourself, or otherwise temper an inappropriate or out-of-control emotion.

Self-motivation refers to a strength of emotional self-control that enables a person to get moving and pursue worthy goals, persist at tasks even when frustrated, and resist the temptation to act on impulse.

The ability to postpone immediate gratification and to persist in working toward some greater future gain is most closely related to success—whether one is trying to build a business, get a college degree, or even stay on a diet.

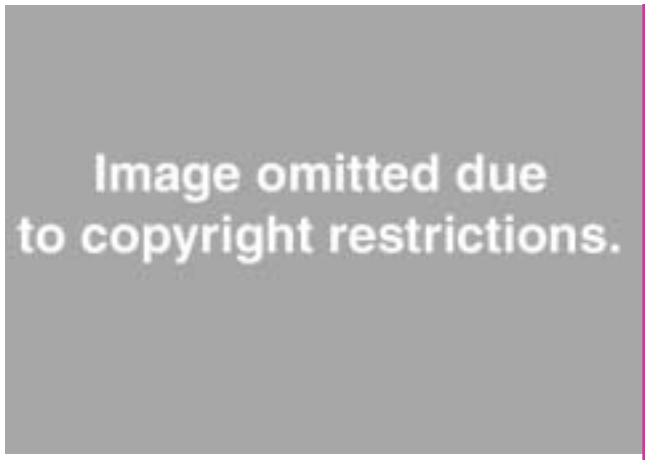
Interpersonal Components of Emotional Intelligence

What are the interpersonal components of emotional intelligence?

The interpersonal aspects of emotional intelligence are empathy and the ability to handle relationships.

The ability to empathize—to recognize and understand the motives and emotions of others—is the cornerstone of successful interpersonal relations. Empathy appears to be a higher level of development that springs from self-awareness. If we have no insight into our own emotions, it is unlikely that we will develop sensitivity and understanding of the emotions of others.

One key indicator, or hallmark, of the empathy component of emotional intelligence is the ability to read and interpret non-verbal behaviour—the gestures, vocal inflections, tones of voice, and facial expressions of others. Non-verbal behaviour is, in a sense, the language of the emotions, because our feelings are most genuinely expressed this way. People may fail to communicate their feelings verbally or even lie about them, but their non-verbal behaviour often reveals their true feelings.



A person with high emotional intelligence shows empathy–recognizing non-verbal signals from others and making appropriate responses.

For most people, hardly anything in life is more important than their relationships—intimate love relationships; family, professional, and work relationships; and relationships with friends. Without rewarding relationships, life would be lonely indeed. What does emotional intelligence have to do with forming and maintaining successful relationships? Virtually everything. Some people are inept at forming and handling mutually satisfying relationships; others seem to be masters of the art.

Two components of emotional intelligence that are prerequisites for handling relationships are (1) the ability to manage one's own emotions, and (2) empathy. These two components combine to produce the ability to respond appropriately to emotions in others. And this, Goleman (1995) maintains, is the very centre of the art of handling relationships. But he does not mean "handling" in an autocratic, dominating sense. People who handle relationships well, says Goleman, are able to shape encounters, "to mobilize and inspire others to thrive in intimate relationships, to persuade and influence, to put others at ease" (p. 113).

Optimism also appears to be a component of emotional intelligence. People who are optimistic have a "strong expectation in general [that] things will turn out all right in life" (p. 88). The most significant

aspect of optimism in the context of emotional intelligence is the way in which optimists explain their successes and failures. When optimists fail, they attribute their failure to something in the situation that can be changed. Thus, they believe that by trying harder, they can succeed the next time. But when pessimists fail, they blame themselves and attribute their failure to some personal characteristic or flaw that cannot be changed.

Imagery and Concepts: Tools of Thinking

In our discussion of intelligence, we reviewed the basic components of IQ tests. Some of these components assess verbal skills, spatial abilities, problem solving, and logic. These underlying competencies are also important when we consider the tools of thinking.

What *are* the tools of thinking? All of us have an intuitive notion of what thinking is. We say, "I think it's going to rain" (a prediction); "I think this is the right answer" (a choice); "I think I will resign" (a decision). But our everyday use of the word *think* does not suggest the processes we use to perform the act itself. Sometimes our thinking is free-flowing rather than goal-oriented. At other times, it is directed at a goal such as solving a problem or making a decision. Just how is the act of thinking accomplished? There is general agreement that at least two tools are commonly used when we think—images and concepts.

Imagery: Picture This—Elephants with Purple Polka Dots

What is imagery?

Can you imagine hearing a recording of your favourite song or someone calling your name? Can you picture yourself jogging or walking, pouring ice water over your hands, or kissing someone you love? The vast majority of us are able to produce mental **imagery**—that is, we can represent or picture a sensory experience in our mind.

In a survey of 500 adults conducted by McKellar (1972), 97 percent said they had visual images; 93 percent reported auditory images (imagine your psychology instructor's voice); 74 percent said they had motor imagery (imagine raising your hand); 70 percent, tactile or touch images (imagine rubbing sandpaper); 6 percent, gustatory images (imagine the taste of a dill pickle); and 66 percent, olfactory images (imagine smelling a rose). Visual imagery is certainly the most common, although auditory imagery is not far behind.

Our images may be dimmer and less vivid than when we are experiencing the real thing, but images are not limited to time, space, size, or other physical realities. We can imagine ourselves flying through the air like an eagle, singing to the thundering applause of adoring fans, or performing all sorts of amazing feats. But normally our imaging is quite similar to the real world we are thinking about.

When we construct visual mental images, we may believe that we form the entire image all at once. But according to Stephen Kosslyn (1988), we do not. Rather, we mentally construct the objects we image, one part at a time. Studies with split-brain patients and normal people suggest that two types of processes are used in the formation of visual images. First, we retrieve stored memories of how parts of an object look; then we use mental processes to arrange or assemble those parts into the proper whole. Both hemispheres participate in the processes of forming visual images. Try forming visual images as you do *Try It!*

Try It!

Forming Visual Images

A. Picture an ant crawling on a newspaper about one metre away. How many legs does the ant have?

B. Picture an ant perched on the end of a toothpick right in front of your eyes. Does the ant have eyelashes?

In which mental picture is the ant larger, A or B? Which mental picture provided more detail of the ant? (After Finke, 1985.)

imagery: The representation in the mind of a sensory experience—visual, auditory, gustatory, motor, olfactory, or tactile.

Kosslyn (1975, 1983) asked research participants many questions like those in *Try It!* and found that they answered questions about larger images about 0.2 seconds faster than questions about small images. It takes us slightly longer to zoom in on smaller images than on larger ones, just as it does when we actually look at real objects (Kosslyn & Ochsner, 1994).

But what if we are forming new images rather than answering questions about large and small images already formed? Picture an elephant standing about a metre away. Now picture a rabbit standing at the same distance. Which image took longer to form? Kosslyn (1975) discovered that it takes people longer to form large mental images—an elephant as opposed to a rabbit. It takes longer to view the elephant because there is more of it to view, and likewise more of it to image.

Not only do we form a mental image of an object, but we manipulate and move it around in our mind much as we would if we were actually holding and looking at the object (Cooper & Shepard, 1984). Shepard and Metzler (1971) asked eight participants to judge some 1600 pairs of drawings like the ones in Figure 7.5. They had to rotate the objects in their imagination to see if they matched. In Figure 7.5 the objects in (a) and (b) are a match; those in (c) are not. But the important finding is that the more the objects had to be rotated in imagery, the longer it took participants to decide whether they matched. This is precisely what happens if the participants rotate real objects; the more they need to be rotated, the longer it takes to make the decision. As this study demonstrates, we manipulate objects in mental imagery in the same way as we manipulate real physical objects.

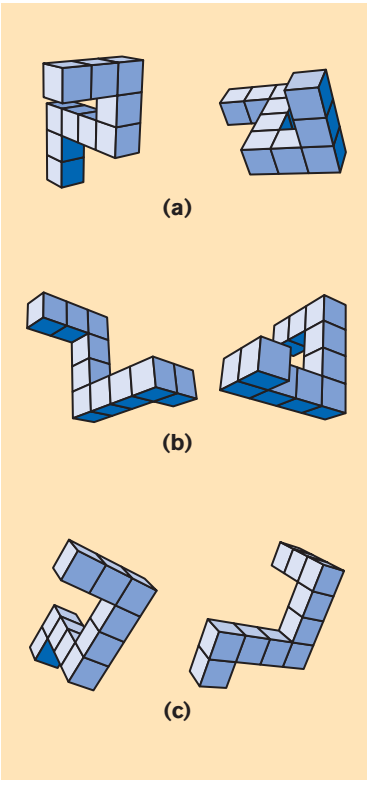


FIGURE 7.5
Samples of Geometric Patterns in Shepard and Metzler's Mental Rotation Study
Mentally rotate one of the patterns in each pair–(a), (b), and (c)–and decide whether the two patterns match. Do you find that the more you have to rotate the objects mentally, the longer it takes to decide if they match? (From Shepard & Metzler, 1971.)

Similarities in the Processes of Imaging and Perceiving

If we form mental images (visual, auditory, etc.) in the brain much as we actually perceive them, then is imaging subject to interference, just like our perceptions? Close your eyes and form a mental image of your psychology instructor. Now keep the visual image and open your eyes. Doesn't the mental image fade or disappear as soon as you see a real object? But if viewing an actual object interferes with a visual image, is the reverse also true? Will a vivid visual image interfere with a real object?

Yes, according to Craver-Lemley and Reeves (1992). In an earlier study, Segal and Fusella (1970) asked students to form either a visual image of a tree or an auditory image of the sound of a typewriter. The researchers then made a faint sound on a harmonica, or flashed a small, dimly lighted blue arrow, or did nothing at all. Students holding the visual image of a tree were less likely to see the blue arrow but more likely to hear the harmonica. Students imaging the sound of a typewriter had the opposite experience: they saw the arrow but missed the sound of the harmonica. To the researchers, this meant that both perceiving and imaging probably use some of the same mental processes and that using the same processes *simultaneously* on two different tasks causes interference.

But not all researchers who study imagery and perception agree (Roland & Gulyás, 1994). There is agreement that certain higher-order visual areas in the temporal and parietal lobes are involved in both imagery and perception (Moscovitch et al., 1994). But some researchers say that the primary visual cortex is not necessarily active during imaging unless the person is actually scrutinizing the features of some object stored in memory—as you did in *Try It!* (Sakai & Miyashita, 1994). Kosslyn and Ochsner (1994; also Kosslyn, 1994), on the other hand, main-

tain that the primary visual cortex is also involved in most imaging. They believe that the same brain pathways are used both in perceiving and in imaging objects, although the pathways for imaging are activated in reverse order from the pathways for perceiving. Patients who have experienced damage in a particular region of the right hemisphere may have a loss of perception in the left half of their visual field. (Remember that information from the left and right visual fields is fed into the opposite brain hemispheres.) Some males with such damage will shave the right side of their face but completely ignore the left side. When these same patients are asked to produce a mental image of an object or a location they know well, they identify only the details on the right half of the object or location (Bisiach & Luzzati, 1978).

Concepts: Our Mental Classification System (Is a Penguin a Bird?)

What are concepts, and how are they formed?

Thinking is not limited to conjuring up a series of pictures, sounds, touches, tastes, and smells. We humans are capable of conceptualizing as well. A **concept** is a label that represents a class or group of objects, people, or events that share common characteristics or attributes. Concepts are useful tools that help us order our world and think and communicate with speed and efficiency.

Imagine that you are walking down the street with a friend, and you see approaching in the distance a hairy, brown-and-white, four-legged animal with two eyes and two ears, its mouth open, its tongue hanging out, and a long, wagging tail. You simply say to your friend, "Here comes a dog." Thanks to our ability to use concepts, we are not forced to consider and describe everything in great detail before we make an identification. We do not need a different name to identify and describe every single rock, tree, animal, or situation we meet. *Dog* is a concept that stands for a family of animals that share similar characteristics or attributes, even though they may differ in significant ways (in this case, according to breed).

We have concepts for abstractions as well as for tangible objects and organisms. Love, beauty, and justice are abstract concepts, yet we can identify and consider aspects of beauty and justice because we have formed concepts of them. We also use relational concepts in our thinking—larger than, smaller than, older than, younger than, and so on—to compare individuals, objects, and ideas.

Concept Formation: Learning What Fits a Concept

How do we acquire concepts, and how do we know what fits or does not fit a given concept? We can form concepts (1) from a formal definition of the concept, (2) by systematically memorizing a concept's common features, (3) through our experiences with positive and negative instances of the concept, (4) through the use of prototypes, or (5) through the use of exemplars.

SYSTEMATIC OR FORMAL APPROACHES Studies have been conducted and theories proposed to explain how we form concepts. Some theorists maintain that we approach concept formation in an active, orderly, and systematic way, rather than in a random, informal, and haphazard way (Bruner et al., 1956). Sometimes we learn a concept from a formal definition or from a formal classification system. You surely have memorized several such systems while studying biology, chemistry, English, or similar subjects.

POSITIVE AND NEGATIVE INSTANCES We acquire many simple concepts through experiences with examples or positive instances of the concept. When children are young, parents may point out examples of a car—the family car, the neighbour's car, cars on the street, and pictures of cars in a book. But if a child points to some other type of moving vehicle and says "car," the parent will say, "No, that is a truck," or "This is a bus." "Truck" and "bus" are negative instances, or "non-examples," of the concept "car." After experience with positive and negative instances of the concept, a child begins to grasp some of the properties of a car that distinguish it from other wheeled vehicles.

PROTOTYPES Eleanor Rosch (1973, 1978) argues that formal theories of concept formation, and the experiments on which they are based, tend to be rather artificial, contrived, and unrelated to our actual experience. She and her colleagues have studied concept formation in its natural setting and have concluded

concept: A label that represents a class or group of objects, people, or events sharing common characteristics or attributes.

that in real life, our thinking and concept formation are somewhat fuzzy, not clear-cut and systematic. Sometimes we identify objects based on a memorized list of features or attributes that are common to instances of a concept. But in addition, we are likely to picture a **prototype** of the concept—an example that embodies the most common and typical features of the concept.

What is your prototype for the concept *bird?* Chances are it is not a penguin, an ostrich, or a kiwi. All three are birds that cannot fly. A more likely bird prototype is a robin or perhaps a sparrow. Most birds can fly, but not all; most mammals cannot fly, but bats are mammals, have wings, and can fly. So not all examples within a concept fit equally well. Nevertheless, the prototype most closely fits a given concept, and items and organisms belonging to the concept share more attributes with their prototype than with the prototype of any other concept.

EXEMPLARS A recent theory of concept formation suggests that concepts are represented by their **exemplars**—individual instances, or examples, of a concept that we have stored in memory from our own experience (Estes, 1994). To decide whether an unfamiliar item belongs to a concept, we compare it with exemplars (other examples) of that concept.

The concepts we form do not exist in isolation. We form them in hierarchies. For example, the canary and the cardinal are subsets of the concept *bird*; at a higher level, birds are subsets of the concept *animal*; and at a still higher level, animals are a subset of the concept *living things.*

A prototype is an example that embodies the most typical features of a concept. Which of the animals shown here best fits your prototype for the concept *bird*?

Remember It!

Imagery and Concepts

1. The two most common forms of imagery are
   a. visual and motor imagery.
   b. auditory and tactile imagery.
   c. visual and auditory imagery.
   d. visual and gustatory imagery.
2. Our images are generally as vivid as the real thing. (true/false)
3. A label that represents a class or group of objects, people, or events that share common characteristics or attributes is called a(n)
   a. image.
   b. concept.
   c. positive instance.
   d. prototype
4. A prototype is the most _____ example of a concept.
   a. abstract
   b. unusual
   c. recent
   d. typical
5. A stork is an exemplar of the concept *bird*. (true/false)

Answers: 1. c 2. false 3. b 4. d 5. true

Problem Solving and Creativity

Approaches to Problem Solving: How Do We Begin?

What are three problem-solving techniques, and how are they used?

All of us are faced every day with a variety of problems needing to be solved. Most of our problems are simple and mundane, like what to have for dinner or what clothes to put on in the morning. But some of our problems are more far-reaching, such as what career to pursue, how to sustain or improve a relationship, or how to stretch our income from one paycheque to the next. Then there are the problems we meet in our schoolwork, which we must think through using problem-solving techniques. Among these techniques are trial and error, algorithms, and heuristics. How would you solve the problem in the *Try It!* box?

Trial and Error

How did you choose to solve the *Try It!* problem? Many people simply start placing the numbers in the boxes and then change them around when a combination doesn't work. This is called **trial and error**. It occurs when we try one solution after another, in no particular order, until by chance we hit upon the answer.

However, other techniques are far more effective and less time-consuming.

Algorithms

Another major problem-solving method is the algorithm (Newell & Simon, 1972). An **algorithm** is a systematic, step-by-step procedure that guarantees a solution to a problem of a certain type if the algorithm is appropriate and executed properly. Formulas used in mathematics and other sciences are algorithms. Another type of algorithm is a systematic strategy for exploring every possible solution to a problem until the correct one is reached. In some cases there may be millions or even billions or more possibilities that one would have to try before reaching a solution. Often computers are programmed to solve such problems, because with a computer an accurate solution is guaranteed and millions of possible solutions can be tried in a few seconds.

Many problems do not lend themselves to solution by algorithms, however. Suppose you were a contestant on *Wheel of Fortune,* trying to solve this missing-letter puzzle: P_Y_ _OL_ _ _. An exhaustive search algorithm would be out of the question—even Vanna White's smile would fade long before the nearly nine billion possibilities could be considered. An easier way to solve such problems is by heuristics.

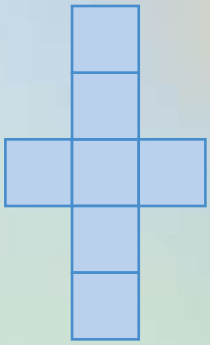
Heuristic Strategies in Problem Solving

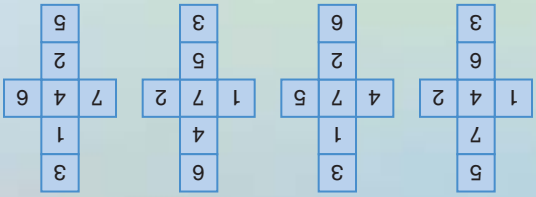
A **heuristic** is a problem-solving method that does not guarantee success but offers a promising way to

Try It!

Testing Problem Solving

Insert the numbers 1 through 7 in the seven boxes, one digit to a box, in such a way that no consecutive numbers are next to each other horizontally, vertically, or diagonally. Several solutions are possible.





prototype: An example that embodies the most common and typical features of a particular concept.

exemplars: The individual instances of a concept that we have stored in memory from our own experience.

trial and error: An approach to problem solving in which one solution after another is tried in no particular order until a workable solution is found.

algorithm: A systematic, step-by-step procedure, such as a mathematical formula, that guarantees a solution to a problem of a certain type if the algorithm is appropriate and executed properly.

heuristic (hyu-RIS-tik): A problem-solving method that offers a promising way to attack a problem and arrive at a solution, although it does not guarantee success.

attack a problem and arrive at a solution. Chess players must use heuristics because there is not enough time in a lifetime to consider all of the moves and countermoves that are possible in a single game of chess (Bransford et al., 1986).

We use heuristics to eliminate useless steps and take the shortest probable path toward a solution. The missing-letter puzzle presented earlier is easily solved through a simple heuristic approach that makes use of our existing knowledge of words (prefixes, roots, suffixes). For example, we would probably try the most common letters (E, R, S, A, T, O, L, N) rather than every possible letter to fill the blank spaces. Next we would identify likely letter combinations first (PSY rather than PNY). Then we would supply the missing letters and spell out PSYCHOLOGY.

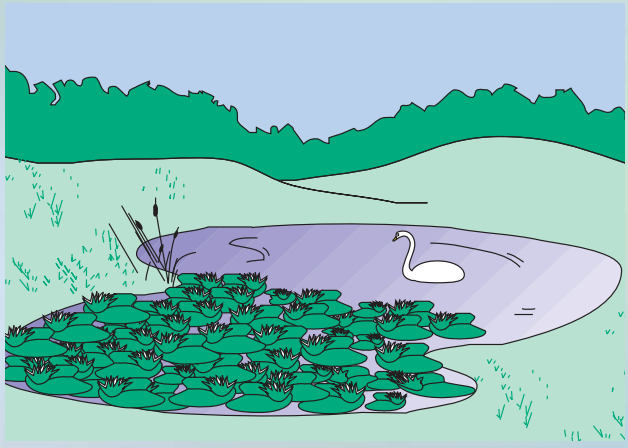
MEANS–END ANALYSIS One popular heuristic strategy is **means–end analysis**, in which the current position is compared with a desired goal, and a series of steps are formulated and then taken to close the gap between the two (Sweller & Levine, 1982). Many problems are large and complex and must be broken down into smaller steps or sub-problems. If your professor assigns a term paper, for example, you probably do not simply sit down and write it. You must first determine how you will deal with your topic, research the topic, make an outline, and then probably write the subtopics over a period of time. At last you are ready to assemble the complete term paper, write several drafts, and put the finished product in final form before handing it in.

WORKING BACKWARD Another heuristic that is effective for solving some problems is **working backward**, sometimes called the "backward search." In this approach we start with the solution—a known condition—and work our way backward through the problem. Once our backward search has revealed the steps to be taken and their order, we can solve the problem. Try working backward to solve the water lily problem in *Try It!*

Try It!

Working Backward to Solve a Problem

Water lilies double the area they cover every 24 hours. At the beginning of the summer there is one water lily on a lake. It takes 60 days for the lake to become covered with water lilies. On what day is the lake half covered?



Answer: The most important fact is that the lilies double in number every 24 hours. If the lake is to be completely covered on the 60th day, it has to be half covered on the 59th day.

Impediments to Problem Solving: Mental Stumbling Blocks

What are the two major impediments to problem solving?

Sometimes the difficulty in problem solving lies not with the problem but with ourselves. The two major impediments to problem solving are functional fixedness and mental set.

Functional Fixedness

Many of us are hampered in our efforts to solve problems in daily living because of **functional fixedness**—the failure to use familiar objects in novel ways to solve problems. We tend to see objects only in terms of their customary functions. Just think of all the items we use daily—tools, utensils, and other equipment—that help us perform certain functions. Often the normal functions of objects become fixed in our thinking so that we do not consider using them in new and creative ways.

What if you wanted a cup of coffee, but the decanter to your coffeemaker was broken? If you suffered from functional fixedness, you might come to the

conclusion that there was nothing you could do to solve your problem at that moment. The solution? Rather than thinking about the object or utensil that you don't have, think about the function you need served in order to solve your problem. What you need is something to catch the coffee, rather than the specific glass decanter that came with the coffeemaker. Could you catch the coffee in some other type of bowl or cooking utensil, or even in a coffee mug?

Mental Set

Another impediment to problem solving, similar to functional fixedness but much broader, is mental set. **Mental set** means that we get into a mental rut in our approach to solving problems, continuing to use the same old methods even though other approaches might be better. Perhaps we hit on a way to solve a problem once in the past and continue to use the same technique in similar situations, even though it is not highly effective or efficient. We are much more susceptible to mental set when we fail to consider the special requirements of a problem. Not surprisingly, the same people who are subject to mental set are also more likely to have trouble with functional fixedness when they attempt to solve problems (McKelvie, 1984).

Creativity: Unique and Useful Productions

What is creativity, and what tests have been designed to measure it?

Creativity can be thought of as the ability to produce original, appropriate, and valuable ideas and/or solutions to problems. But can creativity be measured, and does it differ from conventional thought? According to psychologist J.P. Guilford, who studied creativity for several decades, creative thinkers are proficient in **divergent thinking**. Divergent thinking is the ability to produce multiple ideas, answers, or solutions to a problem rather than a single, correct response. Divergent thinkers can conceive of novel or original ideas that involve the combination and synthesis of unusual associations that lead to an abundant quantity of ideas (Csikszentmihalyi, 1996).

Obviously, creative thinking is divergent. But is divergent thinking necessarily creative thinking? No! All creative thought is divergent, but not all divergent thought is creative. Novelty is not synonymous with creativity. We are not surprised, then, to find that high scores on tests of divergent thinking do not have a very high correlation with creative thinking in real life. Guilford himself admitted (1967) that in studies of students from elementary through high school, the correlations of his divergent-thinking tests with actual creative thinking were not spectacular.

Other researchers have also tried to design tests to measure creative ability. Mednick and Mednick (1967) reasoned that the essence of creativity is the thinker's ability to fit ideas together that might appear remote or unrelated to the less creative thinker. They created the Remote Associates Test (RAT) as a means of measuring creative ability. Try your creative skills in the next *Try It!*

Mednick and Mednick point out that some studies show a relationship between high scores on the RAT and creative thinking in the workplace; other studies, however, have not found this relationship (Matlin, 1983). For more information about creativity, see *Apply It!* at the end of this chapter.

Creativity and Intelligence: How Do They Relate?

Is creativity related to intelligence? There is a modest correlation between the two: highly creative people tend to be well above average in intelligence. However, in the upper IQ ranges (120 +) there seems to be little correlation (Barron & Harrington, 1981).

means-end analysis: A heuristic problem-solving strategy in which the current position is compared with the desired goal, and a series of steps are formulated and taken to close the gap between them.

working backward: A heuristic strategy in which a person discovers the steps needed to solve a problem by defining the desired goal and working backward to the current condition.

functional fixedness: The failure to use familiar objects in novel ways to solve problems because of a tendency to view objects only in terms of their customary functions.

mental set: The tendency to apply a familiar strategy to the solution of a problem without carefully considering the special requirements of the problem.

creativity: The ability to produce original, appropriate, and valuable ideas and/or solutions to problems.

divergent thinking: Producing one or more possible ideas, answers, or solutions to a problem rather than a single, correct response.

Try It!

Testing Creative Ability

One indication of creativity may be the ability to make associations among several elements that seem only remotely related or unrelated. Test your ability to find associations for these 10 sets of words, which are similar to those on the Remote Associates Test. Think of a fourth word that is related in some way to all three of the words in each row. For example, the words *keeper, text,* and *worm* are related to the word *book* and become *bookkeeper, textbook,* and *bookworm.*

1. sales, collector, income
2. flower, room, water
3. red, shot, dog
4. ball, hot, stool
5. rock, man, classical
6. story, true, sick
7. news, plate, waste
8. stuffed, sleeve, sweat
9. class, temperature, bath
10. wrist, man, stop

Answers: 1. tax 2. bed 3. hot 4. foot 5. music 6. love 7. paper 8. shirt 9. room 10. watch

Remember the young geniuses studied by Lewis Terman? Not a single one of them produced a highly creative work in later years (Terman & Oden, 1959). They were geniuses, yes, but not creative geniuses.

Language

Without language, there would be no books to read, no papers to write, no lectures to endure. Not bad so far, you may be thinking. But consider: Without language we would each live in a largely solitary and isolated world, unable to communicate or receive any information, from simple requests to our most intimate thoughts and feelings. Our knowledge would be restricted to the direct and immediate, our own experience locked within us.

Thanks to language, we can profit from the experience, the knowledge, and the wisdom of others and can benefit others with our own. Language is not confined to time and space. The wisdom of the ages from every corner of the world and spanning the centuries of recorded history is available to us through language. Truly, language is one of the most important capabilities of the human species. Civilization could not exist without it. Whether spoken, written, or signed, language is vital to us. What are the components and the structure of this most amazing tool of human communication?

Remember It!

Problem Solving and Creativity

1. Which of the following is guaranteed, if properly applied, to result in the correct answer to a problem?
   a. an algorithm
   b. a heuristic
   c. trial and error
   d. applying prior knowledge
2. Working backward and means–end analysis are examples of
   a. algorithms.
   b. heuristics.
   c. mental sets.
   d. functional fixedness.
3. John uses a wastebasket to keep a door from closing. In solving his problem, he was not hindered by
   a. a heuristic.
   b. an algorithm.
   c. functional fixedness.
   d. mental set.
4. One characteristic of good problem solvers is mental set. (true/false)
5. Divergent thinking tests and the Remote Associates Test are used to measure
   a. imaging ability.
   b. concept formation.
   c. problem-solving ability.
   d. creativity.

Answers: 1. a 2. b 3. c 4. false 5. d

The Structure of Language

What are the four important components of language?

Psycholinguistics is the study of how language is acquired, produced, and used and how the sounds and symbols of language are translated into meaning. Psycholinguists devote much of their time to the study of the structure of language and the rules governing its use. The structure and rules governing language involve four different components—phonemes, morphemes, syntax, and semantics.

LINK IT!

ruccs.rutgers.edu/~almeida/psylinlab.html
Psycholinguistics Lab Home Page, Center for Cognitive Science, Rutgers University

www.ugcs.caltech.edu/~egnor/psycho/
Participate in a psycholinguistic survey

Phonemes

The smallest units of sound in a spoken language are known as **phonemes**. Phonemes form the basic building blocks of a spoken language. Three phonemes together form the sound of the word *cat*—the *c* (which sounds like *k*), *a*, and *t*. Phonemes do not sound like the single letters of the alphabet as we recite them, *a-b-c-d-e-f-g*, but like the sounds of the letters as they are used in words, like the *b* in *boy*, the *p* in *pan*, and so on. The sound of the phoneme *c* in the word *cat* is different from the sound of the phoneme *c* in the word *city*.

Letters combined to form sounds are also phonemes, such as the *th* in *the* and the *ch* in *child*. The same sound (phoneme) may be represented by different letters in different words, as in the *a* in *stay* and the *ei* in *sleigh*. And, as we saw with *c*, the same letter can serve as different phonemes. The letter *a*, for example, can be sounded as three different phonemes, as in *day*, *cap*, and *law*.

How many phonemes are there? There are perhaps 100 or so different sounds that could serve as phonemes, but most languages have far fewer. English uses about 45 phonemes; some languages may have as few as 15 or so and other languages as many as 85 (Solso, 1991). Though phonemes are the basic building blocks of language, they alone, with a few exceptions, do not provide language with meaning. For meaning, we must move to the next component of language, the morphemes.

Morphemes

Morphemes are the smallest units of meaning in a language. In almost all cases in the English language, a morpheme is made of two or more phonemes. But a few phonemes also serve as morphemes, such as the article *a* and the personal pronoun *I*. Many words in English are single morphemes—*book*, *word*, *learn*, *reason*, and so on. In addition to root words, morphemes may also be prefixes (such as *re* in *relearn*) or suffixes (such as *ed* to show past tense—*learned*). The single morpheme *reason* becomes the two-morpheme *reasonable*. The letter *s* gives a plural meaning to a word and is thus a morpheme. The morpheme *book* (singular) becomes the two-morpheme *books* (plural).

So morphemes, singly and in combination, form the words in a language and provide meaning. But sounds and single words alone are not enough. A language also requires rules for structuring or putting together words in an orderly and meaningful fashion. This is where syntax enters the picture.

Syntax

Syntax is the aspect of grammar that specifies the rules for arranging and combining words to form phrases and sentences. An important rule of syntax in English is that adjectives usually come before nouns. So we refer to the caution lights at intersections as yellow lights or amber lights. But in French the noun usually comes before the adjective, and speakers would say *le feu jaune,* or "the light yellow." So the rules of word order, or syntax, differ from one language to another. In English we ask, "Do you speak German?" But speakers of German would ask *Sprechen Sie Deutsch?* or, "Speak you German?"

psycholinguistics: The study of how language is acquired, produced, and used, and how the sounds and symbols of language are translated into meaning.

phonemes: The smallest units of sound in a spoken language.

morphemes: The smallest units of meaning in a language.

syntax: The aspect of grammar that specifies the rules for arranging and combining words to form phrases and sentences.

Semantics

Semantics refers to the meaning we derive from morphemes, words, and sentences. The same word can have different meanings depending upon how it is used in sentences: "I don't mind." "Mind your manners." "He has lost his mind." Or consider another example, "Loving to read, the young girl read three books last week." Here, the word *read* is pronounced two different ways and in one case is in the past tense.

Language is a universal human phenomenon, yet there is great diversity in the way language is used around the world—there are some 6000 spoken languages (Berreby, 1994). But however it is spoken, written, signed, or otherwise used, language is one of the most complex human capabilities.

Language Development

At birth, the infant's only means of communication is crying, but at age 17, the average high school graduate has a vocabulary of 80 000 words (Miller & Gildea, 1987).

Children do much more than simply add new words to their vocabulary. They acquire an understanding of the way words are put together to form sentences (syntax) and the way language is used in social situations. Children acquire most of their language without any formal teaching and discover the rules of language on their own. During their first few months, infants communicate distress or displeasure through crying (Shatz, 1983). The cry is their innate reaction to an unpleasant internal state, such as hunger, thirst, discomfort, or pain.

Cooing and Babbling

During the second or third month, infants begin cooing—repeatedly uttering vowel sounds such as "ah" and "oo."

At about six months, infants begin **babbling**. They utter phonemes. Consonant-vowel combinations are repeated in a string, like "ma-ma-ma" or "ba-ba-ba." During the first part of the babbling stage, infants babble all the basic speech sounds that occur in all the languages of the world. Language up to this point seems to be biologically determined, because all babies throughout the world, even deaf children, vocalize this same range of speech sounds.

At about eight months, babies begin to focus attention on those phonemes common to their native tongue and on the rhythm and intonation of the language. Gradually they cease making the sounds not found in their native language. At about one year, a French-speaking child's babbling sounds like French, and an English-speaking child's babbling sounds like English (Levitt & Wang, 1991). Deaf children who are exposed to sign language from birth babble manually. That is, they make the hand movements that represent the phonemes in sign language (Petitto & Marentette, 1991).

The One-Word Stage

At about one year, the babbling stage gives way to the one-word stage, and infants utter their first real words. The first words usually represent objects that move or those that infants can act upon or interact with. Early words usually include food, animals, and toys—"cookie," "mama," "dada," "doggie," and "ball," to name a few (Nelson, 1973).

Sometimes infants use one-word sentences, called "holophrases," in which the same word is used to convey different meanings depending on the context. "Cookie" can mean "This is a cookie," "I want a cookie," or, if the child is looking down from a high chair, "The cookie is on the floor."

Initially their understanding of words differs from that of an adult. On the basis of some shared feature and because they lack the correct word, children may apply a word to a broader range of objects than is appropriate. This is known as **overextension**. For example, any man may be called "dada," any four-legged animal, "doggie." **Underextension** occurs, too, when children fail to apply a word to other members of the class. Their poodle is a "doggie," but the German shepherd next door is not.

The Two-Word Stage and Telegraphic Speech

Between 18 and 20 months, when the vocabulary is about 50 words, children begin to put nouns, verbs, and adjectives together in two-word phrases and sentences. At this stage children depend to a great extent on gesture, tone, and context to convey their meaning (Slobin, 1972). Depending on intonation, their sentences may indicate questions, statements, or possession. Children adhere to a rigid word order. You might hear "mama drink," "drink milk," or "mama

milk," but not "drink mama," "milk drink," or "milk mama."

By two years, their vocabulary has increased to about 272 words (Brown, 1973). At about two and a half years, short sentences are used, which may contain three or more words. Labelled **telegraphic speech** by Roger Brown (1973), these short sentences follow a rigid word order and contain only essential content words, leaving out plurals, possessives, conjunctions, articles, and prepositions. Telegraphic speech reflects the child's understanding of syntax—the rules governing how words are ordered in a sentence. When a third word is added to a sentence, it usually fills in the word missing from the two-word sentence (for example, "Mama drink milk").

Suffixes, Function Words, and Grammatical Rules

After using telegraphic speech for a time, children gradually begin to add modifiers to make words more precise. Suffixes and function words—pronouns, articles, conjunctions, and prepositions—are acquired in a fixed sequence, although the rate of acquisition varies (Brown, 1973; Maratsos 1983).

Overregularization is the kind of error that results when a grammatical rule is misapplied to a word that has an irregular plural or past tense (Kuczaj, 1978). Thus children who have learned and correctly used words such as "went," "came," and "did" incorrectly apply the rule for past tenses and begin to say "goed," "comed," and "doed." What the parent sees as a regression in speech actually means that the child has acquired a grammatical rule (Marcus et al., 1992).

Theories of Language Development: How Do We Acquire It?

How do learning theory and the nativist position explain the acquisition of language?

The ability to acquire language has fascinated researchers and philosophers alike. Two explanations that explain how language is acquired are the learning theory and the nativist approach.

Learning Theory

Learning theorists have long maintained that language is acquired in the same way that other behaviours are acquired—as a result of learning through reinforcement and imitation. B.F. Skinner (1957) asserted that language is shaped through reinforcement. He said that parents selectively criticize incorrect speech and reinforce correct speech through praise, approval, and attention. Thus the child's utterances are progressively shaped in the direction of grammatically correct speech. Others believe that children acquire vocabulary and sentence construction mainly through imitation (Bandura, 1977a).

On the surface, what the learning theorists propose appears logical, but there are some problems with learning theory as the sole explanation for language acquisition. Imitation cannot account for patterns of speech such as telegraphic speech or for systematic errors such as overregularization. Children do not hear telegraphic speech in everyday life, and "I comed" and "He goed" are not forms commonly used by parents.

There are also problems with reinforcement as an explanation for language acquisition. First, parents seem to reward children more for the content of the utterance than for the correctness of the grammar (Brown et al., 1968). And parents are much more likely to correct children for saying something untrue than for making a grammatical error. Regardless, correction does not seem to have much impact on a child's grammar.

Nevertheless, reinforcement plays an important part in language learning. Responsiveness to infants' vocalizations increases the amount of vocalization, and reinforcement can help children with language deficits improve (Lovaas, 1967; Whitehurst et al., 1989).

semantics: The meaning or the study of meaning derived from morphemes, words, and sentences.

babbling: Vocalization of the basic speech sounds (phonemes), which begins between the ages of four and six months.

overextension: The act of using a word, on the basis of some shared feature, to apply to a broader range of objects than is appropriate.

underextension: Restricting the use of a word to only a few, rather than to all, members of a class of objects.

telegraphic speech: Short sentences that follow a strict word order and contain only essential content words.

overregularization: The act of inappropriately applying the grammatical rules for forming plurals and past tenses to irregular nouns and verbs.

The Nativist Position

A very different theory was proposed by Noam Chomsky (1957), who believes that language ability is largely innate. Chomsky (1968) maintains that the brain contains a language acquisition device (LAD), which enables children to acquire language and discover the rules of grammar. This mechanism predisposes children to acquire language easily and naturally. Language develops in stages that occur in a fixed order and appear at about the same time in most normal children—babbling at about six months, the one-word stage at about one year, and the two-word stage at 18 to 20 months. Deaf children exposed to sign language from birth proceed along the same schedule (Meier, 1991; Petitto & Marentette, 1991). Lenneberg (1967) believes that biological maturation underlies language development in much the same way that it underlies physical and motor development.

Very young infants do seem to have an innate mechanism that allows them to perceive and differentiate phonemes present in any language (Eimas, 1985). But by the end of the first year, their power to distinguish between speech sounds that do not differentiate words in their own language is greatly reduced (Kuhl et al., 1992). This is why adults whose native tongue is Japanese have so much difficulty discriminating between the *r* and *l* sounds in English.

The nativist position accounts more convincingly than does the learning theory for the fact that children throughout the world go through the same basic stages in language development. It can account, too, for the similarity in errors that they make when they are first learning to form plurals, past tenses, and negatives—errors not acquired through imitation or reinforcement. There remain, however, aspects of language development that the nativist position cannot explain.

Having More Than One Language

Many countries in the world, including Canada, have more than one official language (Snow, 1993). Even within countries that formally acknowledge only one official language, considerable variation exists in the languages that are spoken by the inhabitants. The diversity in language can be attributed to many variables, such as immigration, restoration of traditional or native languages, and the introduction of technological advances that have made communication outside one's own land commonplace. In some cases, these changes have made the acquisition of a second language necessary, and in other cases, they have made it desirable or at least noteworthy. Read about Canada's experience with bilingualism in *It Happened in Canada*.

Psychological interests in second language acquisition range from psycholinguistic concerns (that is, structures of language) to social issues. One important concern that affects the study of language acquisition is the age of onset. Learners can acquire a second language at any time in their lifetime and for the most part it can be achieved by almost all learners (e.g., Humes-Bartlo, 1989). A second language can be learned either simultaneously with the first language or at a later time. A learner who is fluent in two languages is considered *bilingual*; a learner who is fluent in many languages is called *multilingual.* Many learners, however, are often more skilled in one language than in others. Children raised in multilingual homes, who have consistent and equivalent access to each language, tend to follow the same steps in language development as monolingual children. It is important to note that the data do not support the myth that fluency in a second language is possible only if learn-

Remember It!

Language Acquisition

1. Which aspect of language acquisition is learning theory *not* able to explain?
   a. how reinforcement is used to encourage language
   b. why children are able to generate sentences they have not heard or used before
   c. why children imitate adults and other children in their speech
   d. why children overgeneralize the concepts expressed in words
2. Which explanation best accounts for the early stages of babbling and telegraphic speech?
   a. reinforcement
   b. imitation
   c. cognitive mapping
   d. the nativist position

Answers: 1. d 2. d

ers are introduced to that second language at a very early age (e.g., Genessee, 1978). Learning a second language later in life requires motivation, a positive attitude, and effort and opportunity to practise the language (e.g., Gardner & Lysynchuk, 1990; Hakuta, 1987; Shulz, 1991).

Acquiring a second language can result in a number of benefits, such as higher scores on aptitude and math tests (Lambert et al., 1993) and reducing ethnocentricity. Canadian research by Lambert, Tucker, and d'Anglejan (1973) suggests that people who have learned a second language tend to hold more positive opinions about the second language group, and are less likely to favour their own language group than are their monolingual counterparts. By comparison, people who can speak only one language are more likely to be intolerant of other linguistic groups (Guimond & Palmer, 1993). Therefore, second-language learning may be an important mediator for enhancing both social perceptions and intellectual ability.

To maximize second language learning we have to be sensitive to the prevalence of the languages that are to be learned. In some cases when a minority language is presented in tandem with a majority language, the minority language is poorly acquired. This phenomenon is called *subtractive bilingualism* because one language detracts from the acquisition of the other and, overall, there is less learned. Researchers suggest that one way to circumvent this problem is to provide early instruction in the minority language (Wright et al., 2000). For example, when Inuit children were provided early instruction in their heritage language (Inuktitut) and maintained that instruction over three years, their heritage language and second language skills were stronger than other Inuit children trained in the second language (English or French). Early instruction in the minority heritage language alleviated the problem of subtractive bilingualism.

IT HAPPENED IN CANADA

Bilingualism

In 1985 the Official Languages Act was introduced. It was later repealed and then by 1993 it was amended and accepted. The official Languages Act recognizes and promotes the use of Canada's two official languages. Although the inhabitants of Canada reflect many first languages, the two official languages are English and French. The proportion of people in each province with French or English as a first language varies. English tends to be the predominant language for most provinces. Across Canada, approximately 73.4 percent of the population identify themselves as English speakers and 26.4 percent identify themselves as French speakers (Statistics Canada, 1996).

Since the introduction of the act, government agencies and educators have been trying to enhance bilingualism and understanding of both official languages. At present, most schools offer instruction in the minority language. Two primary forms of instruction are immersion programs and core language programs. Immersion programs typically start in kindergarten or grade six and involve 100 percent exposure early on with some reduction over the years. Core language programs involve taking a language as a subject in school. In the 1997–1998 school year, approximately 317 000 students were enrolled in French immersion programs and two million were enrolled in core French instruction (Canadian Parents for French, 2000).

Animal Language

How does language in trained chimpanzees differ from human language?

Humans value their ability to communicate with one another. Nonhuman species also have complex ways of communicating. Our earliest attempt to share communication with non-humans dates back more than 70 years. As early as 1933 researchers attempted to teach chimpanzees to speak by raising the chimps in their homes. These experiments failed because the vocal tract in chimpanzees and the other apes is not adapted to human speech.

Researchers next turned to the American Sign Language system used by deaf people in North America. Allen and Beatrix Gardner (1969) took in a one-year-old chimp they named Washoe and taught her sign language. Washoe learned signs for objects, as well as certain commands and concepts such as "flower," "give me," "come," "open," and "more." Though it took Washoe an entire year to learn only 12 signs, by the end of her fifth year she had mastered about 160 (Fleming, 1974).

Another chimp, Sarah, was taught to use signs by David Premack (1971). Premack developed an artificial language consisting of magnetized, metal-backed

plastic chips of various shapes, sizes, and colours, as shown in Figure 7.6. Premack used operant conditioning techniques. Sarah learned to select the plastic chip representing a fruit (apple, banana, etc.) and place it on a magnetized language board. The trainer would then reward Sarah with the fruit she had requested. Later, to receive the reward, Sarah had to add the name of her trainer, Mary, and select chips that symbolized "Mary apple." Still later, rewards would come only when Sarah identified herself as well, and signalled, "Mary give apple Sarah."

Sarah mastered the concepts of similarities and differences, and eventually her performance in signalling whether two objects were the same or different was close to perfect (Premack & Premack, 1983). She even performed well on part–whole relationships and could match such things as half an apple and a glass half-filled with water. Even more remarkable was that Sarah could view a whole apple and a cut apple and, even though she had not seen the apple being cut, match the apple with the utensil needed to cut it—a knife.

Another chimp, Lana, participated in a computer-controlled language training program. She learned to press keys imprinted with geometric symbols that represented words in an artificial language. Sue Savage-Rumbaugh (1977, 1986) varied the location, colour, and brightness of the keys so that Lana had to learn which symbols to use no matter where they were located. One day her trainer, Tim, had an orange that she wanted. Lana had available symbols for many fruits—apple, banana, and so on—but none for an orange. But there was a coloured symbol for the colour orange, so Lana improvised and signalled, "Tim give apple which is orange." Impressive!

But the most impressive performance to date is that of a rare species of ape known as the pygmy chimpanzee. One pygmy chimp, Kanzi, developed an amazing ability to communicate with his trainers without having formally been taught by them. Researchers worked with Kanzi's mother, Matata, during the mid-1980s, teaching her to press symbols representing words. Her progress was not remarkable, but her infant son, Kanzi, who stood by and observed her during training, learned rapidly (thanks to observational learning). When researchers gave Kanzi a chance at the symbol board, his performance quickly surpassed that of his mother and of every other chimp the researchers had tested.

Kanzi demonstrated an advanced understanding (for chimps) of spoken English and could respond correctly even to new commands, such as "Throw your ball to the river," or "Go to the refrigerator and get out a tomato" (Savage-Rumbaugh, 1990; Savage-

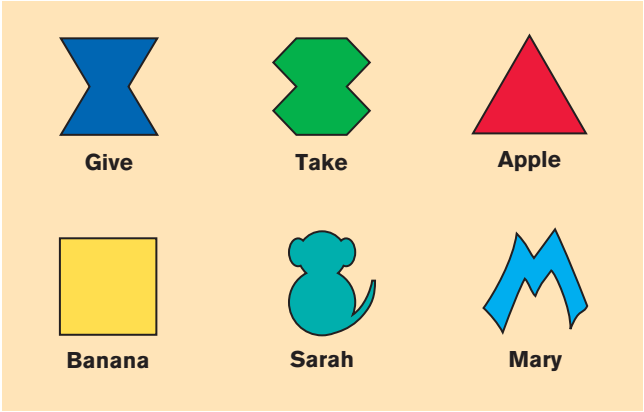


FIGURE 7.6

Sarah's Symbols **A chimpanzee named Sarah learned to communicate using plastic chips of various shapes, sizes, and colours to represent words in an artificial language developed by her trainer, David Premack.**

From their studies of communication among chimps and other animals, researchers have gained useful insights into the nature of language. The pygmy chimp Kanzi is skilled in using a special symbol board to communicate.

Rumbaugh et al., 1992). By the time Kanzi was six years old, a team of researchers who worked with him had recorded more than 13 000 "utterances" and were reporting that he could communicate using some 200 different geometric symbols (Gibbons, 1991). Kanzi could press symbols to ask someone to play chase with him and even to ask two others to play chase while he watched. Furthermore, if Kanzi signalled someone to "chase and hide," it mattered greatly to him that his first command, "chase," be done first (Gibbons, 1991).

On the basis of research with chimps and other animals (especially dolphins), many investigators now believe that language is not necessarily unique to humans (Herman et al., 1993).

Language and Thinking

Does the fact that you speak English or French mean that you reason, think, and perceive your world differently from someone who speaks Spanish, Chinese, or Swahili? According to one hypothesis presented some 45 years ago, it does.

The Linguistic Relativity Hypothesis

What is the linguistic relativity hypothesis, and is it supported by research?

Benjamin Whorf (1956) in his **linguistic relativity hypothesis** suggested that the language a person speaks largely determines the nature of that person's thoughts. According to this hypothesis, our world view is constructed primarily by the words in our language. As proof, Whorf offered his classic example. The languages used by the Inuit have a number of different words for snow: "*apikak*, first snow falling; *aniv*, snow spread out; *pukak*, snow for drinking water," whereas the English-speaking world has but one word, *snow* (Restak, 1988, p. 222). Whorf contended that this rich and varied selection of words for snow provided the Inuit with a different thinking process about snow relative to people whose languages lack specific words for various snow conditions. But do the Inuit perceive snow differently because they have so many words for it? Or do they have so many words for it because they think about and experience snow differently? Whatever language you speak, you can perceive and think about snow according to whether it is falling or on the ground, powdery or slushy, fluffy or packed, without specific words for those conditions.

Eleanor Rosch (1973) tested the linguistic relativity hypothesis. If language determines thinking, she reasoned, then people whose language contains many names for colours will be better at thinking about and discriminating among colours than people whose language has only a few colour names. Her participants for the comparative study were English-speaking Americans and the Dani, a remote New Guinea people whose language has only two names for colours—*mili* for dark, cool colours and *mola* for bright, warm colours. How well would these two groups perform in perceiving, discriminating, and remembering coloured chips of many different hues?

Rosch showed both groups single-colour chips of 11 colours—black, white, red, yellow, green, blue, brown, purple, pink, orange, and grey—for 5 seconds each. After 30 seconds, she had the participants select the 11 colours they had viewed from a larger group of 40 colour chips. If Whorf's hypothesis was accurate, she reasoned, the English speakers would perform with far greater accuracy than the Dani, for whom brown, black, purple, and blue are all *mili*, or dark. But this was not the case. Between the two groups, Rosch found no significant differences in discriminating, remembering, or thinking about the 11 basic colours used in the experiment.

Whorf appeared to go too far in suggesting that language determines how we think. But let us not go too far in the opposite direction and assume that language has little influence on how people think. Language and thought have a mutually supportive relationship.

Sexism in Language

The words we use matter a great deal. Consider the generic use of the pronoun *he* to refer to people in general. If your professor says, "I expect each student in this class to do the best he can," does this announcement mean the same to males and females? Not according to research conducted by Gastil (1990), in which participants read sentences worded in three

linguistic relativity hypothesis: The notion that the language a person speaks largely determines the nature of that person's thoughts.

Try It!

Generic Pronouns and Sexist Language

After reading each of these three sentences, pause and jot down any image that comes to mind.

1. The average Canadian believes he watches too much television.
2. The average Canadian believes he/she watches too much television.
3. Average Canadians believe they watch too much television.

different forms. Use the *Try It!* exercise to see how Gastil's study worked.

The odds are that after reading the first sentence you, like most of Gastil's participants, imagined that the sentence was about a male. Many other studies have confirmed that the generic *he* is interpreted heavily in favour of males (Hamilton, 1988; Henley, 1989; Ng, 1990).

It is important to be aware of the full message in everything we say.

Apply It!

Stimulating Creativity

Creativity is certainly not limited only to "special" people, who are naturally gifted with flair and imagination. Everyone has some potential for creativity. What can you do to become more creative? Psychologists have suggested a variety of techniques for stimulating creativity.

- *"Tune in" to your own creativity and have confidence in it.* The more you develop the habit of thinking of yourself as a creative person and the higher you value creativity as a personal goal, the more likely it is that you will come up with creative ideas and solutions to problems (Hennessey & Amabile, 1988).
- *Challenge yourself to develop your special interests.* Maybe you enjoy cooking or photography? Whatever your creative interest, set small challenges for yourself. Go beyond simply cooking a tasty meal or taking pictures of friends and family. Start inventing new recipes or taking photographs of subjects in original ways. The more you stretch yourself beyond the ordinary, the more creative you will become.
- *Broaden yourself.* The more knowledge and expertise you acquire, the greater potential for creative output you will develop (Epstein, 1996).
- *Change your normal routine.* Have lunch at a different time. Take a new route to school or work. Don't ask yourself why you're making these changes; just do them for the sake of change.
- *Spend more time with creative people.* This will stimulate whatever creativity abilities you might have (Amabile, 1983).
- *Be flexible and open to new possibilities.* Free your thoughts from arbitrary restraints. Learn to avoid mental set, or the failure to consider alternative solutions to common problems.
- *Avoid self-censorship.* Ignore the inner voice that tells you something can't possibly work. Don't be critical of your thoughts or efforts during

Remember It!

Language

1. Match the component (language) with its description.

   ____ 1) the smallest units of meaning

   ____ 2) the meaning derived from phonemes, morphemes

   ____ 3) grammatical rules for arranging and combining words to form phrases and sentences

   ____ 4) the smallest units of sound in a spoken language

   a. syntax
   b. morphemes
   c. semantics
   d. phonemes

2. The linguistic relativity hypothesis is not supported by research. (true/false)

Answers: 1. 1) b 2) c 3) a 4) d 2. true

the early stages of the creative process. Fretting over the correctness of the output inhibits the very process itself (Amabile, 1983).

- *Don't be afraid to make mistakes.* For the creative person, mistakes are valuable learning experiences, not something to be feared and avoided at all costs. In fact, creative people tend to make more mistakes than less imaginative people. Why? Because they make more attempts, try more experiments, and come up with more ideas to be tested (Goleman et al., 1992).
- *Capture your creative thoughts.* Become more attentive to your creative thoughts, and be prepared to preserve them no matter where you might be (Epstein, 1996). Use a notepad, tape recorder, or any other device to capture your good ideas when you get them. It is highly unlikely that they will reappear in the same form at a more convenient time.
- *Relax.* One way to stimulate creative thinking is to relax. Go for a walk, take a long shower, sit in a comfortable chair and daydream, lie on the beach. Relaxing gives the you a chance to play with ideas and combine them in new ways.

In group settings, creativity appears to be fostered by humour. Groups whose members joke, kid around, and laugh easily often have been found to be more creative than groups whose members interact more formally.

Organizations that seek to encourage creativity and innovation should allow employees more leeway in solving problems and more control over performance of their assigned tasks. Moreover, employees should be given sufficient time to allow them to do quality work, should be allowed to work independently where appropriate, and should be free of continuous monitoring.

KEY TERMS

adoption method, p. 225
algorithm, p. 233
babbling, p. 238
behavioural genetics, p. 224
concept, p. 231
creativity, p. 235
culture-fair intelligence test, p. 223
deviation score, p. 219
divergent thinking, p. 235
emotional intelligence, p. 227
exemplars, p. 232
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functional fixedness, p. 234
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validity, p. 220
Wechsler Adult Intelligence Scale (WAIS-R), p. 219
working backward, p. 234

THINKING CRITICALLY

Evaluation

Which of the theories of intelligence best fits your notion of intelligence? Why?

Point/Counterpoint

Prepare an argument supporting each of the following positions:

a. Intelligence tests should be used in the schools.
b. Intelligence tests should not be used in the schools.

Psychology in Your Life

Give several examples of how tools of thinking (imagery and concepts) and problem-solving strategies (algorithms and heuristics) can be applied in your educational and personal life.

SUMMARY & REVIEW

The Nature of Intelligence

What factors underlie intelligence, according to Spearman, Thurstone, and Guilford?

Spearman believed that intelligence is composed of a general ability (*g* factor), which underlies all intellectual functions, and a number of specific abilities (*s* factors). Thurstone points to seven primary mental abilities, which singly or in combination are involved in all intellectual activities. Guilford's model consists of 180 different intellectual abilities that involve all of the possible combinations of the three dimensions of intellect—mental operations, contents, and products.

What types of intelligence did Gardner and Sternberg identify?

Gardner believes that there are seven independent and equally important types of intelligence. Sternberg's triarchic theory of intelligence identifies three: the componential (conventional intelligence), the experiential (creative intelligence), and the contextual (practical intelligence).

Measuring Intelligence

What was Binet's major contribution to psychology?

Binet's major contribution to psychology was the concept of mental age and a method for measuring it—the intelligence test.

What does IQ mean, and how was it originally calculated?

IQ stands for intelligence quotient, an index of intelligence originally derived by dividing a person's mental age by his or her chronological age and then multiplying by 100.

What is the Stanford-Binet Intelligence Scale?

The Stanford-Binet Intelligence Scale is a highly regarded individual intelligence test for those aged 2 to 23. It has been revised several times since Lewis Terman's original, extensive adaptation of the Binet-Simon Intelligence Scale.

What did Wechsler's tests provide that the Stanford-Binet did not?

David Wechsler developed the first successful individual intelligence test for adults, the Wechsler Adult Intelligence Scale (WAIS-R). His tests for adults, children, and preschoolers yield separate verbal and performance (non-verbal) IQ scores as well as an overall IQ score.

What is meant by the terms *reliability, validity,* and *standardization*?

Reliability is the ability of a test to yield nearly the same score each time a person takes the test or an alternative form of the test. Validity is the power of a test to measure what it is intended to measure. Standardization refers to prescribed procedures for administering a test and to established norms that provide a means of evaluating test scores.

What are the ranges of IQ scores that are considered average, superior, and in the range of mental disability?

Fifty percent of North Americans have IQ scores ranging from 90 to 109; 2 percent have scores above 130, considered superior; and 2 percent have scores below 70, in the range of mental disability.

According to the Terman study, how do gifted people differ from the general population?

Terman's longitudinal study revealed that, in general, gifted people enjoy better physical and mental health and are more successful than their less gifted counterparts.

What two criteria must a person meet to be classified as mentally disabled?

To be classified as mentally disabled, one must have an IQ score below 70 and show severe deficiencies in everyday adaptive functioning.

The IQ Controversy: Brainy Dispute

What do intelligence tests predict well?

IQ tests are good predictors of success in school but not good predictors of occupational success among people of the same social class and level of education.

What are some of the abuses of intelligence tests?

Abuses occur when IQ tests are the only criterion for admitting people to educational programs, for tracking children, or for placing people in classes for those with mental disabilities. Many people maintain that IQ tests are biased in favour of the urban middle or upper class.

How does the nature–nurture controversy apply to intelligence?

The nature–nurture controversy is the debate over whether intelligence is primarily the result of heredity or environment.

What is behavioural genetics, and what are the primary methods used in the field today?

Behavioural genetics is the field that investigates the relative effects of heredity and environment on behaviour and ability. The twin study method and the adoption method are the primary methods used.

How do twin studies support the view that intelligence is inherited?

Twin studies provide evidence that intelligence is primarily inherited because identical twins are more alike in intelligence than fraternal twins, even if they have been reared apart.

What kinds of evidence suggest that IQ is changeable rather than fixed?

Several adoption studies have revealed that when infants from disadvantaged environments are adopted by middle- and upper-middle-class parents, their IQ scores are about 15 points higher on average than they would otherwise be expected to be. Furthermore, IQ scores have been rising steadily over the past 50 years in many countries, including the United States and Canada, presumably because of increases in the standard of living and educational opportunities.

What are Jensen's and Herrnstein and Murray's controversial views on race and IQ?

These researchers assert that the black–white IQ gap is due to genetic differences between the races that are too strong to be changed significantly through environmental intervention.

What are the personal components of emotional intelligence?

The personal components are an awareness of and ability to control one's own emotions and the ability to motivate oneself.

What are the interpersonal components of emotional intelligence?

The interpersonal components are empathy and the ability to handle relationships.

Imagery and Concepts: Tools of Thinking

What is imagery?

Imagery is the representation in the mind of a sensory experience—visual, auditory, gustatory, motor, olfactory, or tactile.

What are concepts, and how are they formed?

Concepts are labels that represent classes or groups of objects, people, or events sharing common characteristics or attributes. We can form a concept (1) from a formal definition of the concept, (2) by systematically memorizing features or attributes common to members of a concept (as in formal classification systems), (3) through our experiences with positive and negative instances of the concept, (4) through the use of prototypes, or (5) through the use of exemplars.

Problem Solving and Creativity

What are three problem-solving techniques, and how are they used?

Trial and error is an unsystematic problem-solving technique whereby we try one solution after another until we hit on one that works. An algorithm is a step-by-step procedure that guarantees a solution, such as a mathematical formula or a systematic exploration of every possible solution. A heuristic method does not guarantee success but offers a promising way to solve a problem and arrive at a solution, such as working backward or means–end analysis.

What are the two major impediments to problem solving?

Two major impediments to problem solving are functional fixedness, which is the failure to use familiar objects in novel ways to solve problems, and mental set, which is the tendency to apply familiar problem-solving strategies before carefully considering the special requirements of the problem.

What is creativity, and what tests have been designed to measure it?

Creativity is the ability to produce original, appropriate, and valuable ideas and/or solutions to problems. Two tests used to measure creativity are divergent-thinking tests and the Remote Associates Test.

Language

What are the four important components of language?

The four important components of language are (1) phonemes, the smallest units of sound in a spoken language; (2) morphemes, the smallest units of meaning; (3) syntax, grammatical rules for arranging and combining words to form phrases and sentences; and (4) semantics, the meanings derived from phonemes, morphemes, and sentences.

How do learning theory and the nativist position explain the acquisition of language?

Learning theory focuses on external information that is provided by parents, friends, media, and so on, as sources of information from which we develop our knowledge of language. Nativists believe that the mechanisms for acquiring language are innate.

How does language in trained chimpanzees differ from human language?

Chimpanzees do not have a vocal tract adapted to speech, and their communication using sign language or symbols consists of constructions strung together rather than sentences.

What is the linguistic relativity hypothesis, and is it supported by research?

The linguistic relativity hypothesis suggests that the language a person speaks largely determines the nature of the person's thoughts, but this theory has not been supported by research.