CHAPTER 1

What Is a Gifted Brain?

Ask 50 people what is meant by giftedness and you will likely get 50 different definitions. And that becomes a major problem when deciding who is gifted. Nonetheless, some common elements will emerge from most of the descriptions. These might include describing a person's aptitude in a specific subject area or a talent in the visual or performing arts, or in sports. Also mentioned might be creativity, inventiveness, or just plain "intelligent in everything." Descriptions of giftedness also vary from one culture to another. For example, in a culture with no formal schooling, a skilled hunter might be the gifted one. Gifted abilities are also more likely to emerge when the individual's talents coincide with what is valued by the culture. Chess prodigies, for example, appear in cultures where such talent is valued and nurtured. So it can be said that giftedness is what others in a society perceive to be higher or lower on some culturally embedded scale.

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Even researchers in gifted education have a difficult time agreeing on what giftedness means. But they do agree on one thing: Giftedness derives from a well above average level of intelligence in one or more observable behaviors. So before we can understand what makes a person gifted, we have to take a closer look at what modern research has discovered about intelligence.

UNDERSTANDING INTELLIGENCE

Have We Found the Genes for Intelligence?

An obvious starting point in the search to understand intelligence is our genes. Impressive advances in methods for scanning our genetic makeup have inspired scientists to hunt for the specific gene or genes that can be linked to native intelligence. Imaging technologies that probe the workings of the brain are also valuable tools in this search because they may reveal the brain components that account for the differences in intelligence among individuals. The environment also plays an important role because some genes express their traits only when provoked by environmental influences.

Researchers often use studies of identical twins raised together and apart to explore whether certain traits are the result of genetics or the environment. Results of twin studies conducted over the past two decades have convinced some scientists that genes play a crucial role in intelligence but they do not act alone. So far, the hunt for specific genes related to intelligence has been disappointing. Comparing the DNA of highly intelligent people with each other and with the DNA of people with low and average intelligence can reveal patterns, called markers, which help identify neighboring genes. But tests have so far shown that these genes account for only a small variation in intelligence (Plomin & DeFries, 1998).

Gene Effects in Poor Children: Another factor is the discovery of expressive genes—those which express their traits when provoked by the environment. The same gene can have different effects in different environments. The environment seems to have a particularly powerful influence on genes related to intelligence in poor children. Eric Turkheimer and his colleagues at the University of Virginia analyzed the test scores of more than 300 sets of twins aged 7 years (Turkheimer, Haley, Waldron, D'Onofrio, & Gottesman, 2003). The study included a high portion of twins from racial minorities and impoverished families. Remarkably, the researchers found that the strength of the genes effect depended on the socioeconomic status of the family (as measured in part by family income and education level of the parents). About 60 percent of the variance in IQ could be accounted for by genes in the children from affluent families. But for children from impoverished families, genes accounted for almost none.

A similar study was conducted four years later. Here the researchers looked at how 839 sets of twins scored on the Merit Scholarship Qualifying Test in 1962, when most of them were 17 years old. Once again, genes played only a small role in the variance of scores among poor children, but played a far stronger role in the variance of scores among affluent children (Harden, Turkheimer, & Loehlin, 2007).

> The environment of poverty may exert powerful forces that suppress the genes associated with differences in intelligence from expressing themselves.

What is going on here? The researchers suggest that an impoverished environment includes powerful forces that shape intelligence from the womb through school and beyond, thereby suppressing the genes associated with differences in intelligence from expressing themselves. On the other hand, in children growing up in the relative stability of affluent families, gene-based differences are more likely to emerge (Zimmer, 2008). For example, if a child in an affluent home shows an interest in science, the parent is likely to get the child a book on science and a science kit. So reading about science and experimenting will make this child different from one in an impoverished home whose interest in science will likely go unnoticed or unfulfilled. The results from both of these studies ought to raise concerns over how much schools and communities are doing to address the plight of children in impoverished homes. Although there is some evidence that gene variations play a role in intelligence, their effect is small. The prevailing theory now is that there are many genes, each with a small effect, that together produce the full range of variation in intelligence. And their effects can be moderated by the environment. But finding those genes may take a long time. One thing seems certain: Genetic research demonstrates that intelligence levels can be inherited, but the idea that we are born with a few genes that set forever how intelligent a person is going to be is flawed (Zimmer, 2008). Furthermore, the debate over nature (genes) *versus* nurture (environment) is drawing to a close. Nature *and* nurture work together.

Is Brain Structure Related to Intelligence?

Another avenue of research has looked at changes in brain structure among individuals of different intelligence. Neuroscientists have long thought that intelligence is related to some aspects of brain structure. However, the way certain parts of the brain develop over time may be a much better predictor. Shaw and his colleagues (2006) have analyzed scans of developing brains. To control for individual variation, the researchers followed more than 300 children, ages 5 to 19, as they grew up over a period of 10 years. Most children were scanned two or more times, generally at two-year intervals. The scans were separated into three groups based on IQ test scores: superior (121–145), high (109–120), and average (83–108).

Shaw et al.'s (2006) attention was focused on the development of the cortex, a thin layer on the surface of the brain where most sophisticated information processing occurs. This part of the brain continues to grow and change in structure until about the age of 22 to 24 years. In all children, the cortex gets thicker as neurons grow and produce branches called *dendrites.* Then a pruning process begins to trim away underused dendrites and neurons. As a result, the cortex gets thinner and the brain becomes more efficient in the teen years.

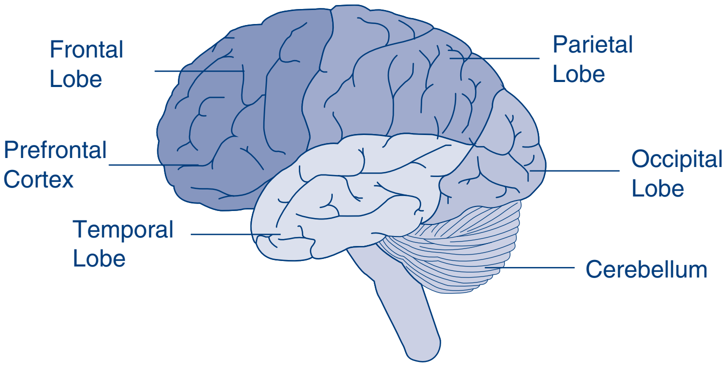

Figure 1.1 The major areas of the brain.

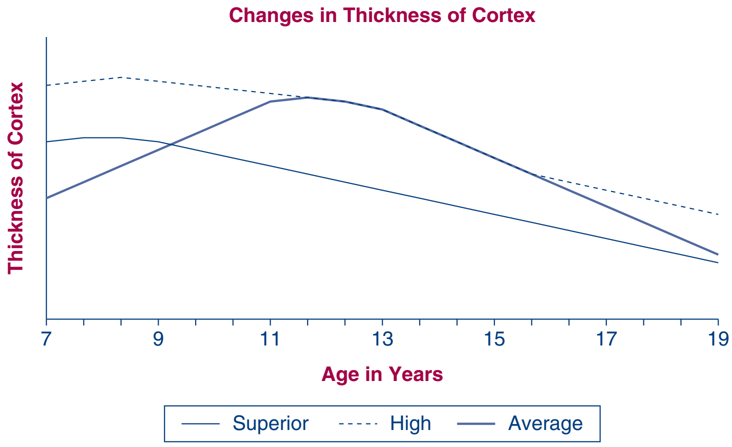

Figure 1.2 Changes in the thickness of the brain's cortex between the ages of 7 and 19 in individuals of superior, high, and average intelligence.

Source: Adapted from Shaw et al., 2006.

The researchers discovered that the thickening and thinning processes varied among children with different levels of intelligence. Variations were particularly noticeable in the *prefrontal cortex*. This is the seat of abstract reasoning, planning, and decision-making, located just behind the forehead (Figure 1.1). The seven-year-olds in the superior group started out with a thinner cortex that thickened rapidly until age 11 or 12 before thinning. But in the same-age group of average intelligence, the cortex started out thicker but peaked by age 8, followed by gradual thinning. Those in the high intelligence group had a similar trajectory to the average group but with a thicker cortex (Figure 1.2). Although the cortex thinned out for all groups, the superior group showed the greatest rate of change. Children with average intelligence had a similar pattern but the changes were slower. In Shaw et al.'s (2006) words, "The most agile minds had the most agile cortex" (p. 678).

Implications: So what does it mean? The findings suggest that IQ is related—at least in part—to how the cortex matures. Perhaps the prolonged thickening process of the prefrontal cortex in children with superior IQ reflects an extended critical period for the development of high-level cognitive circuits. Thus, intelligence is not related so much to the size of the cortex, but to the dynamics of how it develops.

No one is sure what underlies the changes in cortical thickness. One theory is that the rapid thickening and thinning seen in the superior IQ group may indicate greater neural plasticity—the changes that occur in the brain as a result of experience. Having a high degree of neural plasticity may enable individuals to adapt better to the demands of their environment and may also be an indication of possessing a superior IQ (Garlick, 2002).

Richard Haier and his colleagues (2004) found a similar pattern in studies of adult brains. They gave IQ tests to 47 volunteers. The IQ scores, which ranged from 90 to 155, were then correlated with brain scans that look at volume of matter at different brain regions. People with high intelligence scores tended to have certain regions of the cortex that were larger than average (Haier, Jung, Yeo, Head, & Alkire, 2004). Furthermore, these

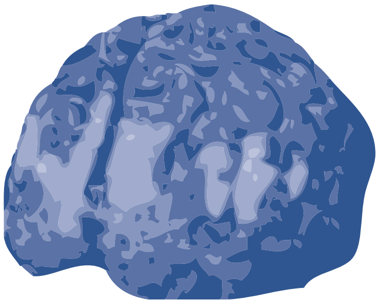

Figure 1.3 This front view of the brain shows the regions that some researchers believe are strongly associated with intelligence. They include the frontal and parietal lobes.

Source: Adapted from Haier et al., 2004.

regions were not limited to the frontal lobe where most scientists have long identified as the seat of intelligence. Rather, other brain regions located in the parietal lobe were also involved. Figure 1.3 shows a front view of the brain. The shaded areas represent those regions in the frontal and parietal lobes where larger mass correlated with higher intelligence. Shaw et al. (2006) suspect that some of the patterns will turn out to be the result of environmental influences, especially since neuron development is occurring at a rapid pace during the teenage and early adult years. But nature also plays a role. Studies show these brain regions to be the same size in identical twins, indicating that genes are also responsible for some of the differences in intelligence.

There are important implications here. If further research supports the theory that the environment is a principal factor affecting early cortical development, then we need to re-examine closely what schools do in the primary and intermediate grades. We must assess whether the learning environment is truly challenging and creative for all students. Of course, this should be the goal of all schools regardless, but the research implies that school experiences for this age group may have a significant impact on an individual's eventual level of intelligence. That bears repeating: What happens in classrooms may actually raise or lower a student's IQ—maybe even the teacher's!

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Where in the Brain Is Intelligence Located?

One of the long-standing mysteries of science: Where in the brain lies intelligence? As mentioned earlier, scientists for a long time thought that the seat of intelligence lay in the frontal lobe (Figure 1.1). But in the study of adult brain structure mentioned earlier (Haier et al., 2004), the scans showed that intelligence was correlated with greater volumes of gray matter (cortex) in regions of the frontal and parietal lobes (Figure 1.3). These findings prompted Haier et al. to review other similar studies to determine whether there was any consistency among the areas correlated to intelligence.

The Parieto-Frontal Integration (P-FIT) Theory: After reviewing 37 imaging studies related to intelligence, including their own, Haier and Rex Jung of the University of New Mexico claimed to have identified a brain network related to intelligence (Jung & Haier, 2007). They found surprising consistency among the studies they reviewed even though the studies represented a variety of research approaches. It seems the brain areas related to intelligence are the same areas related to attention and memory as well as to more complex functions, such as language and sensory processing. This integration of cognitive functions suggests that intelligence levels might be based on how efficiently the frontal-parietal networks process information (Figure 1.3).

Information moves throughout the brain in the white matter located just below the cortex's gray matter. Think of the white matter as the wiring that connects distant areas of the brain to one another. Jung and Haier (2007) found that individuals with high intelligence tend to have tracts of white matter that are more organized than other individuals. High intelligence requires processing power and speed. The larger cortical areas provide it the processing power while the well-organized white matter gives it the speed. In this model individual differences in intelligence depend, in part, upon individual differences in specific areas of the brain and in the

> One theory suggests that high intelligence requires a lot of processing power and speed.

connections between them. Of course, one person may have higher processing power but lower speed, another the opposite, and others all the combinations in between. So you may have two people of equal intelligence, but their brains are arriving at that behavior in different ways. The model, dubbed the Parieto-Frontal Integration (P-FIT) Theory of Intelligence, provides a framework for future research.

THEORIES OF INTELLIGENCE AND GIFTEDNESS

Are you intelligent? Are you gifted? How do you know? Compared to whom? How could you tell if someone is more intelligent than you? And what about your students or your own children? How can you spot the highly intelligent or gifted ones? These sensitive questions have plagued researchers and educators for a long time. Yet to this day we still have no universally accepted definitions or measures of intelligence and giftedness. But many theories abound. What follows is a brief overview of why our understanding of giftedness went beyond IQ tests as well as some of the more predominant theories of what constitutes intelligent and gifted behavior.

Limited Value of IQ Tests

In the 1950s, researchers and psychologists described giftedness mainly in terms of intelligence: high IQ was the same as gifted. Creativity and motivation were soon added as other characteristics of gifted performers. Consequently, as the push in schools for special programs for gifted students got underway, IQ tests became the primary screening vehicle for program selection. But IQ tests had their own problems. They assessed analytical and verbal skills but failed to measure practical knowledge and creativity, components critical to problem solving and success in life. Some psychologists complained that because many IQ test items had a cultural and socioeconomic bias, students from minority or poor families were destined to get lower scores. It eventually became apparent that IQ tests were not a satisfactory measure of giftedness and that people could be gifted in different ways, such as in academic areas, sports, performing arts, or in business ventures. As early as 1951, researchers realized that IQ tests did not measure these capabilities (Lally & LaBrant, 1951).

Very few people are gifted in all areas. Paradoxically, some people can be gifted in some aspects of learning while displaying learning disorders in others (see Chapter 4). Clearly, relying on only one quantitative criterion (the IQ score) and maybe two qualitative criteria (creativity and motivation) was not adequate in the process of describing the collective and varied characteristics of gifted and talented people. More expansive theories of giftedness were needed.

Renzulli's Definition of Giftedness

In an effort to challenge the notion that *giftedness* meant demonstrating high performance in nearly all areas of intellectual and artistic pursuit, Joseph Renzulli (1978) proposed his own definition. He suggested that giftedness resulted from the interaction of the following three traits:

- *General abilities* (processing information, integrating experiences, and abstract thinking) or specific abilities (the capacity to acquire knowledge and to perform in an activity) that were above average
- *Commitment to task* (perseverance, hard work, endurance, perceptiveness, self-confidence, and a special fascination with a specific subject)
- *Creativity* (flexibility, fluency, originality of thought, sensitivity to stimulations, openness to experiences, and a willingness to take risks)

He named this the Three-Ring Conception of Giftedness (Figure 1.4). A few years later, he distinguished the following two types of gifted performance (Renzulli, 1986):

- *Schoolhouse giftedness,* which is characterized by the ease of acquiring knowledge and taking tests as demonstrated through high grades and high test scores. It is the type most often used for selecting students into special programs for the gifted.
- *Creative-productive giftedness,* which involves creating new products and ideas designed to have an impact on a specific audience or field.

Renzulli's position was that creative-productive giftedness was often overlooked in schools that relied primarily on traditional tests of aptitude, intelligence, and achievement. His work stimulated school districts to include more opportunities for creative expression in their programs for gifted students.

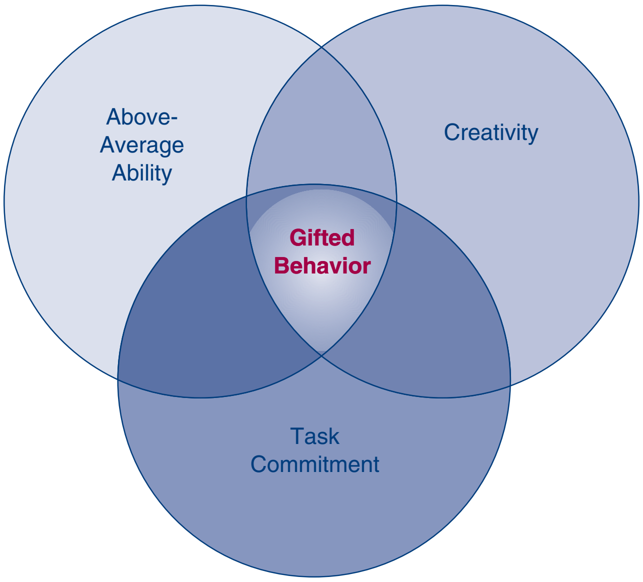

Figure 1.4 Renzulli's Three-Ring Conception of Giftedness. In this model, gifted behavior results from the interaction of above-average abilities, creativity, and task commitment.

Source: Renzulli, 1978.

Brain Research Support for Renzulli's Model: Most of the traits that comprise the Renzulli model are behaviors not easily associated with any specific brain region. The complex qualities included in general abilities, such as processing information, integrating experiences, and abstract thinking, all require input from the frontal lobe, parts of the emotional system (called the limbic area), and other regions as well. Commitment to task is often rooted in intrinsic motivation (the desire to do something because one enjoys doing it). Brain studies do confirm that motivated subjects rely heavily on elements in the limbic area to sustain interest and maintain attention. Creativity shows more promise. Recent imaging studies suggest that certain brain areas are highly activated when an individual is involved in creative work. Creativity is discussed in more detail in Chapter 2.

Gardner's Multiple Intelligences

During the 1980s, psychologists unleashed new and different models to describe intelligence. Harvard researcher Howard Gardner (1983) published a significant book suggesting that intelligence is not a unitary concept, that humans possess at least seven intelligences, and that an individual is predisposed to developing each of the intelligences to different levels of competence. The seven intelligences are *bodily-kinesthetic, logical/mathematical, musical/rhythmic, verbal/linguistic, visual/spatial, interpersonal,* and *intrapersonal.* (A few years later he added the *naturalist* intelligence, and most recently he proposed the *spiritualist* and *emotionalist* intelligences.) Figure 1.5 takes a closer look at eight of the intelligences and some of their relevant behaviors as described and revised by Gardner (1993). The diagram does not include the *spiritualist* and *emotionalist* because there has not been sufficient time to study and explore their characteristics and educational implications.

For Gardner, the intelligences represented ways of processing information and of thinking. He also suggested that the intelligences are the product of the interaction between genetic predisposition and the environment, a sort of nature-nurture combination that is not a question of either–or, but both–and. He selected an intelligence if it met the following eight criteria:

- Potential isolation by brain damage
- Existence of savants, prodigies, and other exceptional individuals
- An identifiable core operation or set of core operations
- A distinctive developmental history, along with a definable set of expert "end-state" performances
- An evolutionary history and evolutionary plausibility
- Support from experimental psychological tasks
- Support from psychometric findings
- Susceptibility to encoding in a symbol system

According to Gardner, the intelligences are not the same as thinking style, which tends to remain consistent and independent of the type of information being processed. Rather, individuals at any given time use those intelligences that will allow them to solve specific problems, generate new problems, or create products or services of value to their particular culture. As the information and tasks change, other intelligences are called into action. One of Gardner's legacies is the oft-quoted

> In Gardner's schema, giftedness can be defined as an individual being exceptionally competent in one or more of the intelligences.

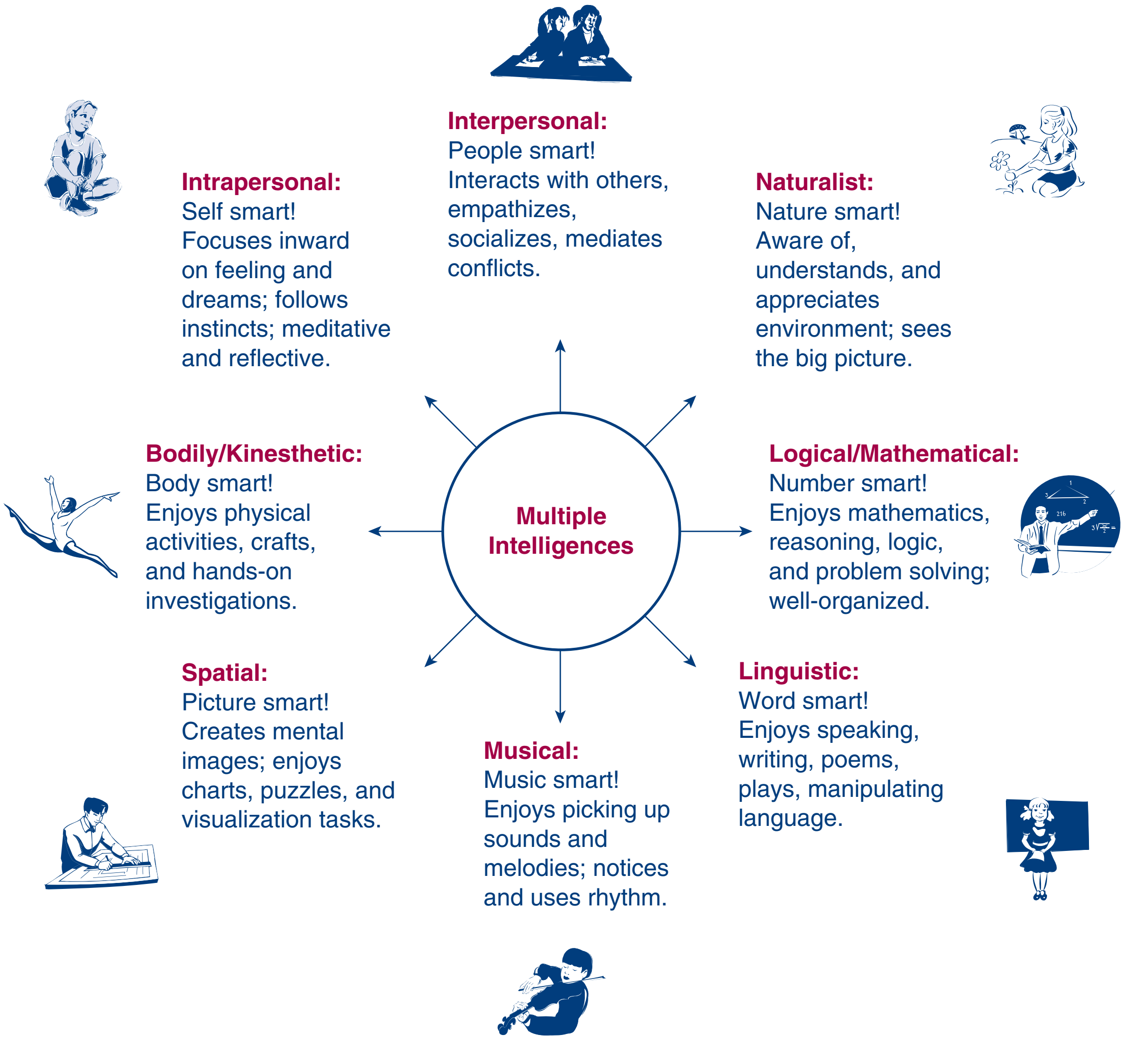

Figure 1.5 The eight intelligences describe the different types of competencies that we all possess in varying degrees and that we use in our daily lives.

Source: Adapted from Gardner, 1993.

aphorism, "Ask not how smart is the child, but how is the child smart?" Nevertheless, in this schema, *giftedness* can be defined as a individual being exceptionally competent in one or more of Gardner's intelligences.

In the 20-plus years since Howard Gardner proposed his theory of multiple intelligences, educators have been developing activities to apply his ideas to classroom practice.

Brain Research Support for Gardner's Model: You may be surprised to learn that there is little physical evidence from neuroscience to support Gardner's theory. About the best neuroscientists can say is that scanning studies show that different parts of the brain are used to perform certain tasks associated with Gardner's intelligences. For example, language processing is largely devoted to the left frontal lobe, while many visual-spatial operations are generally located in the right parietal lobe. Creating and processing music involves the temporal lobes, and running and dancing are controlled mainly by the motor cortex and cerebellum (Figure 1.1). Some theorists suggest that Gardner's model is simply a taxonomy of intellectual pursuits based on judgments that lack scientific support and ignore the notion and contribution of general intelligence (White & Breen, 1998).

Of course, there is plenty of anecdotal evidence to indicate different degrees and types of intelligences, as any veteran teacher will confirm. We encounter, for example, the star athlete (high bodily-kinesthetic) who can hardly write a complete sentence (low linguistic), or the mathematics whiz (high logical-mathematical) who rarely communicates with classmates (low interpersonal). Classroom observations and studies have shown that more students are likely to be motivated and succeed in classes where teachers use a variety of activities designed to appeal to students whose strengths lie in one or more of the intelligences described by Gardner (Shearer, 2004). However, it is important to remember that these intelligences describe the different types of competencies that we all possess in varying degrees and that we use in our daily lives.

Using Multiple Intelligences Theory With the Gifted

Multiple intelligences (MI) theory has been used in school systems all over the world to promote all sorts of curricular and instructional changes. Several curricular programs are almost exclusively based on MI. In his writings, Gardner (1983) has suggested that traditional measures for identifying gifted students rely too heavily on IQ tests that focus on linguistic and logical/mathematical skills. Consequently, schools are increasingly resorting to MI as an alternative means of identifying gifted students. However, the problem with this approach is deciding how to develop instruments that can measure each of the intelligences with reliability and validity.

Educators need to be wary of the fad-like nature of some of the MI programs and recognize that, without further research support, they cannot depend on MI as a panacea for gifted education.

Although MI may be theoretically useful in identifying gifted and talented children, especially those from culturally diverse backgrounds, more empirical data are needed to help develop reliable measures for the identification process. Educators need to be wary of the fad-like nature of some of the MI programs and recognize that, without further research support, they cannot depend on MI as a panacea for gifted education.

Gardner himself has decried some of the misinterpretations and confusion surrounding his theory, including among educators of the gifted. He maintains that too many educators still hold that someone who is gifted scholastically will be very good at other things. It is this unitary notion of intelligence that his theory was designed to demolish, and yet after 20 years it still persists (Henshon, 2006).

Whether scientists will eventually discover the underlying neurological networks that comprise different intelligences remains to be seen. In the meantime, Gardner's theory can still be beneficial because it reminds teachers that students have different strengths and weaknesses, different interests, and that they learn in different ways. By using Gardner's ideas, teachers are likely to address the needs of a wider range of students, including the gifted.

Sternberg's Theories

The Triarchic Theory: Two years after Gardner's work appeared, Robert Sternberg (1985) at Yale proposed a theory that distinguishes three types of intelligence: analytical, creative, and practical. People with analytical intelligence (the analyzers) have abilities in analyzing, critiquing, and evaluating. Those who are creatively intelligent (the creators) are particularly good at discovering, inventing, and creating. By contrast, the practically intelligent (the practitioners) excel at applying, utilizing, and implementing. In this model, *intelligence* is defined by these three types of behavior, and *giftedness* results from the ability to perform the skills in one or more of these areas with exceptional accuracy and efficiency. According to Sternberg, various combinations of these three areas produce different patterns of giftedness (Figure 1.6). This concept was tested in several studies conducted by Sternberg and his colleagues. Students were assessed for their memory as well as their analytical, creative, and practical achievement. The results showed that those students who were taught in ways that best matched their achievement patterns outperformed those whose method of instruction was not a good fit for their pattern of abilities (Sternberg, Ferrari, Clinkenbeard, & Grigorenko, 1996; Sternberg et al., 2000).

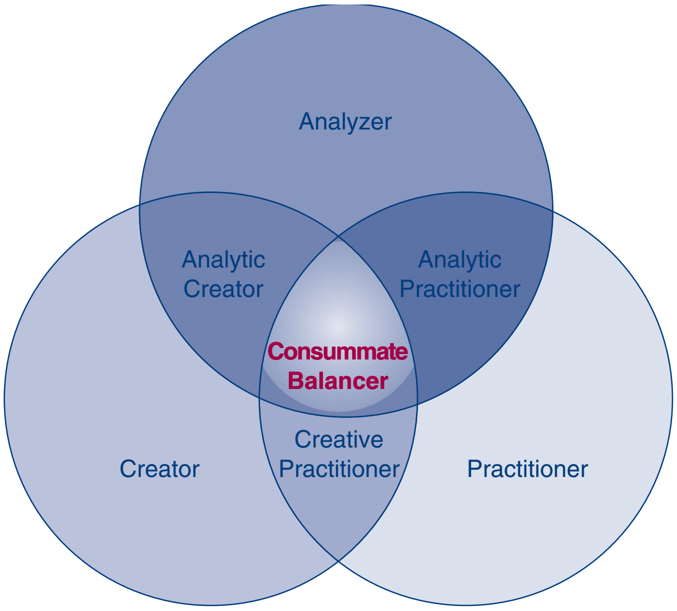

Figure 1.6 In Sternberg's model, the combination of the three types of intelligence produce different patterns of giftedness.

Source: Sternberg, 1985.

The Pentagonal Implicit Theory of Giftedness: Ten years later, Sternberg and Zhang (1995) introduced another theory to describe giftedness. Their goal was to capture in one model most people's intuitions about what makes a person gifted (Figure 1.7). The result stated that a gifted person is one who meets the following five criteria:

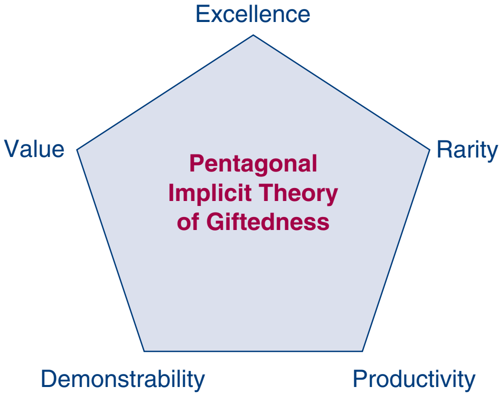

Figure 1.7 A model showing the five criteria comprising Sternberg and Zhang's Implicit Theory of Giftedness.

Source: Sternberg & Zhang, 1995.

- *Excellence.* The individual is superior in some dimension or set of dimensions relative to peers. The term "relative to peers" is important because that is the group against whom one is being judged. For example, a musical performance that would be extraordinary for a 10-year-old taking weekly music lessons, Sternberg notes, might be quite ordinary for another 10-year-old who has been trained at a conservatory since age 4.
- *Rarity.* The individual possesses a skill or attribute that is rare among peers. This criterion supplements the excellence criterion because a person may demonstrate high aptitude in a particular skill. But if that aptitude is not judged to be rare, then the person is not viewed as gifted. For instance, suppose we gave a difficult chemistry test to a group of high school seniors in an advanced chemistry class. Even if they all got perfect or near-perfect scores, we could not say they all were gifted.

- *Productivity.* The individual must produce something in the area of giftedness. It is not sufficient in this model to just get a high score on an intelligence test. The individual must be able to do something so that potential can be translated into productive work.
- *Demonstrability.* The skill or aptitude of giftedness must be demonstrable through one or more valid assessments.
- *Value.* The individual shows superior performance in a dimension that is valued by that person's society.

Sternberg and Zhang's theory helps provide a basis for understanding why we call some people gifted and others not. They caution, however, that although this theory can be helpful in identifying gifted individuals, it should be used in conjunction with other generally accepted assessment measures.

The Theory of Successful Intelligence: In 1997, Sternberg introduced his Theory of Successful Intelligence, which involves using one's intelligence to achieve the goals one sets for oneself in life, within a specific social and cultural context (Sternberg, 1997). Successfully intelligent people recognize their strengths and make the most of them while they recognize their weaknesses and find ways to correct or compensate for them. Both are important. Although students need to learn to correct aspects of their performance in which they are underperforming, they also must recognize that they probably will never be superb at all kinds of performance. It is intelligent to find ways around weaknesses, such as seeking help from others and giving it in return.

> Successful intelligence involves recognizing one's strengths and making the most of them while recognizing one's weaknesses and finding ways to correct them.

Sternberg explains that successfully intelligent people *adapt, shape,* and *select* their environment. For example, a teacher may adapt to the expectations of her principal by teaching in a way she believes the principal will support. Through shaping, individuals change the environment to fit them. In this example, the teacher may try to persuade the principal to support her new way of teaching even though it is different from what the principal has endorsed in the past. An alternative is selection, where individuals find a new environment. Here, the teacher may seek to transfer to another school if she is unable to convince the principal that her way of teaching is valid and will result in benefits for the students. In essence, successful intelligence is a direct extension of Sternberg's Triarchic Theory because these individuals accomplish their goals by finding a balance in their use of analytical, creative, and practical abilities (Sternberg, 1999).

Successful Intelligence in the Classroom. Teaching and assessment should provide a balanced use of the triarchic components of analytical, creative, and practical thinking. In this approach, teachers help students capitalize on their strengths and compensate for their weaknesses. Class work and assessments are largely centered around activities that require analysis, creativity, and application. This variety reaches more of the students' patterns of abilities so they are likely to be intrinsically motivated to succeed in their work. Sternberg suggests that teaching for successful intelligence improves student performance for the following reasons:

- It encourages *deeper* and more *elaborative* memory encoding than traditional teaching, so students learn and remember material in a way that enhances retrieval at test time.
- It encourages more *diverse* forms of encoding material, so there are more retrieval pathways to the material and a greater likelihood of recall.
- It enables students to capitalize on strengths and compensate for weaknesses.
- It is more motivating to both teachers and students.

Studies by Sternberg and others demonstrated that students taught and assessed with this approach, across many subject areas, performed better on assessments than students taught and assessed in conventional ways (Sternberg & Grigorenko, 2004). See specific suggestions on how teachers can use Successful Intelligence in their classrooms in the **Applications** section at the end of this chapter.

Brain Research Support for Sternberg's Theories: Sternberg's theories are also based on complex psychological traits, such as excellence and productivity, which most likely require contributions from many brain areas. To date, no brain studies have isolated the brain regions that appear to be specifically responsible for any of the traits in Sternberg's model. But that admission does not lessen the value of what Sternberg proposes. Although neuroscience has made some remarkable discoveries in recent years, it is still in its infancy. In the meantime, case studies and controlled research projects may still provide evidence that theoretical models, such as Sternberg's and others, when properly implemented, can result in improved student and teacher performance. In the meantime, Sternberg's triarchic model continues to influence decisions regarding instructional approaches that enhance giftedness.

Gagné's View of Giftedness and Talent

For many years in gifted education, the terms "gifted" and "talented" were often used interchangeably, and attempts to differentiate them were only moderately successful. Indeed, some researchers saw no real difference between the two. In the 1980s, Francoys Gagné (1985) of the University of Quebec at Montreal proposed a comprehensive model that made a distinction between the components of giftedness and the nature of talent (Figure 1.8).

Gagné (2003) differentiates between giftedness and talent, proposing that giftedness represents innate abilities in multiple domains, while talent is a skill in a single domain that has been systematically developed. The innate abilities fall into four aptitude domains: *intellectual, creative, socioaffective,* and *sensorimotor.* These aptitudes have a genetic basis and can be readily observed in the tasks that children perform in school.

Talents in this model emerge from a developmental process that transforms aptitudes into the skills that are characteristic of a particular field of human activity or performance. Figure 1.8 shows the many talent fields relevant to school-age youth. The model proposes that abilities and aptitudes are the raw constituents of talent. In other words, talent implies the presence of well above average natural abilities. One cannot be talented without having gifts. However, according to Gagné (2003), the reverse is not true. Some students with well above average natural abilities do not translate these gifts into talents, as evidenced by academic underachievement in intellectually gifted students. You may have encountered some of these students, although many go through school unidentified. We will have an in-depth discussion of them in Chapter 3.

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Translating Aptitude to Talent: Gagné (2003) explains that the process of developing talent occurs when the child or adolescent engages in systematic *learning, training,* and *practicing.* The higher the level of talent sought, the more intensive these three activities will be. This process is helped or hindered by the action of two types of catalysts, *intrapersonal* and *environmental.* Intrapersonal catalysts include *motivation* and *volition,* which play an important role in initiating the process of talent development, guiding it, and sustaining it through obstacles, boredom, and occasional failure. *Temperament* and *adaptive strategies* also contribute significantly to support and stimulate, or slow down and even block, talent development.

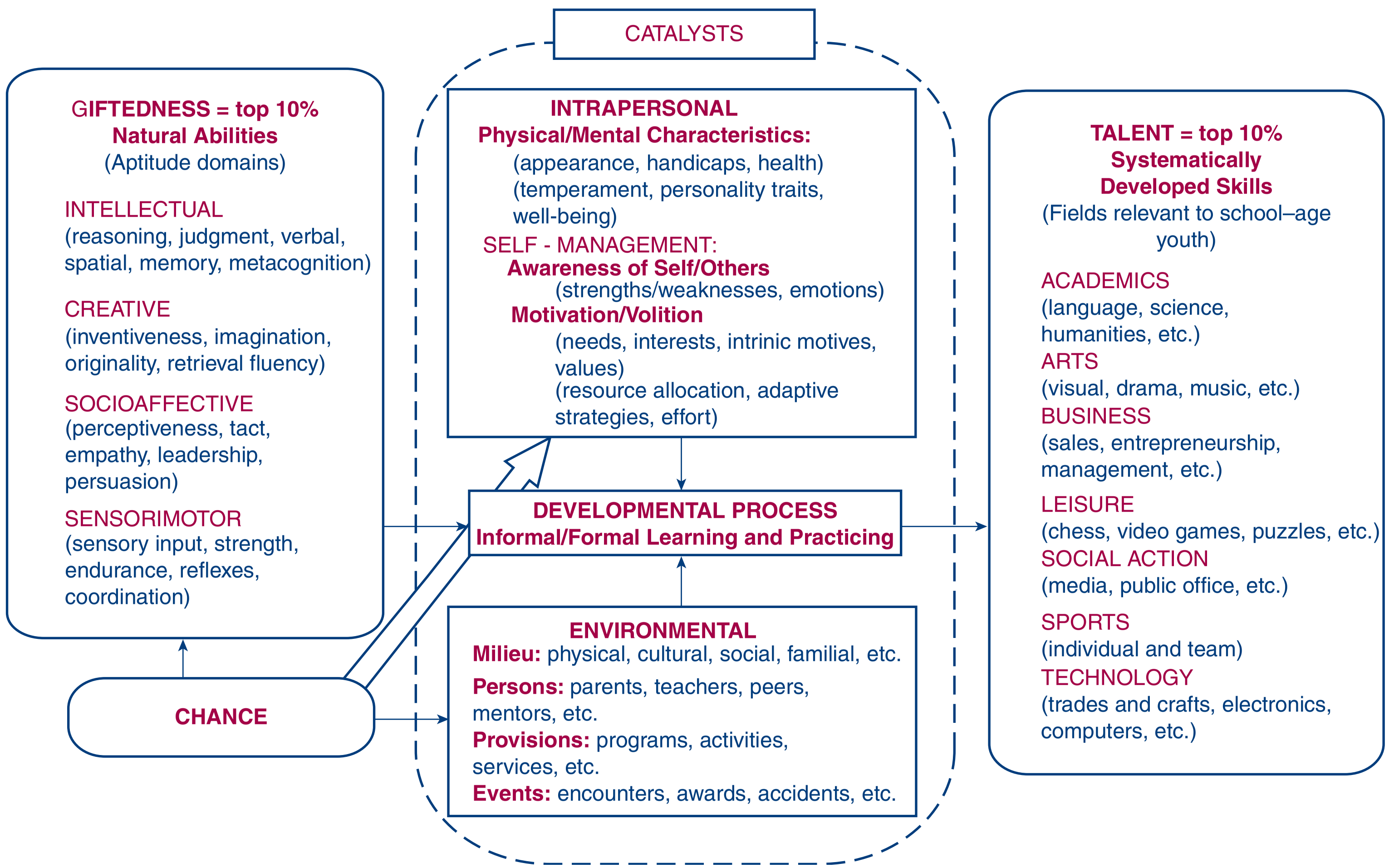

Figure 1.8 Gagné's differentiated model defines giftedness as innate abilities in multiple domains and talent as a systematically developed skill in a single domain.

Source: Adapted from Gagné, 2003.

Environmental catalysts exert their influence in various contexts. Many different *persons*, including parents, teachers, siblings, and peers, may exert positive or negative influences on the process of talent development. Gifted education programs within or outside the school belong to the category of *provisions* because they are a more systematic form of intervention to promote talent development. Finally, significant *events,* such as the death of a parent, winning an award, or suffering a major accident, can significantly influence the course of talent development.

Chance is a causal factor that affects the influence of other elements in the model, as for example, the chance of being born in a particular family, or the chance of the school in which the child is enrolled deciding to develop a program for gifted and talented students. Chance is also a major causal factor in determining genetic inheritance. According to Gagné, the power of chance should not be ignored or given too much weight when assessing one's potential talents (Gagné & Schader, 2006).

Practical Applications of Gagné's Model: Gagné believes that the model is most useful in differentiating giftedness from talent. He maintains that the persistent lack of differentiation has resulted in gifted and talented programs that focus mainly on the academically gifted and provide little or no support for highly talented students. He also suggests that, when properly interpreted, the model suggests the steps that schools and school districts should take to appropriately identify and serve gifted and talented students. See more about Gagné's specific suggestions in Chapter 8.

Brain Research Support for Gagné's Model: Studies in behavioral and cognitive psychology over the past few decades have shown that many of the components associated with Gagné's model contribute to student success in the gifted domains as well as in the various fields of talent (Bouchard & Shepard, 1994; Carroll, 1993; Fingelkurts & Fingelkurts, 2003; Mayer, Salovey, & Caruso, 2000), and are some of the studies that support components of the model. In neuroscience, however, a few studies using scanning technology have looked at how the brain responds when playing challenging games, getting motivated, solving logical and creative problems, and processing sensory input. But it will be a long while before studies in neuroscience can shed some light on how the many components of this model interact to reveal intellectual gifts and how they translate into talents.

Other Theoretical Models

The models we have just examined are among those that are cited most in the literature on gifted education. At least a dozen other models exist, many with common elements running through them. A full discussion of the other models goes beyond the scope of this book, but here is a brief explanation of two more recent models along with the Internet sites where readers can find additional information.

The Munich Model of Giftedness: This model was developed in Germany in the 1980s by Kurt Heller, Christopher Perleth, and Ernst Hany as part of the Munich longitudinal study of giftedness. It is based on the following four interdependent dimensions (Heller, 2004):

- **Talent factors (predictors of giftedness):** intellectual abilities, creative abilities, social competence, practical intelligence, artistic abilities, musicality, and psycho-motor skills
- **Non-cognitive personality characteristics (moderators of giftedness):** coping with stress, achievement motivation, learning and working strategies, test anxiety, and control expectations

- **Environmental conditions (moderators of giftedness):** family learning environment, family climate, quality of instruction, classroom climate, and critical life events
- **Performance areas (criteria for giftedness):** athletics and sports, art (music, painting), computer science, languages, mathematics, natural sciences, social relationships, and technology

A number of similar components can be found in the Munich and Gagné models. However, researchers with the Munich model have developed a series of instruments to measure the components of each of the four dimensions in students.

For more information on the details of the Munich Model of Giftedness, visit the following Web site: www.pabst-publishers.de/psychology-science/3-2004/05.pdf.

The Actiotope Model of Giftedness: In this highly complex and dynamic model, developed by Albert Ziegler, gifts and talent are not personal attributes, but attributions made by scientists. These are based on our assumption that a person is in the position to carry out specific actions in the future. According to Ziegler, gifted behavior is displayed when a person has a wish to do something, the ability to do it, and the awareness that it can be done. Furthermore, the environment must consider this behavior as gifted. Giftedness is a characteristic that *changes* over time within an environmental context and is the result of various interactions between the individual and the environment (Ziegler, 2005).

CHARACTERISTICS OF GIFTEDNESS

Are the Gifted More Excitable?

Are gifted children more sensitive to touch and smell? Do they appear more impulsive? Are they more emotional? Do their imaginations run wild? For a long time, parents and teachers observed certain personality characteristics that were more noticeable in highly gifted children compared to their peers. The work of Polish psychiatrist and psychologist Kazimierz Dabrowski (1902–1980) provides a useful framework for understanding these characteristics. Dabrowski worked in Europe with genius and depravity during the pre–World War II years. After observing how highly gifted people reacted under stress, he developed the notion of *overexcitabilities*, as part of his larger Theory of Positive Disintegration. Dabrowski observed that innate abilities combined with overexcitability predicted an individual's potential for higher level development. Not all gifted people have overexcitabilities, he noted, but there are more gifted people with overexcitabilities than in the general population (Dabrowski, 1964).

Overexcitabilities are innate characteristics that reveal a heightened response to stimuli. They are found more frequently in gifted individuals than in the general population.

Dabrowski's work was introduced to gifted education by his colleague Michael Piechowski in 1979 (Colangelo & Zaffran, 1979). The notion of overexcitabilities has gained popularity in recent years, especially among researchers who look at the social and emotional areas of giftedness. Some researchers also see overexcitabilities as a means for identifying gifted students that is different from the usual standardized tests.

Overexcitabilities: Overexcitabilities (OE) are innate characteristics that reveal a heightened ability to respond to stimuli due to increase sensitivity of the neurons. They are expressed through increased sensitivity, awareness, and intensity, and have an impact on an individual's quality of experiences. Dabrowski identified the five areas of intensity: *psychomotor, sensual, intellectual, imaginational,* and *emotional.* A person may possess one or more of these. Here is a brief description of each of the overexcitabilities (Lind, 2001).

- **Psychomotor overexcitability:** This is a heightened excitability of the neuromuscular system that results in movement for its own sake, surplus of energy demonstrated by rapid speech, enthusiasm, and intense physical activity. When tense, these individuals may talk compulsively, act impulsively, misbehave, display nervous habits (such as tics, nail-biting), show intense drive, and be highly competitive. Although they derive joy from their activity, others may find them overwhelming. At home and at school, these children seem to be constantly on the go and never still. As a result, they have the potential of being misdiagnosed as having attention-deficit hyperactivity disorder (ADHD).
- **Sensual overexcitability:** This is expressed as a heightened and more expansive experience of sensual pleasure or displeasure emanating from sight, smell, touch, taste, and hearing. These individuals have an early and increased appreciation of aesthetic pleasures such as music, language, and art. They may also feel overstimulated or uncomfortable with sensory input. When emotionally tense, some may overeat, go on shopping sprees, or seek the center of attention, while others may withdraw from stimulation. As children, they may find clothing tags, classroom noise, or cafeteria smells so distracting that schoolwork becomes secondary. These children may also become deeply absorbed in a particular piece of art or music to the exclusion of the outside world.
- **Intellectual overexcitability:** This is demonstrated by a need to seek understanding and truth, to gain knowledge, and to analyze and synthesize. These individuals have incredibly active minds, are intensely curious, avid readers, and keen observers. They are able to concentrate, engage in prolonged intellectual activities, and can be tenacious problem solvers. The enjoy elaborate planning, love thinking about thinking, and have excellent visual recall. They may focus on moral thinking, which often translates into strong concerns about moral and ethical issues, such as fairness on the playground, lack of respect for children, or even being concerned about the homeless, AIDS, or war. Sometimes, they appear impatient with others who cannot sustain their intellectual pace. They may be so excited about an idea that they interrupt the class at inappropriate times.
- **Imaginational overexcitability:** This reflects a heightened imagination with rich association of images and impressions, frequent use of metaphor, facility for invention and fantasy, and detailed visualization. These children often mix truth with fiction, and they escape boredom by creating their own private worlds with imaginary companions and dramatizations. They have difficulty paying attention in a classroom focused on teaching a rigid academic curriculum. In that case, they may write stories or draw instead of doing assigned work or participating in class discussions. A novel idea may send them off on an imaginative tangent and distract them from their classroom tasks.
- **Emotional overexcitability:** This is often the first OE to be noticed by parents. It is reflected in intense feelings, extremes of complex emotions, identification with others' feelings, and strong affective expression. It may also include physical responses, such as stomachaches, blushing, or concern with death and depression. These individuals have a remarkable capacity for compassionate and empathetic relationships and demonstrate strong emotional attachments to people, places, and things. They are acutely aware of their own feelings, of their own growth and change, and often carry on inner dialogs and practice self-judgment. Their concern for others, their focus on relationships, and the intensity of their feelings may interfere with everyday tasks like homework or household chores.

Research Studies on Overexcitabilities: A summary of the results of numerous studies conducted over the last two decades supported the application of OEs to gifted persons, especially in the imaginational, intellectual, and emotional OEs (Mendaglio & Tillier, 2006). A recent study of nearly 500 elementary and middle school students found that the OEs showed greater application to gifted students than their typical peers. The results also noted that (1) the power of the application was stronger among elementary students than among middle school students and (2) was stronger in all gifted females than gifted males in every OE except intellectual (Tieso, 2007). A study in Turkey of more than 700 students found the OE scores of highly intelligent, motivated, creative, and leader students in some OE areas were significantly greater than those of their typical peers. No gender differences are found in regard to OEs (Yakmaci-Guzel & Akarsu, 2006). As of this writing, there have been no studies using brain imaging technologies that looked specifically at the nature of Dabrowski's overexcitabilities.

Implications for Schools: Dabrowski's ideas and subsequent studies can help schools in at least the following two ways:

- Valid questionnaires based on the five OEs can be useful tools beyond traditional intelligence tests to identify gifted students. One such questionnaire was developed in 1999 and has shown consistent validity. The instrument is known as the Overexcitability Questionnaire-Two, or OEQ-II, and is available at www.gifteddevelopment.net (Falk, Lind, Miller, Piechowski, & Silverman, 1999).
- By describing the nature of the OEs, teachers and parents gain a better understanding of how to work with highly gifted students who display these OEs. Some strategies are suggested in the **Applications** section at the end of this chapter.

For more information on the details of the Dabrowski and his work, visit the following Web site: www.positivedisintegration.com.

Thinking About Thinking

Some of the research on the characteristics of giftedness has focused on cognition and metacognition. In these studies, researchers observed how students identified as gifted thought through a given problem or situation (cognition), and how they reflected on their thinking throughout the problem-solving experience (metacognition).

Cognitive Strategies: Not surprisingly, the studies on cognitive strategies showed that gifted students acquired information and solved problems faster, better, or at earlier stages than other students, even in the primary grades (Cho & Ahn, 2003; Delcourt, Cornell, & Goldberg, 2007). Some studies showed that higher IQ individuals had more efficient memories, more information-processing strategies, larger and more elaborately organized knowledge bases, and a better ability to solve mathematical problems by employing their own symbolic encoding (Robinson & Clinkenbeard, 1998).

Sternberg has also investigated how different thinking styles in gifted students affect their academic performance (Grigorenko & Sternberg, 1997). The study found that there were no differences in thinking styles among groups of students at different ability levels, and that certain thinking styles contributed significantly to prediction of academic performance. For example, the style that involved analyzing, grading, or comparing things had the highest predictive value. Further, this contribution was independent of the type of instruction the students were given. One other finding of interest was that the gifted students performed best on assessment procedures that closely matched their thinking style. (This last finding corroborates the results of decades of earlier research on different types of student learning styles.) Other studies have found similar results (Rayneri, Gerber, & Wiley, 2006; Zhang & Sternberg, 2006).

Metacognitive Strategies: Research studies in metacognition (i.e., thinking about one's own thinking) have focused around three aspects:

- What do students know about thinking strategies?
- Can they use the strategies?
- Can they monitor their own cognitive processing?

Compared to other students, the studies showed that gifted students knew more about metacognitive strategies and could use them more easily in new contexts. The first edition of this book noted that several studies in the 1990s found that gifted students did not use a *greater variety* of metacognitive strategies than other students, nor did they monitor their strategies any more than the other students (Alexander, Carr, & Schwanenflugel, 1995). However, more recent studies have found that high performing elementary and secondary school students with strong metacognitive skills were aware of them and knew how to use them to successfully complete academic tasks (Coutinho, 2008; Steiner, 2006).

Neuroscientists—or more specifically, cognitive neuroscientists—also think about thinking. In recent years, they have explored what differences in the structure and functions of the gifted brain may allow it to achieve remarkable levels of performance. These researchers use many tools in their investigations. They include imaging technologies, such as PET scans and functional magnetic resonance imaging (fMRI), as well as electroencephalography (EEG) and magnetoencephalography (MEG). The techniques reveal similarities and differences in the function of high-performing brains compared with the brains of students showing no signs of the same kinds of giftedness. One area of particular interest is determining whether there is any difference in how information flows in gifted brains as compared to typical brains.

The Cerebral Hemispheres

Since the work of Roger Sperry in the 1960s, neuroscientists have accepted the notion that the two cerebral hemispheres are not mirror images of each other. That is, they differ structurally, biochemically, and functionally (Sousa, 2006). In most people, for example, the right frontal lobe protrudes over, and is wider than, the left frontal lobe. The left occipital lobe (at the back of the brain) protrudes over, and is wider than, the right occipital lobe. The neurotransmitter norepinephrine is more prevalent in the right hemisphere, while dopamine is more prevalent in the left hemisphere. Estrogen receptors are more prevalent in the right hemisphere than in the left hemisphere.

As for brain functions, more evidence is accumulating that the brain has a much greater degree of specialization than was previously thought. Even so, because of advancements in neuroimaging, the earlier idea that the brain is a set of modular units carrying out specific tasks has yielded to a new model, which holds that moving across the brain's surface results in a gradual transition from one cognitive function to another. Goldberg (2001) refers to this as the "gradiential" view of brain organization. This view does not discard the notion that particular areas of the brain perform specific functions. Rather, it uses recent evidence from neurological studies to suggest a pattern of organization whereby the boundaries between the specific areas are fluid, not fixed. The ability of certain areas of the brain to perform unique functions is known as *lateralization* or *specialization* (Sousa, 2006).

The left hemisphere monitors the areas for speech. It understands the literal interpretation of words, and recognizes words, letters, and numbers written as words. It is analytical, evaluates factual material in a rational way, and detects time and sequence. It also performs simple arithmetic computations. Arousing attention to deal with outside stimuli is another specialty of the left hemisphere. The right hemisphere gathers information more from images than from words, and looks for patterns. It interprets language through context—body language, emotional content, and tone of voice—rather than through literal meanings. It specializes in spatial perception; recognizes places, faces, and objects; and focuses on relational and mathematical operations, such as geometry and trigonometry (Gazzaniga, Ivry, & Mangun, 2002).

Specialization and Learning: The two hemispheres of the brain communicate with each other through a tight bundle of about 200 million nerve cells called the *corpus callosum*. Researchers have been particularly interested in how the specialized functions of each hemisphere affect new learning, and the degree to which they communicate with each other during that process. Early theories held that new learning occurs in the hemisphere mainly responsible for the functions associated with that learning. Thus, the left hemisphere would be largely involved in spoken language acquisition and sequential procedures, and the right side would support the learning of visual images and spatial relationships. These theories were based mainly on the results of tests done with patients who had damage to specific areas of the brain.

More recent research, however, lends credence to an alternative explanation. Goldberg (2001), for example, proposes that hemispheric specialization may center around the differences between novelty and routine. Closer examination of brain-damaged patients shows that those with severe right hemisphere problems experience difficulty in facing new learning situations, but can perform routine, practiced tasks (e.g., language) normally. Conversely, patients with severe left hemisphere damage can create new drawings and think abstractly, but have difficulty with routine operations.

Goldberg's notion gives us a different way of looking at how the brain learns (Figure 1.9). It suggests that upon encountering a novel situation for which the individual has no coping strategy, the right hemisphere is primarily involved and attempts to deal with the situation (Chong et al., 2008). With repeated exposure to similar situations, coping strategies eventually emerge and learning occurs because it results in a change of behavior. In time, and after sufficient repetition, the responses become routine and shift via the corpus callosum to the left hemisphere. The amount of time and the number of situational exposures needed to accomplish this right-to-left hemisphere transition vary widely from one person to the next. But it may be that one component of giftedness is the ability of that person's brain to make the transition in less time and with fewer exposures than average.

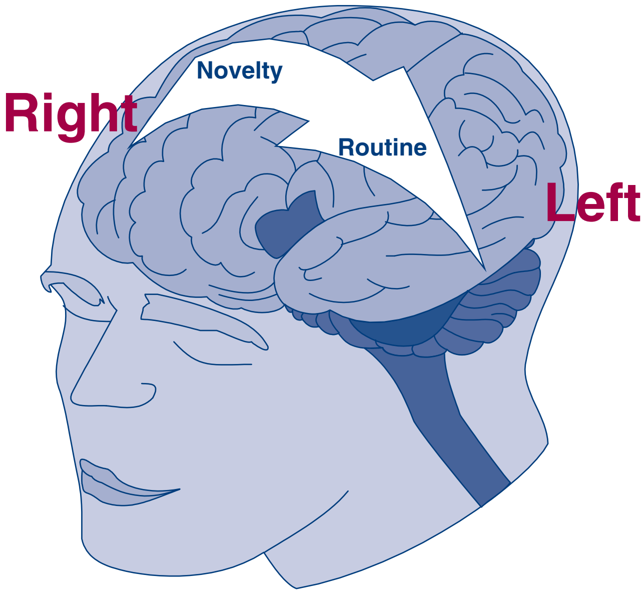

Figure 1.9 With repeated exposures, novel experiences become routine, and their main cortical processing areas shift from the right hemisphere to the left hemisphere.

Studies using neuroimaging provide evidence to support Goldberg's theory. In one major study, researchers used PET scans to measure the changes in brain flow patterns when subjects were asked to learn various types of information. Changes in blood flow levels indicate the degree of neural activation. When the information was novel, regions in the right temporal lobe were highly activated. After the information had been presented several times to the subjects, activity in the right temporal lobe decreased dramatically (Figure 1.10). In both instances, however, the level of activation in the left temporal lobe remained constant (Martin, Wiggs, & Weisberg, 1997).

Similar results were reported from other studies involving a variety of learning tasks, such as recognizing faces and symbols (Cycowisz & Friedman, 2007; Henson, Shallice, & Dolan, 2000; Speer & Curran, 2007), learning a complex motor skill (Shadmehr & Holcomb, 1997; Vogt et al., 2007), and learning and relearning different systems of rules (Berns, Cohen, & Mintun, 1997). The same shifts were detected no matter what type of information was presented to the subjects. In other words, says Goldberg, the association of the right hemisphere with novelty and the left hemisphere with routine appears to be independent of the nature of the information being learned.

One component of giftedness may be the brain's ability to make the transition from novelty to routine in less time and with fewer exposures than average.

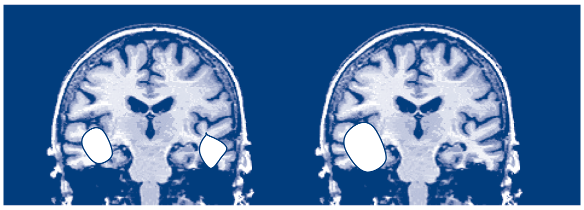

Figure 1.10 In this representation of PET scans, the white areas show the changes in regional blood flow for novel and practiced tasks. The images reveal areas of high activation in the left and right temporal lobes for novel tasks, but only in the left temporal lobe for practiced tasks.

Source: Martin et al., 1997.

The Prefrontal Cortex

Cognitive thought and related activities are located in the foremost part of the frontal lobes, called the *prefrontal cortex.* This area comprises about 29 percent of the total cortex and is interconnected to every distinct functional region (Figure 1.1). Often called the executive control area, the prefrontal cortex is embedded in a rich network of neural pathways so that it can coordinate and integrate the functions of all areas. Like the conductor of an orchestra, the prefrontal cortex blends individual inputs from various regions of the brain into a comprehensive and comprehendible whole. Its interpretations ultimately define personality, and its decision-making abilities determine how successfully an individual copes with each day.

To accomplish this task, the prefrontal cortex must converge the inputs from within an individual with those from the outside world. The brain's organization facilitates this process. As shown in Figure 1.11, sensory signals from the outside environment pass along the sensory nerves to the control center—called the *thalamus*—and are routed to other areas toward the back of the brain (reception). These inputs are then directed to specific sites in the parietal and temporal lobes, as well as in the limbic areas, for further analysis (integration). Finally, the frontal lobes combine this input with information from the individual's memory (interpretation) to determine what subsequent action, if any, should be taken (Bruguier, Preuschoff, Quartz, & Bossaerts, 2008).

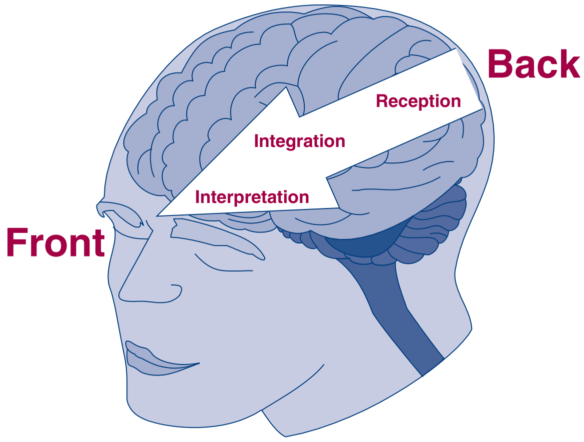

Figure 1.11 Stimuli from the outside world are received toward the rear of the brain, integrated in the center, and interpreted by the frontal lobes. Gifted individuals may be able to do this faster and with greater accuracy than typical individuals.

The prefrontal cortex also seems to be strongly interested in task novelty. Several imaging studies show that when processing new information, cerebral blood flow levels in the frontal lobes reached their highest levels. But when the subject became familiar with the task, frontal lobe involvement—as measured by blood flow—dropped significantly (Goldberg, 2001; Habib, McIntosh, Wheeler, & Tulving, 2003). If a somewhat different task was introduced, frontal lobe activation picked up once again. We noted before that the right hemisphere was more

Gifted individuals may be able to carry out the reception, integration, and interpretation processes with greater speed and accuracy than typical individuals.

associated with novelty than the left. These findings infer that the frontal lobes are more closely aligned with the right hemisphere when dealing with novel learning situations. One can speculate, once again, that gifted individuals may be able to carry out the reception, integration, and interpretation processes with greater speed and accuracy than typical individuals.

Decision Making

The prefrontal cortex faces many decisions in the course of a day. Some involve simple concrete problems, such as the following:

"What is my doctor's telephone number?"

"How much money is left in my savings account?"

"When is my nephew's birthday?"

Each question is clear and the situations require searching for a single, indisputable answer. This process is called *veridical decision making*, or finding the single, true answer.

I may be faced with other questions as well:

"Am I sick enough to see the doctor or should I wait a few days?"

"Should I use some of my savings to buy stocks or bonds?"

"What gift should I get for my nephew's birthday?"

> Veridical decision making gets us through the day. Adaptive decision making gets us through life.

These questions are ambiguous and have no intrinsically unique answer. I will choose the answer for a variety of reasons. My decision to see the doctor might depend on whether my body temperature rises or falls. Buying stocks or bonds might depend on where I think the stock market may be headed in the next year. In any event, my brain is engaging in *adaptive decision making,* that is, I adapt the decision on the basis of context and my priorities at the moment. At another time and place, my decision might be different.

No one doubts that finely tuned veridical decision-making skills are valuable in certain technical occupations. But, life in general is fraught with ambiguities, and most critical decisions—personal and occupational—often require choosing from among equally valid options. Deciding among ambiguities is one of the most important functions of the prefrontal cortex. Studies show that (1) different parts of the brain are engaged, depending on the type of decision-making employed (Johnson et al., 2005); (2) individuals with damage to the prefrontal cortex have difficulty dealing with adaptive decision making, while damage to other parts of the brain does not seem to affect this process (Goldberg, 2001); and (3) drug addiction affects adaptive decision making much more than veridical decision making (Verdejo-García, Vilar-López, Pérez-García, Podell, & Goldberg, 2006).

To be successful, we need to be competent in both types of skills. Veridical decisions help us get through the day: What time do I need to be at work and when is my first appointment? How much gasoline is in the car? Who's picking up the kids after practice? Adaptive decisions, on the other hand, get us through life: Is this the person I should marry? Is this the right job for me? When should we start a family?

Neural Efficiency: When the frontal lobes gain more experience at making adaptive decisions and solving complex problems, the neuron pathways responsible for these processes should become more efficient and thus require less effort. Indeed, this concept—known as *neural efficiency*—has long been part of most theoretical models of the gifted brain. The idea is that gifted brains can perform tasks more quickly and accurately because they contain networks comprising neurons working together in vast arrays and with such efficiency that they require less cerebral energy than unorganized networks. One way to measure the level of brain activity is to monitor the pattern of waves produced by the brain's electrical activity.

Obtaining experimental evidence to support this idea requires using EEG technology to measure the activity of the brain while it was performing different functions. One study of chess players of various levels of intelligence and expertise showed that superior and brighter chess players performed better and with greater neural efficiency than less intelligent and lower expertise players (Grabner, Neubauer, & Stern, 2006).

EEG and fMRI Studies: When using the EEG to detect brain functioning, two wave patterns are of particular interest: alpha waves (8–13 cycles per second) and beta waves (14–60 cycles per second). Neurobiologists theorize that alpha activity is the result of neurons firing together (in synchrony) and resting together—an indication of neural pathway efficiency. Thus, alpha activity produces high voltage, rhythmic, and sinusoidal patterns. The higher the amplitude of the alpha wave (called *alpha power*), the more efficiently the neurons are firing, resulting in less mental effort.

Beta waves, on the other hand, result from the activity of neurons that are doing different things at different times (asynchrony), producing a low voltage, irregular pattern (Figure 1.12). Beatty (2001) offers the analogy of a marching band. When the band members are marching in synchrony, their footsteps are a loud beat with silence between the steps (alpha waves). But as the band members disperse after the march, one hears the constant sound of many steps at random intervals (beta waves).

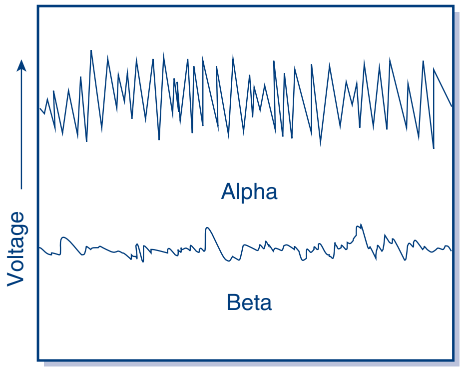

Figure 1.12 Typical activity patterns of alpha and beta brain wave activity.

Norbert Jausovec (2000) used EEG to study the differences in brain activity during problem solving in about 50 young adults who were separated into four groups based on their intelligence (average or high) and creativity (average or high). On the basis of their scores on various assessment measures, Jausovec placed them into the categories of intelligent, gifted, creative, and average (Figure 1.13). He then measured their alpha wave activity as they were solving closed problems (those requiring convergent and logical thinking) and creative problems (those requiring more adaptive decision making). His findings were threefold:

- Alpha wave activity showed that high IQ individuals (gifted and intelligent) used less mental effort than the average IQ individuals (creative and average) when solving closed problems.
- Alpha wave activity showed that high creative individuals (creative and gifted) used less mental effort than average creative individuals (intelligent and average) when engaged in creative problem solving.
- Creative individuals showed more cooperation among brain areas than did gifted ones, who showed greater decoupling (disconnecting from each other) of brain areas when solving ill-defined problems.

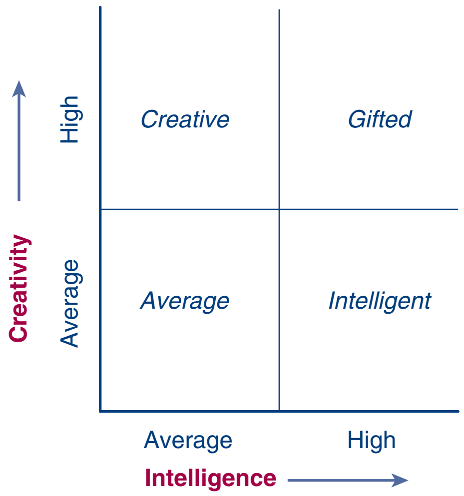

Figure 1.13 Jausovec's system for classifying subjects for the EEG study based on levels of creativity and intelligence.

These results first suggest that when individuals are solving problems in their area of strength, less mental effort is needed so the alpha power is high, an indication of neural efficiency. Second, the results appear to support the concept that creativity and intelligence are

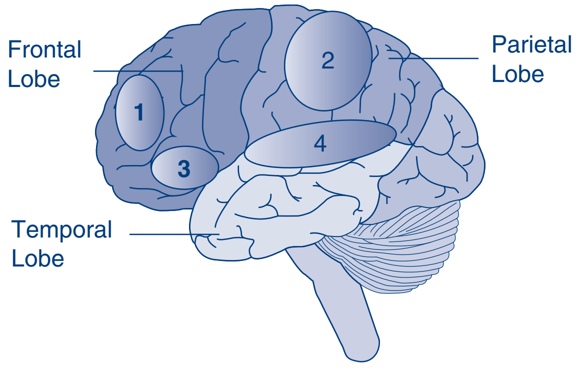

Figure 1.14 Areas 1 and 2 show the brain regions with high alpha wave activity during the generation of creative ideas to solve a problem, as measured by EEG. Areas 3 and 4 show regions that are highly activated while performing a task, as measured by fMRI.

Source: Fink et al., 2009.

> Creativity and intelligence are different abilities that involve different areas of the brain while solving problems.

different abilities that involve different areas of the cortex while solving closed or creative problems. This finding enhances the position of those who urge that creativity be considered as a separate measure of giftedness.

Jausovec continued his EEG studies and found that individuals of average to low intelligence expend more neural energy—thus, have less neural efficiency—than high intelligence individuals when solving problems involving working memory (Jausovec & Jausovec, 2004).

Recently, researchers measured brain activity during creative thinking in two studies employing different technologies, EEG and fMRI. In both studies, participants worked on tasks that required generating creative ideas. The EEG was used to determine which brain regions produced synchronized alpha waves when the individual was generating creative ideas to solve a problem, essentially adaptive decision making. The fMRI was used to identify brain areas that were highly activated when the individual was completing a task, an activity more associated with veridical decision making.

The EEG study revealed that the generation of original ideas was associated with synchronized alpha wave pattern in the frontal lobe and with a widespread pattern over the parietal regions, as shown in areas 1 and 2 in Figure 1.14. When solving tasks, the fMRI study revealed strong activation in frontal regions of the left hemisphere, and task-specific effects in the parietotemporal brain areas, areas 3 and 4 (Fink et al., 2009). These results further strengthen the notion that the brain recruits different regions when confronted with veridical and adaptive decision making.

Implications for Schools: Far too frequently, what is taught in schools emphasizes veridical, rather than adaptive, decision making. Most course work—and the resulting tests—ask students to search for the unique answers to concrete and unambiguous questions. Some students adapt to this strategy quickly and excel at veridical decision making. As a result, their test scores are high, and they may even be considered gifted. However, when faced with ambiguous problems, they often vacillate and become indecisive. Seldom do schools offer students consistent opportunities to develop adaptive decision-making skills. Instead, these are acquired individually, through trial and error.

With such emphasis on veridical decision making in schools, one wonders what happens to students who favor adaptive decision making. Do they get bored easily and act out or become withdrawn? Do they get frustrated if teachers insist they find only the unique answer? Are there areas in the curriculum where they can excel with their adaptive skills? Is it possible that those students who prefer adaptive decision making will seem different from the rest of the class? Is it also possible that a high aptitude in adaptive decision making is a characteristic of the gifted brain?

Given the appropriate adjustments in curriculum, most students can be taught to improve their adaptive decision-making skills. This process involves helping students to make connections and to discover relationships between the new learning and what they already know. One valuable strategy for accomplishing this is the frequent use of elaborative rehearsal. See the **Applications** section at the end of this chapter for suggestions on how to use elaborative rehearsal to enhance adaptive decision-making skills.

> Is it possible that a high aptitude in adaptive decision making is a characteristic of the gifted brain?

SOCIAL AND EMOTIONAL CHARACTERISTICS OF GIFTEDNESS

Social Characteristics

Despite stories that often circulate in schools about gifted students being loners, surveys indicate that preadolescent and adolescent gifted students were at least as popular as other students their age, and most gifted students felt good about themselves and their relationships with peers. However, highly gifted students had more difficulty with peer relationships and often developed coping strategies to deal with such circumstances. Several researchers have found that the most frequent coping strategies used by highly gifted students were hiding their giftedness, denying their giftedness, conforming to peer expectations, valuing peer acceptance, minimizing the importance of popularity, using humor, and helping others (Rudasill, Foust, & Callahan, 2007; Swiatek, 1995, 2001).

> Highly gifted adolescents use a variety of coping strategies when interacting with their peers, ranging from denying their giftedness to helping others.

The research studies revealed gender and age differences in selecting the coping strategies as shown in Table 1.1. Males tended to use humor to laugh off perceptions of their giftedness while females were more likely to use prosocial behavior in the form of helping others. Males were also more apt to minimize the importance of popularity while females preferred to deny their giftedness in order to fit into their preferred social circles. As for age differences, younger students tended to use conformity as a major coping strategy while older students were more apt to minimize popularity or deny and hide their giftedness. It should be noted that the gender and age differences found in these studies were not large, so caution should be used in interpreting the results. Nonetheless, one implication from these findings is that females seem to be using coping strategies to hide their aptitude rather than embracing it (Foust & Booker, 2007).

Some studies have also found a significant relationship between gifted students' self-concept and the coping strategies they chose. Those students who used positive strategies, such as helping others, also tended to have a higher self-concept. Conversely, gifted students who opted for more negative strategies, such as denying giftedness, had a lower self-concept. In other words, those students who have a more positive view of themselves select more positive coping strategies. This finding has implications for those who work with highly gifted students. There is research evidence that educators can change gifted students' views of

Table 1.1 Gender and Age Differences in Selecting Social Coping Strategies

Gender	**Males**	**Females**
	Using humor Minimizing the importance of popularity	Helping others Denying giftedness Valuing peer acceptance Conformity
Age	**Younger**	**Older**
	Conformity Minimizing the importance of popularity	Helping others Minimizing the importance of popularity Denying giftedness Hiding giftedness

Source: Foust & Booker, 2007.

themselves (Ziegler & Stoeger, 2004). This suggests that by improving gifted students' self-concepts, we may be able to help them select those coping strategies that enhance their academic achievement and contribute to a positive social adjustment.

Emotional Characteristics

Earlier in this chapter we discussed the notion of overexcitabilities in gifted children. One of these is emotional overexcitability, which is more evident in younger children. Apart from this characteristic, numerous studies in recent years on the emotional, personality, and motivational characteristics of gifted students have yielded similar results. In general, the studies showed that, when compared to average students, gifted students

- Were at least as well or somewhat better adjusted
- Possessed more personality traits considered to be favorable
- Displayed personality traits similar to older students
- Had lower levels of anxiety about school
- Scored higher on measures of self-concept
- Displayed higher levels of intrinsic motivation and autonomy, especially for reading, thinking, and solitude

Some gender and age differences have been noted. For example, gifted high school girls had significantly less self-confidence, more perfectionism, and more discouragement than younger gifted girls. Gifted high school boys, however, felt less discouragement than younger boys, and there were no age differences in self-confidence and perfectionism. High school girls scored higher on discouragement than high school boys (Cross, Cassady, Dixon, & Adams, 2008; Robinson and Clinkenbeard, 1998).

Although the studies present a useful profile, it is important to remember that some groups of gifted students will look quite different. For example, gifted students who are underachievers, and those whose talents are very far from the norm, are more likely to have difficulty fitting in socially and emotionally with their peers (see Chapter 7).

Asynchronous Development: One of the more puzzling observations with gifted children is how they can talk and act like an adult in one instance, and a few minutes later, throw a screaming fit because it is time to go to bed. This phenomenon may very well be due to *asynchronous development.* In typical children, intellectual, physical, and emotional development progresses at about the same rate. We can describe this development as synchronized. An average three-year-old has the intellectual and physical abilities as well as the emotional maturity of most other three-year-olds. However, in gifted children, the development of those areas is often not synchronized (or asynchronous) in that they do not progress at the same rate. For example, the developmental profile of three different gifted three-year-old children could look like this:

Child A	Child B	Child C
Intellectual ability: Age 6	Intellectual ability: Age 7	Intellectual ability: Age 6
Physical ability: Age 3	Physical ability: Age 3	Physical ability: Age 4
Emotional maturity: Age 2	Emotional maturity: Age 4	Emotional maturity: Age 3

Any other combination of the three developmental areas is possible, although intellectual ability is always advanced. The higher a child's IQ, the more asynchronous the development is likely to be. The advanced intellectual development of gifted children can lead teachers and parents to also expect more advanced behavior from these children. A six-year-old who can discuss global warming like a 10-year-old is often also expected to behave like a 10-year-old. When the child acts like a six-year-old instead, adults see that as immature behavior. Gifted children who are years ahead of their same-age peers are not always years ahead emotionally or socially. Advanced intellectual ability simply does not enable a gifted child to manage emotions any better than any other child.

As these children develop into adolescents, the asynchrony of the developmental areas may increase in some and diminish in others. An increase in asynchrony may produce difficulties, especially if emotional development lags while intellectual development leaps ahead. This imbalance could cause the adolescent to get anxious, frustrated, upset, overly sensitive, and self-critical (Alsop, 2003). These emotional needs should be addressed by parents, teachers, and counselors so that these gifted students can understand and deal with their developmental stages.

IMPACT OF PRAISE ON GIFTED STUDENTS

Gifted children should be commended for their good grades and high test scores. With restrained praise, gifted students are likely to attribute failure in a task to lack of effort rather than lack of ability (Assouline, Colangelo, Ihrig, & Forstadt, 2006). However, research seems to indicate that *excessively* complimenting children for their intelligence and academic performance may lead them to believe that good test scores and high grades are more important than learning and mastering something new (Mueller & Dweck, 1998). Six studies of 412 fifth-graders compared the goals and achievement behaviors of children praised for intelligence with those praised for effort and hard work under conditions of failure as well as success. Through their studies, the psychologists demonstrated that commending children for their intelligence after good performance might backfire by making them highly performance-oriented and thus extremely vulnerable to the effects of subsequent setbacks. In contrast, children who are commended for their effort concentrate on learning goals and strategies for achievement.

The researchers also observed that children who were commended for their ability when they were successful learned to believe that intelligence is a fixed trait that cannot be developed or improved. The children who were explicitly commended after their successes were the ones who blamed poor performances on their own lack of intelligence. They had a *fixed mind-set* about their abilities. However, when children praised for their hard work performed poorly, they blamed their lack of success on poor effort and demonstrated a clear determination to learn strategies that would enhance subsequent performances. They had a *growth mind-set.* Similar studies have demonstrated that children who are praised for their intelligence learn to value performance, while children praised for their effort and hard work value learning opportunities. Virtually all of the findings were similar not only for boys and girls but also among children from several different ethnic groups in rural and urban communities.

> Studies show that children who are praised for their intelligence learn to value performance, while children praised for their effort and hard work value opportunities to learn.

One important study monitored 373 students for two years during their transition to junior high school (Blackwell, Trzesniewski, & Dweck, 2007). At the beginning of seventh grade, the students were asked whether they agreed or disagreed with a statement that said their intelligence is something very basic and cannot be really changed. Students with a growth mind-set believed that the more hard work you put into something, the better you became at it. Fixed mind-set students, however, were concerned about looking smart, and believed that hard work at something was a sign of low ability. These different mind-sets had an impact on academic performance. At the start of the seventh grade, the mathematics scores for both mind-set groups were similar. But as the work became more difficult, the growth mind-set students showed greater persistence and the gap in the mathematics grades over two years continued to widen, as shown in Table 1.2.

Table 1.2 Mathematics Grades of Growth and Fixed Mind-Sets

	Fall 7th Grade	Spring 7th Grade	Fall 8th Grade	Spring 8th Grade
Growth mind-set	73.0	74.0	74.9	75.8
Fixed mind-set	71.1	71.0	70.8	70.7

Source: Blackwell et al. (2007).

These findings may also explain why bright young girls who do well in grade school often perform poorly in upper grades. In their desire to bolster young girls' confidence in their abilities, educators have praised them for their intelligence, which, these studies have shown, could have an undesired impact on their subsequent motivation and performance.

Labeling children as gifted or talented too soon may also have a negative impact on them. Such labeling may cause the children to become overly concerned with justifying that label and less concerned with meeting challenges that enhance their learning and mastery skills. They may begin to believe that academic setbacks indicate that they do not deserve to be labeled as gifted. Gifted and talented programs should emphasize how to meet challenges, apply effort, and search for new learning strategies. Furthermore, when students succeed, attention and approval should be directed at their effort and hard work rather than for the final product or their ability. In summary, researchers in this area stress that praise may undermine, enhance, or have no effect on children's intrinsic motivation. Praise is particularly motivating when it encourages solid performance, promotes autonomy, enhances competence without an over-reliance on "innate intelligence," and conveys standards and expectations that are attainable (Henderlong & Lepper, 2002).

APPLICATIONS

USING SUCCESSFUL INTELLIGENCE IN THE CLASSROOM

Teaching for successful intelligence is a method for helping students learn in a way that matches their patterns of ability. Based on Robert Sternberg's Triarchic Theory of Intelligence, the approach involves teaching in a way that balances learning for analytical, creative, and practical thinking. These methods help all students, including the gifted, reach their full potential. Here are some examples across the school curriculum suggested by Sternberg and Grigorenko (2004).

Teaching analytically: analyze, critique, judge, compare/contrast, evaluate, assess

- *Analyze* the development of the character of Fagan in *Oliver Twist.* (Literature)
- *Critique* the design of the experiment (just reviewed in class) showing that certain minerals improve plant growth while others do not. (Biology)
- *Judge* the artistic merits of Andy Warhol's op-art, discussing its strengths and weaknesses as fine art. (Art)
- *Compare and contrast* the American Revolution to the French Revolution, showing ways in which they were similar and different. (History)
- *Evaluate* the validity of the following solution to a mathematical problem, and discuss weaknesses in the solution, if there are any. (Mathematics)
- *Assess* the strategy used by the winning player in the tennis match you just watched, focusing on the techniques that were used to defeat the opponent. (Physical Education)

Teaching creatively: create, invent, discover, imagine if, suppose that, predict

- *Create* an alternative ending to *Romeo and Juliet* that shows a different way that things might have turned out for the main characters. (Literature)
- *Invent* a dialogue between an American tourist in Madrid and a Spanish police officer he encounters on the street from whom he is asking directions on how to get to the Prado museum. (Spanish)
- *Discover* the underlying principle that determines whether solutions will be acidic, basic, or neutral. (Chemistry)
- *Imagine if* the population of India continues to increase at its current rate over the next 15 years. What demands would that increase make on India's government? (Political Science)
- *Suppose that* you were to design a new musical instrument for a symphony orchestra. What would it look like and why? (Music)
- *Predict* changes that are likely to occur in the vocabulary and grammar of spoken French in the areas near the U.S.-Quebec Province border over the next 50 years as a result of continuous interaction between English and French speakers. (Languages/Linguistics)

Teach practically: apply, use, put into practice, implement, employ, render practical

- *Apply* the formula for computing compound interest to a problem that people are likely to face when planning for retirement. (Economics, Mathematics)

- *Use* your knowledge of Chinese to greet a new acquaintance in Beijing. (Chinese)
- *Put into practice* what you have learned about teamwork in basketball to make a classroom team project succeed. (Physical Education, Athletics)
- *Implement* a business plan you have written in a simulated business environment. (Business)
- *Employ* Ohm's Law to determine the voltage in this circuit. (Physics)
- *Render practical* the proposed design for a new building that is aesthetically inconsistent with the surrounding buildings, all of which are at least 100 years old. (Architecture)

It is not necessary to teach each curriculum topic in the three ways. Rather, the teacher alternates teaching styles so that the variety of student learning styles are addressed.

From a Teacher's Desk: *An Elementary Example*

Ways for Students to Demonstrate Various Intelligences:

Analytically

- Allow students self-assessment opportunities with expectations from a rubric or criteria chart to practice evaluation based on various modes of criteria. See next page for an example of a rubric.

Creatively

- Challenge students to predict the effects of an experiment, the solution in a story, or the consecutive trends of the economy. To add a component of creative thinking, prompt students to list many, varied outcomes and possibilities. Examples of specific prompts:

  "What many, varied, and unusual changes, or transformations, can you think of that might occur in the character throughout the story? Prove why some are purposeful and lead to another. Make a written list of your ideas."
  "What are other many, varied, and unusual examples of weather patterns that could follow this natural disaster? Make a written list of your ideas."

Practically

- Teach students to apply a learned skill or concept to a new content area or topic to enhance depth and promote transfer. For instance, after practicing how to change fractions to decimals, such as ¼ = 0.25, apply the skill to money for real-world application by relating the word form to the pictorial and decimal forms:

1/4 = one quarter of a dollar = $0.25 = 

Name: ______ *Topic:* ______ *Date:* ______				
Independent Study Project/Presentation Rubric				
	4 ☆ ☆ ☆ ☆	3 ☆ ☆ ☆	2 ☆ ☆	1 ☆
Knowledge	Conveys insightful information that helps others learn	Shares basic facts and information	Lacks clarity	Unfinished or does not include meaningful information
Accuracy	The information is cited from reliable sources	Some information is questionable or not clearly cited	No references are cited	There is evidence of plagiarism - copying others' words & ideas
Creativity	Display/ presentation demonstrates great unique thought and effort	Display/ presentation demonstrates some imaginative thought and effort	Display/ presentation demonstrates little thought and/or effort	Display/ presentation does not demonstrate any thought and/or effort
Communication	Terms and facts are defined, exemplified, and explained adequately so that audience understands	Some terms and facts are defined, exemplified, and explained so that audience understands	Few terms and facts are defined, exemplified, and explained	Little or no terms and facts are defined, exemplified, or explained
My overall score: ______				

APPLICATIONS

SOME STRATEGIES FOR WORKING WITH STUDENTS WHO EXHIBIT OVEREXCITABILITIES

It is often quite difficult and demanding to work and live with overexcitable individuals. Their behaviors may seem unexplainable, frequently incomprehensible, and often bizarre. Here are some strategies suggested by Lind (2001) that may help teachers and parents who work and live with students who demonstrate overexcitabilities. The first set are general strategies that are applicable regardless of which OEs are present.

General Strategies

- **Discuss the concept of overexcitability.** Share the descriptions of OEs with the family, class, or counseling group, as appropriate. Ask individuals if they see themselves with some of the characteristics. Point out that being overexcitable is understood and accepted.
- **Focus on the positives.** Discuss the positives of each OE when you first introduce the concept, and continue to point out these merits. Benefits include being energetic, enthusiastic, sensual, aesthetic, curious, loyal, tenacious, moral, metacognitive, creative, metaphorical, dramatic, poetic, compassionate, empathetic, and self-aware.
- **Cherish and celebrate diversity.** To some degree, the pursuit of educational and societal equity has diminished the celebration of diversity and individual differences. Highly gifted individuals, because of their uniqueness, may succumb to the public belief that they are not OK. When discussing OEs, it is essential that individuals realize that overexcitability is just one more description of who they are, such as being tall, or Asian, or left-handed. Since OEs are inborn traits, they cannot be unlearned. Therefore, we must accept our overexcitable selves, children, and friends. This acceptance provides validation and helps to free people from feelings of strangeness and isolation.
- **Use and teach clear verbal and nonverbal communication skills**. All people need to be listened to and responded to with respect. Overexcitable people need understanding and patience to a greater degree because they are experiencing the world with greater intensity and need to be able to share their intensity and feelings to thrive. Good communication skills are useful on several levels, from improving the chances of getting what you want, to nurturing and facilitating growth in others. The outcomes will include less stress, greater self-acceptance, greater understanding from and about others, and less daily friction at home, school, work, or anywhere else.

  When teaching communication skills, be sure to include verbal-listening, responding, questioning, telephoning, and problem solving. Nonverbal skills should include the use of time, interpersonal distance and touch, gestures and postures, facial expressions, tone of voice, and style of dress. Verbal and nonverbal strategies improve interpersonal communication and provide the skills individuals need to fit in when they wish to, to change the system if necessary, and to treat others with caring and respect.

- **Teach stress management as early as possible.** Everyone deals regularly with stress. But overexcitable individuals have increased stress reactions because of their increased sensitivity and reaction to external input. It is important to (1) learn to identify your stress symptoms: headache, backache, pencil tapping, pacing, etc.; (2) develop strategies for coping with stress: talk about your feelings, do relaxation exercises, change your diet, exercise, meditate, ask for help, develop organizational and time management skills; and (3) develop strategies to prevent stress: make time for fun, practice tolerance of your own and others' imperfections, and develop a group of people who will help, advise, and humor you.

- **Create a comforting environment whenever possible.** Intense people need to know how to make their environment more comfortable in order to create places for retreat or safety. For example, they need to find places where they can work or think without distraction, listen to music, look at a lovely picture, carry a comforting item, move while working, or wear clothing that does not scratch or cling. Learning to select one's environment to meet one's needs takes experimentation and cooperation from others, but the outcome will be a greater sense of well being and improved productivity.
- **Help to raise awareness of one's behaviors and their impact on others.** Overexcitable people are often insensitive and unaware of how their behaviors affect others. They may assume that everyone will just understand why they interrupt to share an important idea, or tune out when creating a short story in their head during dinner. It is important to teach children and adults to be responsible for their behaviors, to become more aware of how their behaviors affect others, and to understand that their needs are not more important than those of others. The key is to realize that you can show children and adults how they are perceived, you can teach them strategies to fit in, but they must choose to change.
- **Remember the joy.** When people discuss overexcitability, the examples and concerns are often mostly negative. Remember that being overexcitable also brings with it great joy, astonishment, beauty, compassion, and creativity. Perhaps the most important thing is to acknowledge and relish the uniqueness of an overexcitable child or adult.

Here are some strategies that are targeted to each overexcitability.

Psychomotor Strategies

- Allow enough time for physical or verbal activity, before, during, and after normal daily and school activities. These individuals love and need to be in motion. Build activity and movement into their daily routines.
- Ensure that the physical or verbal activities are acceptable and not distracting to those around them. This may take some planning, but the project should be fun and beneficial to all.
- Provide time for spontaneity and open-ended activities.

Sensual Strategies

- Whenever possible, create an environment that limits offensive stimuli (for example, loud noises, strong odors, or visual overload) and provides comfort.
- Provide appropriate opportunities for being noticed by giving unexpected attention, or facilitating creative and dramatic productions that have an audience. These individuals literally feel the recognition that comes from being the center of attention.
- Provide time for them to dwell in the delight of the sensual and to create a soothing environment.

Intellectual Strategies

- Show how to find the answers to questions. This respects and encourages the individual's desire to analyze, synthesize, and seek understanding.

- Provide or suggest ways for those interested in moral and ethical issues to act upon their concerns, such as collecting blankets for the homeless or writing to soldiers in Iraq. This enables them to feel that they can contribute, in even a small way, to solving community or worldwide problems.
- If individuals are critical or too outspoken to others, help them to see how their intent may be perceived as cruel or disrespectful. For example, saying "that is a dumb idea" may not be well received, even if the idea is truly dumb.

Imaginational Strategies

- Imaginational people may confuse reality and fiction because their memories and new ideas become blended in their mind. Help individuals to differentiate between their imagination and the real world by asking them to write down or draw the factual account before they embellish it.
- Help people use their imagination to function in the real world and promote learning and productivity. For example, instead of the conventional school organized notebook, ask the students to create their own system for organizing their work.

Emotional Strategies

- Accept all feelings, regardless of intensity. For people who are not highly emotional, this may seem particularly unusual. They may feel that those high in Emotional OE are just being melodramatic or seeking attention. But if we accept their emotional intensity as an innate trait and help them work through any problems that might result, we will facilitate their healthy growth and adjustment.
- Teach individuals to anticipate physical and emotional responses and to prepare for them. Emotionally intense people often are not aware when they are becoming so overwrought that they may lose control or may have physical responses to their emotions. Help them to identify the physical warning signs of their emotional stress such as a headache, sweaty palms, or stomachache. By knowing the warning signs and acting on them early, individuals will be better able to cope with emotional situations and not lose control.

From a Teacher's Desk: *An Elementary Example*

I had the challenging pleasure of two "twice exceptional" students in my class one year who evidenced several different kinds of overexcitability. Although they were both autistic and gifted, they were very different in their mannerisms. One student, Nathan, demonstrated sensual and imaginational overexcitability, while the other, Jamie, possessed psychomotor and intellectual overexcitability characteristics. Their varied intensities promised and delivered a year without a boring day!

In order to give the students an opportunity to evidence special abilities, one day I had the class play a PowerPoint *Jeopardy* game to review parts of speech. Jamie declared, "This is the best day ever!" Everyone wanted to be on his team because I set the scene with the facts that he regularly viewed the television show and had an excellent memory. He was quivering with enthusiasm at the prospect and desired to present the introductory part of the "show," which he recited verbatim. His team did end up earning the most points and more importantly, he had the chance to be a social leader and demonstrate his intellect at the same time.

Some students are simply dissonant with the routines and rules of standard school structure. As Nathan resisted compliancy and preferred to be in his imaginative world, drawing all day, I struggled to challenge him. Creative humor and exaggeration would get his attention and connect with him on a personal level, but wouldn't always produce results. Our "aha!" breakthrough moment was when I utilized independent study through technology. The Web site I found merged his interests and my expectations—he could research and explore his fascinations while also meeting standards. That day he changed from the stubborn underachiever who would hardly complete a sentence to a scholar that needed multiple pages to write down all of his ideas.

That year taught me some valuable ways to deal with overexcitability:

- Meet exaggeration with exaggeration
- Find humor in each intense situation
- Allow opportunity for intensities to be shown (get excited with and for them)
- Use specific phrases as the teacher and demonstrate for other students (e.g., “When you interrupt like that, it hurts my feelings because I feel disrespected and I lose my train of thought . . .” or “When you tap like that it distracts me and I can’t concentrate” and “You see that child crying, with tears running down the face? That means they are sad and they need my help first-thing.”
- Patience, patience, patience

Overexcited students can be exhausting one day and revitalizing another day. Basically, if you give them attention and patience, they will repay you with positive reinforcement and revelations.

APPLICATIONS

IMPROVING ADAPTIVE DECISION MAKING THROUGH ELABORATIVE REHEARSAL

Rehearsal refers to the learner's reprocessing of new information in an attempt to determine sense and meaning. It occurs in two forms. Some information items have value only if they are remembered *exactly* as presented, such as the letters and sequence of the alphabet, spelling, poetry, telephone numbers, notes and lyrics of a song, and the multiplication tables. This is called *rote rehearsal.* Sense and meaning are established quickly, and the likelihood of long-term retention is high. Most of us can recall poems, songs, and telephone numbers that we learned many years ago.

More complex concepts require the learner to make connections and to form associations and other relationships in order to establish sense and meaning. Thus, the information will need to be reprocessed several times as new links are found. This is called *elaborative rehearsal.* The more senses that are used in this elaborative rehearsal, the more reliable the associations. Thus, when visual, auditory, and kinesthetic activities assist the learner during rehearsal, the probability of long-term storage rises dramatically. That is why it is important for students to talk about what they are learning *while* they are learning it, and to have visual models as well.

Elaborative rehearsal can also develop adaptive decision-making skills because students will have more opportunities to make new connections and to see relationships that would otherwise not be possible through rote rehearsal.

Rehearsal is teacher-initiated and teacher-directed. Much of what students practice in schools is rote rehearsal, which is essentially veridical decision making. Recognizing the value of elaborative rehearsal as a necessary ingredient for retention of learning, teachers should consider the following strategies when designing and presenting their lessons:

Elaborative Rehearsal Strategies

- ***Paraphrasing.*** Students orally restate ideas in their own words, which then become familiar cues for later storage. Using the auditory modality helps the learner attach sense, making retention more likely. For example:
  - After studying about the Declaration of Independence one could say: "This was a document that listed the many reasons why the American colonies should no longer recognize the British king as their ruler, and why they should become self-governing states."
- ***Selecting and Note Taking.*** Students review texts, illustrations, and lectures, deciding which portions are critical and important. They make these decisions on the basis of criteria from the teacher, authors, or other students. Students then paraphrase the idea and write it into their notes. Adding the kinesthetic exercise of writing furthers retention.
- ***Predicting.*** After studying a section of content, the students predict the material to follow or what questions the teacher might ask about that content. Prediction keeps students focused on the new content, adds interest, and helps them apply prior learnings to new situations, thus aiding retention. Some examples:
  - Having read to a certain point in a fable, predict its moral.
  - Predict how the earth's continued growth in population may affect the future.

- ❍ Having read the first three acts of Shakespeare's *Romeo and Juliet,* predict a believable ending to the story based on what you already know.

- ***Questioning.*** After studying content, students generate questions about the content. To be effective, the questions should range from lower-level thinking of recall, comprehension, and application to higher-level thinking of analysis, synthesis, and evaluation. When designing questions of varying complexity, students engage in deeper cognitive processing, clarify concepts, predict meaning and associations, and examine options—all contributors to retention and to improving adaptive decision-making skills. Some examples:
  - ❍ What would be another way to solve this arithmetic problem?
  - ❍ What are some things I was wondering about when this was happening in the story?
  - ❍ How might the USA be different today if the Confederate states had won the Civil War?
  - ❍ What are the arguments for and against genetic engineering? Which side would you support and why?

- ***Summarizing.*** Students reflect on and summarize in their heads the important material or skills learned in the lesson. They can then share their summary with a partner or with the class. This is often the last and critical stage, in which students can attach sense and meaning to the new learning and thereby increase the likelihood that they will remember it. Here is a useful format to consider:
  - ❍ What did I learn today about . . .?
  - ❍ What did I already know that ties in to what I learned today?
  - ❍ How can what I learned today help me in the future?