Key Questions/ Chapter Outline	Core Concepts	Psychology Matters
5.1 What Are the Components of Thought? Concepts Imagery and Cognitive Maps Thought and the Brain Intuition	• Thinking is a cognitive process in which the brain uses information from the senses, emotions, and memory to create and manipulate mental representations, such as concepts, images, schemas, and scripts.	**Schemas and Scripts Help You Know What to Expect** But sometimes they fill in the blanks—without your realizing it.
5.2 What Abilities Do Good Thinkers Possess? Problem Solving Judging and Making Decisions Becoming a Creative Genius	• Good thinkers not only have a repertoire of effective strategies, called algorithms and heuristics, they also know how to avoid the common impediments to problem solving and decision making.	**Using Psychology to Learn Psychology** Psychologists have learned the secrets of developing expertise—in psychology or any other subject.
5.3 How Is Intelligence Measured? Binet and Simon Invent a School Abilities Test American Psychologists Borrow Binet and Simon's Idea Problems with the IQ Formula Calculating IQs "on the Curve" IQ Testing Today	• Intelligence testing has a history of controversy, but most psychologists now view intelligence as normally distributed and measurable by performance on a variety of tasks.	**What Can You Do for an Exceptional Child?** In both mental retardation and giftedness, children should be encouraged to capitalize on their abilities.
5.4 Is Intelligence One or Many Abilities? Psychometric Theories of Intelligence Cognitive Theories of Intelligence Cultural Definitions of Intelligence Animals Can Be Intelligent—But Do They Think?	• Some psychologists believe that intelligence comprises one general factor, *g*, while others believe that intelligence is a collection of distinct abilities.	**Test Scores and the Self-Fulfilling Prophecy** An IQ score can create expectations that have a life of their own.
5.5 How Do Psychologists Explain IQ Differences among Groups? Intelligence and the Politics of Immigration What Evidence Shows That Intelligence Is Influenced by Heredity? What Evidence Shows That Intelligence Is Influenced by Environment? *Heritability* (not *Heredity*) and Group Differences	• While most psychologists agree that both heredity and environment affect intelligence, they disagree on the source of IQ differences among racial and social groups.	**Stereotype Threat** Just a reminder that you belong to a minority group may be enough to lower your test scores.
Critical Thinking Applied		**The Question of Gender Differences**

chapter 5

thinking and intelligence

Follow your passions and you, too, may become a multimillionaire. At least that's what happened to Sergey Brin and Larry Page, graduate students in computer science at Stanford University. Both were deeply interested in finding a quicker way to search the World Wide Web and extract specific information from its abundance of informational riches.

It was January of 1996, and both Brin and Page had some creative ideas about how to search the Web more efficiently than the existing "search engines" could do the job. After deciding to combine forces, the first thing this duo did was to build a computer in Larry's dorm room, equipping it with as much memory as they could afford.

The first-generation search engine to come out of their collaboration was BackRub, so called because it could identify and follow "back links" to identify which websites were listing a particular page—giving them an index of how valuable users had found a site to be. And, while their search engine performed well, Brin and Page couldn't get any of the big computer companies or existing Internet entrepreneurs to buy their design. So, they started their own business—with a little financial help from

their family and friends. One friend of a Stanford faculty member saw so much promise in their enterprise that he wrote them a check for $100,000. The check sat in a drawer in Page's desk for two weeks because they hadn't yet set up a company that could cash the check.

In most respects, Brin and Page's search engine worked like any other web-searching software. It sent out electronic "spiders" that crawl across web pages, looking for important terms and lists these in an index, along with their web addresses. It also followed links on the web pages it scans (both forward and backward) and lists more terms. The main secret ingredient for their success remains as closely guarded as the formula for Coca-Cola. It involves the way results are ranked for presentation to the user. More often than not, it manages to put the sites users want near the top of a list that can stretch to millions of possible sources. Thus, the software is designed to serve as the link between a concept in the user's mind and billions of words on the web. That is, Brin and Page had to organize their search engine to "think" as much as possible like a person—which is what this chapter is about.

The public seemed to like their search engine. In fact, the public liked it far better than did the big companies that had turned it down. And over the next decade it became "the little engine that could." First it outgrew Page's dorm room and—in the great tradition of American inventors and rock bands—into a garage. Now it has its own Silicon Valley building complex, with 1000 employees. It also has a reputation as the most comprehensive of search engines, indexing key words from billions of web pages. Every day it processes hundreds of millions of search requests. Things got so busy that Brin and Page had to take a leave from graduate school to run the company—which they renamed after the term mathematicians use for the number 1 followed by 100 zeros. They called it Google.

In some respects, Brin and Page are like other legendary pioneers in the computer field: the two Steves, Jobs and Wozniak, who started Apple Computers in a garage, and Bill Gates who, with his friend Paul Allen, launched Microsoft on a shoestring. All could be called "geniuses," a term that frames our initial problem for this chapter:

PROBLEM: What produces "genius," and to what extent are the people we call "geniuses" different from others?

As we consider this problem, here are some additional questions worth pondering:

- Thomas Edison once said that genius is 1% inspiration, 99% perspiration. If so, does that mean genius is mainly a matter of high motivation, rather than aptitude or talent?
- Is genius a product mainly of nature or nurture?
- Do geniuses think differently from the rest of us? Or do they just use the same thought processes more effectively?
- Could Einstein (for example), whose specialty was physics, have been a genius in painting or literature or medicine, if he had chosen to do so? That is, are there different kinds of genius? And is the potential for genius specific to a particular field?

We will address all of these questions in the following pages. But first, let's return to Google and the computer metaphor for the human mind, as we begin our inquiry into thinking and intelligence.

Despite its phenomenal success, Google is only a pale imitation of the human mind. Sure, it can scan its memory, amassed from 4 billion web pages, and return 12 million links on, say, the term "search engine" in about a half second. But ask it what food to serve at a birthday party, and it will merely serve up (at this writing) 7,500,000 links to the terms "birthday" and "party" and "food." Unlike most human minds, Google and its network of supportive hardware is clueless. So is the computer on your desk. Computers just don't index information by *meaning*.

Nevertheless, computers in the hands of cognitive scientists can be powerful tools for studying how we think—for three reasons. First, these scientists use computers in brain imaging studies, which have shown the brain to be a system of interrelated processing modules, as we have seen. Second, researchers use computer simulations that attempt to model human thought processes. And third, while they haven't yet made a computer function exactly like a brain, cognitive scientists have adopted the computer as a metaphor for the brain as a processor of information.

This **computer metaphor**—the brain as an information processor—suggests that thinking is nothing more, or less, than information processing. The information we use in thought can come from the raw data we receive from our senses, but it can also come from the meaningful *concepts* that we retrieve from long-term memory. As you can see, then, the psychology of thinking deals with the same processes that we discussed in connection with learning and memory.

To be sure, the computer metaphor is not perfect. Computers can't deal with meaning. And, as we will see, they are not very good at abstract thought or humor (although they are *very* good at transmitting the millions of jokes shared on e-mail each day). Consequently, some psychologists have called for moving beyond the computer metaphor to talk about the sort of modular, parallel information processing that we now know the brain really does when it thinks. Says David Rubin (2006): "Instead of viewing the mind as a general-purpose computing machine, we should view it as a collection of more specialized systems or devices, each with properties tuned for the problems it is to process." Nevertheless, the computer metaphor is a good place to begin our thinking about thought.

In the first two sections of this chapter, we will focus on the processes underlying thought, especially in decision making and problem solving. This discussion will examine the building blocks of thought: *concepts, images, schemas,* and *scripts*. Our excursion into thinking will also give us the opportunity to return for a closer look at that mysterious quality known as "genius."

In the second half of the chapter, we will turn to the form of thinking we call **intelligence**. There you will learn about IQ tests, conflicting perspectives on what intelligence really is, and what it means to say that IQ is "heritable." In the "Using Psychology to Learn Psychology" feature, you will learn how to apply the knowledge in this chapter to become an expert in psychology—or any other field you choose. Finally, our critical thinking application will look at the hot-button issue of gender differences in thought.

5.1 KEY QUESTION
WHAT ARE THE COMPONENTS OF THOUGHT?

Solving a math problem, deciding what to do Friday night, and indulging a private fantasy all require *thinking*. We can conceive of thinking as a complex act of *cognition*—information processing in the brain—by which we deal with our world of ideas, feelings, desires, and experience. Our Core Concept notes that this information can come from within and from without, but it always involves some form of mental representation:

Computer metaphor The idea that the brain is an information-processing organ that operates, in some ways, like a computer.

Intelligence The mental capacity to acquire knowledge, reason, and solve problems effectively.

DO IT YOURSELF! Your Memory for Concepts

Read the following passage carefully:

> Chief Resident Jones adjusted his face mask while anxiously surveying a pale figure secured to the long gleaming table before him. One swift stroke of his small, sharp instrument and a thin red line appeared. Then the eager young assistant carefully extended the opening as another aide pushed aside glistening surface fat so that the vital parts were laid bare. Everyone stared in horror at the ugly growth too large for removal. He now knew it was pointless to continue.

Now, without looking back, please complete the following exercise.

Circle below the words that appeared in the passage:

patient	scalpel	blood	tumor
cancer	nurse	disease	surgery

In the original study, most of the subjects who read this passage circled the words *patient, scalpel,* and *tumor.* Did you? However, none of the words were there! Interpreting the story as a medical story made it more understandable, but also resulted in inaccurate recall (Lachman et al., 1979). Once the subjects had related the story to their schema for hospital surgery, they "remembered" labels from their schema that were not present in what they had read. Drawing on a schema not only gave people an existing mental structure to tie the new material to but also led them to change the information to make it more consistent with their schema-based expectations.

core concept

Thinking is a cognitive process in which the brain uses information from the senses, emotions, and memory to create and manipulate mental representations, such as concepts, images, schemas, and scripts.

These mental representations, then, serve as the building blocks of cognition, while thinking organizes them in meaningful ways. The ultimate results can be the higher thought processes that we call reasoning, imagining, judging, deciding, problem solving, expertise, creativity, and—sometimes—genius.

Concepts

Have you ever visited a new place only to feel like you had been there before? Or had a conversation with someone and felt that the experience was uncannily familiar? If so, you have experienced a phenomenon known as *déjà vu* (from the French for "seen before"). The term refers to the strange feeling that your present experience jibes with a previous experience, even though you cannot retrieve the explicit memory. This feeling reflects the brain's ability to treat new stimuli as instances of familiar categories, even if the stimuli are slightly different from anything it has encountered before. Here's the point: The ability to assimilate experiences, objects, or ideas into familiar mental categories—and to take the same action toward them or give them the same label—is regarded as one of the most basic attributes of thinking organisms (Mervis & Rosch, 1981).

The mental categories that we form in this way are known as **concepts**. We use them as the building blocks of thinking, because they enable us to organize our knowledge (Goldman-Rakic, 1992). Concepts can represent classes of objects, such as "chair" or "food." Concepts can also represent living organisms, such as "birds" or "buffaloes," as well as events, like "birthday parties." They may also represent properties (such as "red" or "large"), abstractions (such as "truth" or "love"), relations (such as "smarter than"), procedures (such as how to tie your shoes), or intentions (such as the intention to break into a conversation) (Smith & Medin, 1981). But because concepts are mental structures, we cannot observe them directly. For the cognitive scientist, this means inferring concepts from their influence on behavior or on brain activity. For example, you

Concepts Mental groupings of similar objects, ideas, or experiences.

cannot be sure that another person shares your concept of "red," but you can observe whether he or she responds in the same way you do to stimuli that you both call "red."

Two Kinds of Concepts Everyone conceptualizes the world in a unique way, so our concepts define who we are. Yet behind this individual uniqueness lie similarities in the ways that all of us form concepts. In particular, we all distinguish between *natural concepts* and *artificial concepts* (Medin et al., 2000).

Natural concepts are rather imprecise mental categories that develop out of our everyday experiences in the world. You possess a natural concept of "bird" based on your experiences with birds. You probably also have natural concepts associated with artichokes, elephants, your mother's face, and the Statue of Liberty. While each of these examples may involve words, natural concepts also can involve visual images, emotions, and other nonverbal memories.

Your natural concept of "bird" invokes a mental **prototype**, a generic image that represents a typical bird from your experience (Hunt, 1989). To determine whether some object is a bird or not, you can quickly compare the object to your bird prototype. The more sophisticated your prototype, the less trouble you will have with flightless birds, such as ostriches and penguins; or with birdlike flying creatures, such as bats; or with egg-laying creatures like turtles and platypuses. Natural concepts are sometimes called "fuzzy concepts" because of their imprecision (Kosko & Isaka, 1993).

Empirical support for the idea of a prototype comes from studies showing that people respond more quickly to typical members of a category than to more unusual ones—that is, their reaction times are faster. For example, it takes less time to say whether a robin is a bird than to say whether an ostrich is a bird, because robins resemble most Americans' prototype of a bird more closely than ostriches do (Kintsch, 1981; Rosch et al., 1976).

By comparison, **artificial concepts** are defined by a set of rules or characteristics, such as dictionary definitions or mathematical formulas. The definition of "rectangle" that you learned in math class is an example. Artificial concepts represent precisely defined ideas or abstractions, rather than actual objects in the world. So, if you are a zoology major, you may also have an artificial concept of "bird," which defines it as a "feathered biped." In fact, most of the concepts you have learned in school are artificial concepts. "Cognitive psychology" is also an artificial concept; so is the concept of "concept"!

Concept Hierarchies You organize much of your declarative memory into **concept hierarchies**, arranged from general to specific, as illustrated in Figure 5.1. For most people, the broad category of "animal" has several subcategories, such as "bird" and "fish," which are divided, in turn, into specific forms, such as "canary," "ostrich," "shark," and "salmon." The "animal" category may itself be a subcategory of the still larger category of "living beings." We can think of these concepts and categories as arranged in a hierarchy of levels, with the most general and abstract at the top and the most specific and concrete at the bottom. They are also linked to many other concepts: Some birds are edible, some are endangered, some are national symbols.

Culture, Concepts, and Thought Concepts can carry vastly different meanings in different cultures. For example, the concepts of "democracy" and "freedom," so dear to Americans, may have the connotation of chaos, license, and rudeness in parts of Asia and the Middle East.

Americans also differ with many Asians in the ways they deal with conflicting ideas and contradictions (Peng & Nisbett, 1999). We can see this in the way the Chinese have dealt with the conflicting ideologies of capitalism and communism by allowing elements of both to flourish in their economy, an approach that many Americans find difficult to understand. The Chinese culture encour-

Your natural concept of "bird" involves a* prototype *that is probably more like a robin than an ostrich. Biology majors, however, may also have an artificial concept of "bird" that works equally well for both.

Natural concepts Mental representations of objects and events drawn from our direct experience.

Prototype An ideal or most representative example of a conceptual category.

Artificial concepts Concepts defined by rules, such as word definitions and mathematical formulas.

Concept hierarchies Levels of concepts, from most general to most specific, in which a more general level includes more specific concepts—as the concept of "animal" includes "dog," "giraffe," and "butterfly."

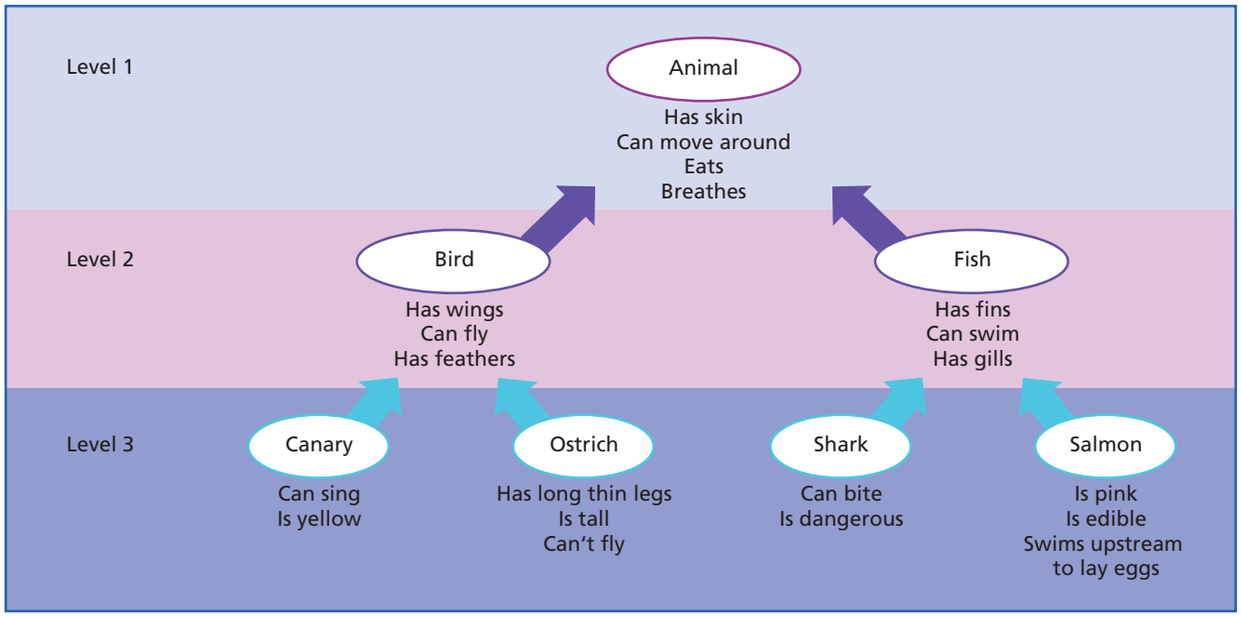


FIGURE 5.1
Hierarchically Organized Structure of Concepts

ages thinkers to keep opposing perspectives in mind and seek a "middle way," while American culture tends toward thinking in more polarized "either-or" terms—capitalism *or* communism.

Another big cultural difference involves the use of logic: Many cultures do not value the use of logical reasoning as much as do Europeans and North Americans (Bower, 2000a; Nisbett et al., 2001). Some seek "truth" by comparing new ideas with the wisdom of sacred writings, such as the Koran, the Bible, or the Upanishads. Even in the United States, many people place higher value on qualities variously known as "common sense," which refers to thinking based on experience, rather than on logic.

What is the lesson to be learned from these cultural differences? While there are some universal principles of thought that cut across cultures, they involve very basic processes, such as the fact that everyone forms concepts. But when it comes to *how* they form concepts or the *meaning* they attach to them, we should be cautious about assuming that others think as we do.

Imagery and Cognitive Maps

We think in words, but we also may think in pictures and spatial relationships or other sensory images. Taking a moment to think of a friend's face, your favorite song, or the smell of warm cookies, makes this obvious. Visual imagery adds complexity and richness to our thinking, as do images that involve the other senses (sound, taste, smell, and touch). Thinking with sensory imagery can be useful in solving problems in which relationships can be grasped more clearly in an image rather than in words. That is why books such as this one often encourage visual thinking by using pictures, diagrams, and charts.

A cognitive representation of physical space is a special form of visual concept called a *cognitive map*. Cognitive maps help you get to your psychology class, and they enable you to give another person directions to a nearby theater or deli. By using cognitive maps, people can move through their homes with their eyes closed or go to familiar destinations even when their usual routes are blocked. As you can see in Figures 5.2 and 5.3, people's cognitive maps can be vastly different.

CONNECTION • CHAPTER 3
Learning theorist Edward C. Tolman suggested that we form cognitive maps of our environment, which we use to guide our actions toward desired goals.

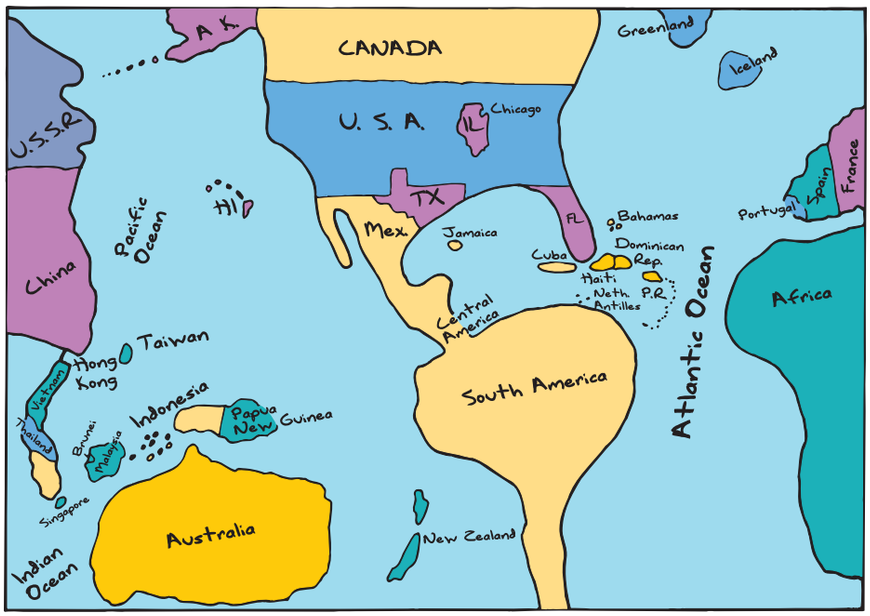


FIGURE 5.2
Chicagocentric View of the World

How does this student's sketch compare with your view of the world?

(*Source:* From Robert L. Solso, *Cognitive Psychology,* 5th ed. Published by Allyn and Bacon, Boston, MA. Copyright © 1998 by Pearson Education. Reprinted by permission of the publisher.)

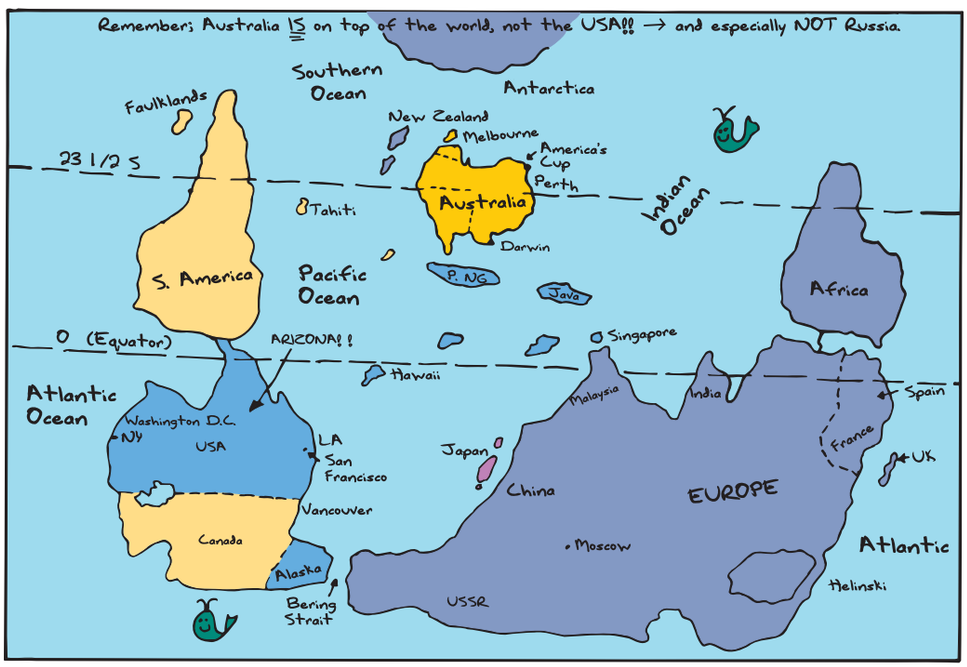


FIGURE 5.3
Australiocentric View of the World

Now who's "down under"? It probably would not occur to most Americans to draw a map "upside down" like this one drawn by an Australian student, placing Australia near the center of the world.

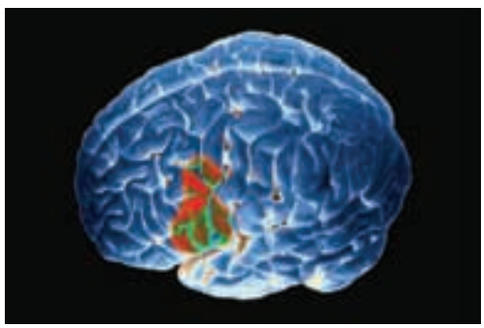
The maps we carry in our minds mirror the view of the world that we have developed from the perspective of our own culture. The maps you see here and in the previous figure came from a study aimed at understanding how nearly 4000 students from 71 cities in 49 countries visualize the world. The majority of maps had a Eurocentric world view: Europe was placed in the center of the map and the other countries were arranged around it—probably due to the dominance for many centuries of Eurocentric maps in geography books. But the study also yielded many interesting culture-biased maps, such as the one by a Chicago student in Figure 5.2 and this one by an Australian student. American students, incidentally, performed especially poorly on this task, often misplacing countries. Students from the former Soviet Union and Hungary made the most accurately detailed maps (Saarinen, 1987).

(*Source:* From Robert L. Solso, *Cognitive Psychology,* 5th ed. Published by Allyn and Bacon, Boston, MA. Copyright © 1998 by Pearson Education. Reprinted by permission of the publisher.)

Thought and the Brain

Developments in brain imaging have allowed cognitive researchers to begin mapping the mind itself (Ashby & Waldron, 2000). With the help of the computer, scientists can connect certain thoughts, such as "dog" or "pencil," with specific electrical wave patterns in the brain (Garnsey, 1993; Osterhout & Holcomb, 1992). They do this by repeatedly presenting a stimulus (such as the word *dog* flashed on a screen) to a volunteer "wired" to record the brain's electrical responses. While the brain waves on just one trial may show no clear pattern, a computer can average many brain wave responses to a single, repeated stimulus (such as a tone or a visual image), eliminating the random background "noise" of the brain and isolating the unique brain wave pattern evoked by that stimulus (Kotchoubey, 2002). These EEG patterns associated with particular stimuli are called **event-related potentials**.

Thinking in Modules Other methods can also tell us which parts of the brain switch on and off while we think. With PET scans and magnetic resonance imaging (MRI), neuroscientists have identified brain regions that become active during various mental tasks. Two broad conclusions have come from this work. First, *thinking is an activity involving widely distributed areas of the brain—not just a single "thinking center."* Second, *neuroscientists now see the brain as a community of highly specialized modules, each of which deals with different components of thought* (Cree & McRae, 2003). Moreover, the brain generates many of the images used in thought with the same circuitry it uses for sensation. Thus, visual imagery drawn from memory activates the visual cortex, while auditory memories engage the auditory cortex (Behrmann, 2000). And thinking with language may involve different regions, depending on the topic. One brain-imaging study found that most jokes tickle us mainly in the language processing areas of the cortex, while sound-alike puns activate the brain's sound-processing circuits, as well (Goel & Dolan, 2001). In general, the picture of thought coming out of this work reveals thinking as a process composed of many modules acting in concert.



Different thoughts and actions make different parts of the brain "light up" on brain scans. This image shows the brain areas used in thinking about words and producing speech.

Frontal Lobe Control The frontal lobes of the brain play an especially important part in coordinating mental activity when we make decisions and solve problems (Helmuth, 2003a; Koechlin et al., 2003). To do so, the prefrontal cortex performs three different tasks: keeping track of the *episode* (the situation in which we find ourselves), understanding the *context* (the meaning of the situation), and responding to a specific *stimulus* in the situation. Here's how it works. Suppose that the phone rings (the stimulus). Normally—at your own house—you would answer it. But suppose that you are at a friend's house (a different context). Under this condition, you would probably let the phone ring without answering it. But if your friend, who has just hopped into the shower, has asked you to take a message if the phone happens to ring (the episode), you will answer it. From a neuroscience perspective, the interesting thing is that each of these tasks is performed cooperatively by different combinations of brain modules. It's an impressive and sophisticated system.

Intuition Another fascinating discovery involves the location of brain circuits associated with what we often call "common sense," or the ability to act on "intuition." Psychologists have long known that when people make decisions—whether about buying a house or selecting a spouse—they may make quick judgments that draw on feelings, as well as reason (Gladwell, 2005; Myers, 2002). This emotional component of thinking apparently involves regions of the frontal lobes just above the eyes. These structures allow us unconsciously to add emotional "hunches" to our decisions in the form of information about past rewards and punishments. Indi-

Event-related potentials Brain waves shown on the EEG in response to stimulation.

viduals with severe damage to this area of the brain may display little emotion. They may also have impairments in **intuition**—the ability to make judgments without consciously reasoning. Such persons frequently make unwise choices when faced with decisions (Damasio, 1994).

But not all intuitive thinking draws on emotion. Much of what we know "intuitively" comes from implicit memory. Says psychologist Seymour Epstein, "Intuition is just the things we've learned without realizing we've learned them. And sometimes they're useful. Sometimes they're maladaptive" (Winerman, 2005d, p. 5). Nor is intuition always right—sometimes our intuitive snap judgments, which may feel like truth, are merely our prejudices and biases (Myers, 2002). That has been shown to be true of executives, who commonly overestimate the power of their intuition by believing that they are especially good judges of other people's abilities and character. Accordingly, executives often rely exclusively on in-person interviews as the basis for hiring, even though studies show that they usually make better judgments by factoring in some more objective data, such as educational levels and test scores (Dawes, 2001).

CONNECTION • CHAPTER 4

Implicit memory holds information that can affect behavior without becoming fully conscious.

Sometimes, however, quick intuitive judgments can be surprisingly on target. Dr. Nalini Ambady has found that people make remarkably accurate judgments of a person's personality traits after viewing only a six-second video clip. Similarly, students' quick judgments about a professor's teaching effectiveness correlate highly with end-of-course ratings (Ambady & Rosenthal, 1993; Greer, 2005). Daniel Kahneman suggests that intuition is an evolutionary invention that helped our ancestors make snap judgments in difficult and dangerous situations (2003).

So, where do the seemingly contradictory findings about intuition leave us? Much of the time our "instincts" about personality are correct—but, notes psychologist Frank Bernieri, the serial killer Ted Bundy made a good first impression (Winerman, 2005c). Kahneman notes that one of the most unreliable aspects of intuition concerns statistical judgments. (How many English words end with *r*? Or how likely is it that I will be killed by a terrorist?)

It is important for us to realize when we are making intuitive judgments and to realize that they can be wrong: As we saw in our discussion of memory, confidence is not a reliable indicator of accuracy. For psychologists, the task that lies ahead is to help us learn to use intuition more accurately (see Haslam, 2007). This is particularly important for people who must make rapid life-and-death decisions: police officers, soldiers, pilots, air traffic controllers, and medical personnel.

PSYCHOLOGYMATTERS

Schemas and Scripts Help You Know What to Expect

Much of your knowledge is stored in your brain as *schemas* (Oden, 1987). We can define a *schema* as a cluster of related concepts that provides a framework for thinking about objects, events, ideas, or even emotions. So, you probably have schemas that represent "cat," "Internet," "classical conditioning," "music," and "fear." Some of your schemas could even contain an entire hierarchy of other concepts. Let's look at some important ways that these schemas are used.

CONNECTION • CHAPTER 6

Piaget said that cognitive development involves changes in *schemas*.

Expectations Schemas are one of the attributes that Google and other search engines lack, so they have no real understanding of "birthday" or "psychology" or "nonfat mocha." But for us, schemas provide contexts and expectations about the features likely to be found when you encounter familiar people, situations,

Intuition The ability to make judgments without consciously reasoning.

images, and ideas (Baldwin, 1992). For example, to an airline passenger, the word *terminal* probably conjures up a schema that includes scenes of crowds, long corridors, and airplanes. For a heart attack victim, however, the schema for *terminal* might include feelings of anxiety and thoughts of death. And for an auto mechanic, *terminal* might mean a connection for a battery cable.

Making Inferences New information, which is often incomplete or ambiguous, makes more sense when you can relate it to existing knowledge in your stored schemas. So schemas enable you to make inferences about missing information. Consider this statement:

> Tanya was upset to discover, on opening the basket, that she'd forgotten the salt.

With no further information, what can you infer about this event? *Salt* implies that the basket is a picnic basket containing food. The fact that Tanya is upset that the salt is missing suggests that the food in the basket is food that is usually salted, such as hard-boiled eggs or vegetables. You automatically know what other foods might be included and, equally important, what definitely is not: Everything in the world that is larger than a picnic basket and anything that would be inappropriate to take on a picnic—from a boa constrictor to bronze-plated baby shoes. Thus, the body of information you now have has been organized around a "picnic-basket" schema. So by relating the statement about Tanya to your preestablished schema, the statement has meaning.

How important are schemas to you? According to researchers Donald Norman and David Rumelhart, schemas are the primary units of meaning in the human information-processing system (1975). You comprehend new information by integrating new input with what you already know, as when your favorite pizza parlor advertises a new spicy Thai chicken curry pizza that you had never even dreamed of before. (Psychologists call this process of blending the new with the old *assimilation*.) If you find a discrepancy between new input and existing schemas, you may deal with it by changing your schema (a process called *accommodation*), as most of us did when the concept of "telephone" was revolutionized by the introduction of cell phones.

In a practical application of schema theory, researchers taught low-achieving math students how to classify word problems into just a few different types. For example, one type involved a "change" schema. The students learned that all "change" problems involve a story, such as this one: "Rudy had three pennies, and his mother gave him four more. How many does he now have?" They also learned some common strategies for solving "change" problems. After several months of schema-based instruction, test results showed that these low-achieving students had made tremendous gains in their math scores—enough to move into the "above average" ranks (Jitendra et al., 2007).

Schemas and Humor Schemas also serve as the foundation for much of our humor (Dingfelder, 2006). We often find things funny when they invoke two or more incongruous or incompatible schemas at once. Consider this joke:

> A horse walks into a bar, and the bartender says, "Why the long face?"

This brief (and possibly lame) joke features several incongruous schemas, including (a) our knowledge that horses don't frequent bars and (b) the confusion over the horse's long nose and the "long face" as a metaphor for sadness.

Not everything we find incongruous is funny, however. A person being struck by a car on the sidewalk is not humorous. Generally, if the conflicting frames of reference involve threat or if the situation holds a cherished belief up to ridicule, we won't find it funny. If, however, schemas in a joke serve to demean someone who we consider threatening, we may well find it humorous. This accounts for much humor that we call racist, sexist, or political.

Scripts as Event Schemas We have schemas not only about objects and events but also about persons, roles, and ourselves. These schemas help us to decide what to expect or how people should behave under specific circumstances. An *event schema* or **script** consists of knowledge about sequences of interrelated, specific events and actions expected to occur in a certain way in particular settings (Baldwin, 1992). We have scripts for going to a restaurant, using the library, listening to a lecture, going on a first date, and even making love.

Cultural Influences on Scripts Scripts used in other cultures may differ substantially from ours. For example, American women living in conservative Arab countries often report that many behaviors they might take for granted at home—such as walking unescorted in public, wearing clothing that showed their faces and legs, or driving a car—are considered scandalously inappropriate by citizens of their host country. To maintain good relations, these women have had to change their habits and plans to accommodate local customs. We can see from such examples that the scripts found in diverse cultures have developed from distinct schemas for viewing the world.

When people from the same culture get together, they may feel comfortable because they follow the same scripts, helping them to comprehend the "meaning" of the situation in the same way and have the same expectations of each other (Abelson, 1981; Schank & Abelson, 1977). When people do not all follow similar scripts, however, they may be made uncomfortable by a script "violation" and may have difficulty understanding why the scene was "misplayed" by others. Unfortunately, when scripts from different cultures clash, people may say, "I tried to interact, but it was so awkward that I don't want to try again" (Brislin, 1993).

CheckYourUnderstanding

1. **APPLICATION:** A dictionary definition would be an example of which kind of concept?
2. **APPLICATION:** Give an example of a concept hierarchy.
3. **APPLICATION:** Give an example of a script.
4. **UNDERSTANDING THE CORE CONCEPT:** All of the following are components of thought, except
   a. concepts.
   b. images.
   c. schemas.
   d. stimuli.

Answers 1. An artificial concept. **2.** Our example is animal, mammal, dog, cocker spaniel. Any such series forms a concept hierarchy, provided that each category includes the one that follows. Another example would be food, Italian food, pasta, spaghetti. **3.** Knowing how to check out a book at the library is an example of a script. So is any other procedure, such as knowing how to study for a test or how to boil an egg. **4.** d

5.2 KEY QUESTION
WHAT ABILITIES DO GOOD THINKERS POSSESS?

The popularity of lotteries and casino games, in which the chances of winning are small, shows us that human thought is not always purely logical. Instead, we might say that thinking is *psycho*logical—which has some advantages. Departures from logic allow us to fantasize, daydream, act creatively, react unconsciously, respond emotionally, and generate new ideas.

We are, of course, capable of careful reasoning. After all, our species did invent that most logical of devices, the computer. Still, the psychology of thinking teaches us that we should not expect people to behave always in a strictly logical manner or that good judgment will be based on reason alone. This

Script A cluster of knowledge about sequences of events and actions expected to occur in particular settings.

ability to think *psycho*logically enhances our ability to solve problems. And, as we will see, good thinkers also know how to use effective thinking strategies and the avoidance of ineffective or misleading strategies. We will also see that *psycho*logical thinking is more useful than mere logic because it helps us make decisions rapidly in a changing world that usually furnishes us incomplete information. Our Core Concept puts all this in more technical language:

core concept

Good thinkers not only have a repertoire of effective strategies, called algorithms and heuristics, they also know how to avoid the common impediments to problem solving and decision making.

Problem Solving

Artists, inventors, Nobel Prize winners, great presidents, successful business executives, world-class athletes, and high-achieving college students—all must be effective problem solvers. And what strategies do these effective problem solvers use? No matter what their field, those who are most successful share certain characteristics. They, of course, possess the requisite knowledge for solving the problems they face. In addition, they are skilled at (a) *identifying the problem* and (b) *selecting a strategy* to attack the problem. In the next few pages we will examine these two skills, with the aid of some examples.

Identifying the Problem

A good problem solver learns to consider all the relevant possibilities, without leaping to conclusions prematurely. Suppose that you are driving along the freeway, and your car suddenly begins sputtering and then quits. As you coast to the shoulder, you notice that the gas gauge says "empty." What do you do? Your action in this predicament depends on the problem you think you are solving. If you assume that you are out of fuel, you may hike to the nearest service station for a gallon of gas. But you may be disappointed. By representing the problem as "out of gas," you may fail to notice a loose battery cable that interrupts the supply of electricity both to the spark plugs and to the gas gauge. The good problem solver considers all the possibilities before committing to one solution.

Selecting a Strategy

The second ingredient of successful problem solving requires selecting a strategy that fits the problem at hand (Wickelgren, 1974). For simple problems, a trial-and-error approach will do—as when you search in the dark for the key to open your front door. More difficult problems require better methods. Problems in specialized fields, such as engineering or medicine, may require not only specialized knowledge but special procedures or formulas known as *algorithms*. In addition, expert problem-solvers have a repertoire of more intuitive, but less precise, strategies called *heuristics*. Let's look more closely at both of these methods.

Algorithms

Whether you are a psychology student or a rocket scientist, selecting the right algorithms will guarantee correct solutions for many of your problems. And what are these never-fail strategies? **Algorithms** are nothing more than formulas or procedures, like those you learned in science and math classes. They can help you solve particular kinds of problems for which you have all the necessary information. For example, you can use algorithms to balance your checkbook, figure your gas mileage, calculate your grade-point average, and make a call on your cell phone. If applied correctly, an algorithm always works because you merely follow a step-by-step procedure that leads directly from the problem to the solution.

Algorithms Problem-solving procedures or formulas that guarantee a correct outcome, if correctly applied.

Despite their usefulness, however, algorithms will not solve every problem you face. Problems involving subjective values or having too many unknowns (Will you be happier with a red car or a white car? Which is the best airline to take to Denver?) and problems that are just too complex for a formula (How

can you get a promotion? What will the fish bite on today?) do not lend themselves to the use of algorithms. And that is why we also need the more intuitive and flexible strategies called *heuristics*.

Heuristics Everyone makes a collection of heuristics while going through life. Examples: "Don't keep bananas in the refrigerator." "If it doesn't work, see if it's plugged in." "Feed a cold and starve a fever" (or is it the other way around?). **Heuristics** are simple, basic rules—so-called "rules of thumb" that help us cut through the confusion of complicated situations. Unlike algorithms, heuristics do not guarantee a correct solution, but they often give us a good start in the right direction. Some heuristics require special knowledge, such as training in medicine or physics or psychology. Other heuristics, such as those you will learn in the following paragraphs, are more widely applicable—and well worth remembering.

Some Useful Heuristic Strategies

Here are three essential heuristics that should be in every problem-solver's tool kit. They require no specialized knowledge, yet they can help you in a wide variety of puzzling situations. The common element shared by all three involves getting the problem solver to approach a problem from a different perspective.

Working Backward Some problems, such as the maze seen in Figure 5.4, may baffle us because they present so many possibilities we don't know where to start. A good way to attack this sort of puzzle is by beginning at the end and *working backward*. (Who says that we must always begin at the beginning?) This strategy can eliminate some of the dead ends that we would otherwise stumble into by trial and error. In general, working backward offers an excellent strategy for problems in which the goal is clearly specified, such as mazes or certain math problems.

Searching for Analogies If a new problem is similar to another you have faced before, you may be able to employ a strategy that you learned previously. The trick is to recognize the similarity, or *analogy,* between the new problem and the old one (Medin & Ross, 1992). For example, if you are an experienced cold-weather driver, you use this strategy to decide whether to install tire chains on a snowy day: "Is the snow as deep as it was the last time I needed chains?" Even very complex problems may yield to this strategy. The cracking of the genetic code was assisted by the analogy of the DNA molecule being shaped like a spiral staircase, as you can see in the accompanying photos.

Breaking a Big Problem into Smaller Problems Are you facing a huge problem, such as an extensive term paper? The best strategy may be to break the big problem down into smaller, more manageable steps, often called *subgoals*. In writing a paper, for example, you might break the problem into the steps of selecting a topic, doing your library and Internet research, outlining the paper, writing the first draft, and revising the paper. In this way, you will begin to organize the work and develop a plan for attacking each part of the problem. And, by tackling a problem in a step-by-step fashion, big problems will seem more manageable. Any large, complex

Watson and Crick used the analogy of a spiral staircase to help them understand the structure of the DNA molecule and crack the genetic code.

Heuristics Cognitive strategies or "rules of thumb" used as shortcuts to solve complex mental tasks. Unlike algorithms, heuristics do not guarantee a correct solution.

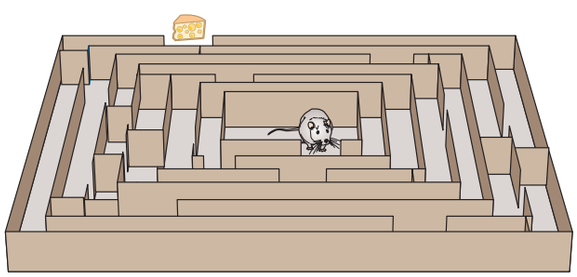


FIGURE 5.4
Working Backward

Mazes and math problems often lend themselves to the heuristic of working backward. Try solving this maze, as the mouse must do, by starting at what would normally be the finish (in the center) and working backward to the start.

problem—from writing a paper to designing an airplane—may benefit from this approach. In fact, the Wright Brothers deliberately used this heuristic to break down their problem of powered human flight into its components. By using a series of kites, gliders, and models, they studied the component problems of lift, stability, power, and directional control. Later they put their discoveries together to solve the larger problem of powered human flight (Bradshaw, 1992).

Obstacles to Problem Solving

Having a good repertoire of strategies is essential to successful problem solving, but people often get stuck because they latch onto an ineffective strategy and won't let go. For this reason, problem solvers must learn to recognize when they have encountered an obstacle that demands a new approach. Becoming a successful problem solver has as much to do with recognizing such obstacles as it does with selecting the right algorithm or heuristic. Here are some of the most troublesome of the obstacles problem solvers face.

Mental Set

Sometimes you may persist with a less-than-ideal strategy simply because it has worked on other problems in the past. In psychological terms, you have an inappropriate **mental set**—the tendency to respond to a new problem in the same way you approached a similar problem previously. You have "set" your mind on a single strategy, but this time you've chosen the wrong analogy or algorithm. Let's illustrate this with the following puzzle.

Each of the groups of letters in the columns below is a common, but scrambled, word. See if you can unscramble them:

nelin	frsca	raspe	tnsai
ensce	peshe	klsta	epslo
sdlen	nitra	nolem	naoce
lecam	macre	dlsco	tesle
slfal	elwha	hsfle	maste
dlchi	ytpar	naorg	egran
neque	htmou	egsta	eltab

Check your answers against the key on page 190.

Most people, whether they realize it or not, eventually solve the scrambled word problem with an algorithm by rearranging the order of the letters in all the words in the same way, using the formula 3-4-5-2-1. Thus,

n e l i n becomes l i n e n
1 2 3 4 5 3 4 5 2 1

Notice, however, that by using that algorithm, your answers for the last two columns won't agree with the "correct" ones given on page 190. The mental set that you developed while working on the first two columns prevented you from seeing that there is more than one answer for the last 14 items. The lesson of this demonstration is that a mental set can make you limit your options, without realizing that you have done so. While a mental set often does produce results, you should occasionally stop to ask yourself whether you have slipped into a rut that prevents your seeing another answer. (Now can you find some other possible answers to the scrambled words in the last two columns?)

Mental set The tendency to respond to a new problem in the manner used for a previous problem.

Functional fixedness The inability to perceive a new use for an object associated with a different purpose; a form of mental set.

CONNECTION • CHAPTER 4
Compare *functional fixedness* with *proactive interference.*

Functional Fixedness

A special sort of mental set occurs when you think you need a screwdriver, but you don't realize that you could tighten the bolt with a dime. Psychologists call this **functional fixedness**. Under this condition, the function of a familiar object becomes so set, or fixed, in your mind that you cannot see a new function for it. To illustrate, consider this classic problem:

> Your psychology professor has offered you $5 if you can tie together two strings dangling from the ceiling (see Figure 5.5) without pulling them down.

But when you grab the end of one string and pull it toward the other one, you find that you cannot quite reach the other string. The only objects available to you in the room are on the floor in the corner: a Ping-Pong ball, five screws, a screwdriver, a glass of water, and a paper bag. How can you reach both strings at once and tie them together?

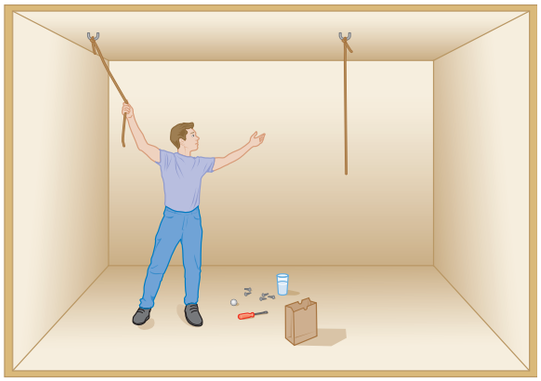


FIGURE 5.5
The Two-String Problem

How could you tie the two strings together, using only the objects found in the room?

Read the following if you want the answer: In this problem you may have had functional fixedness with regard to the screwdriver. Did you realize that you could use the screwdriver as a pendulum weight to swing one of the strings toward you?

Self-Imposed Limitations We can be our own worst enemies when we impose unnecessary limitations on ourselves. The classic nine-dot problem in Figure 5.6 illustrates this neatly. To solve this one, you must connect all nine dots with no more than four connecting straight lines—that is, drawn without lifting your pencil from the paper. The instructions allow you to cross a line, but you may not retrace a line.

Hint: Most people who confront this problem impose an unnecessary restriction on themselves by assuming that they cannot draw lines beyond the square made by the dots. Literally, they don't "think outside the box." Figure 5.7 gives two possible correct answers. Translating this into personal terms, we can find many instances in which people impose unnecessary restrictions on themselves. Students may assume that they have no talent for math or science—thereby eliminating the possibility of a technical career. Or because of gender stereotypes a man may never consider that he could be a nurse or a grade school teacher, and a woman may assume that she must be a secretary, rather than an administrator. What real-life problems are you working on in which you have imposed unnecessary limitations on yourself?

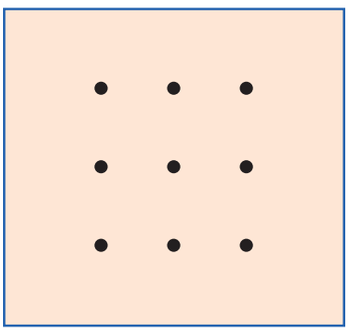


FIGURE 5.6
The Nine-Dot Problem

Can you connect all nine dots with four connecting straight lines without lifting your pencil from the paper?

(*Source:* Adapted from "Can You Solve It?" in *How to Solve Mathematical Problems: Elements of a Theory of Problems and Problem Solving* by Wayne A. Wickelgren. Copyright © 1974 by W. H. Freeman and Company. Reprinted by permission of Dover Publications.)

Other Obstacles There are many other obstacles to problem solving that we will simply mention, rather than discuss in detail. These include lack of specific knowledge required by the problem, lack of interest, low self-esteem, fatigue, and drugs (even legal drugs, such as cold medicines or sleeping pills). Arousal and the accompanying stress represent another important stumbling block for would-be problem solvers. When you study emotion and motivation later in this book, you will see that there is an optimum arousal level for any task, be it basketball, brain surgery, or making a presentation in class. Beyond that critical point, further arousal causes performance to deteriorate. Thus, moderate levels of arousal actually facilitate problem solving, but high stress levels can make problem solving impossible.

In general, our discussion of problem solving shows that we humans are thinkers who readily jump to conclusions, based on our knowledge and biased by our motives, emotions, and perceptions. In view of this, it is surprising that our thinking so often serves us well in day-to-day life. Yet, from another perspective it makes perfect sense: Most of our problem-solving efforts draw on past experience to make predictions about future rewards or punishments. This, of course, is exactly what operant conditioning is all about—which suggests that this mode of thinking is a fundamental part of our nature. Many of the "flaws" in our reasoning abilities, such as functional fixedness, are actually part of an adaptive (but necessarily imperfect) strategy that helps us use our previous experience to solve new problems.

CONNECTION • CHAPTER 3
Operant conditioning involves the control of behavior by rewards and punishments.

Judging and Making Decisions

Whether you are a student, a professor, or a corporate president, you make decisions every day. "How much time do I need to study tonight?" "What grade does this paper deserve?" "How much should I invest?" You can think of each decision as the solution to a problem—a problem for which there may not be a

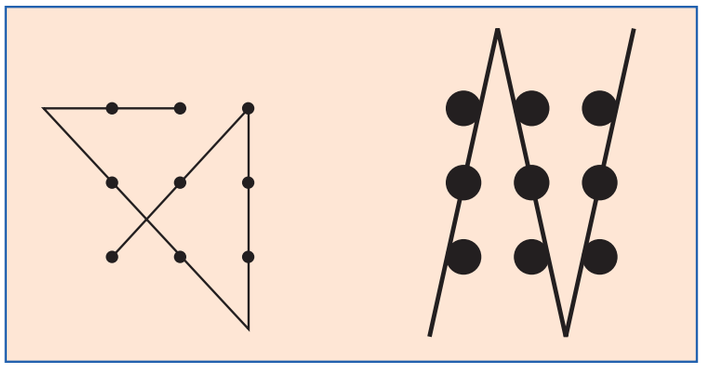


FIGURE 5.7
Two Solutions to the Nine-Dot Problem

(*Source:* Adapted from "Can You Solve It?" in *How to Solve Mathematical Problems: Elements of a Theory of Problems and Problem Solving* by Wayne A. Wickelgren. Copyright © 1974 by W. H. Freeman and Company. Reprinted by permission of Dover Publications.)

clearly right answer, but a problem requiring judgment. Unfortunately, especially for those who have not studied the psychology of decision making, judgment can be clouded by emotions and biases that interfere with critical thinking. Let's examine the most common of these causes of poor judgment.

Confirmation Bias Suppose that Tony has strong feelings about raising children: "Spare the rod and spoil the child," he says. How do you suppose Tony will deal with the news that punishment can actually encourage aggressive behavior? Chances are that he will be swayed by *confirmation bias* to ignore or find fault with information that doesn't fit with his opinions and to seek information with which he agrees. He will probably tell you tales of spoiled children who didn't get much punishment for their transgressions or of upstanding adults, like himself, who owe their fine character to harsh discipline. A great deal of evidence shows that the confirmation bias is a powerful and all-too-human tendency (Aronson, 2004; Nickerson, 1998). In fact, we all act like Tony sometimes, especially on issues on which we hold strong opinions.

CONNECTION • CHAPTER 1
Confirmation bias makes us pay attention to events that confirm our beliefs and ignore evidence that contradicts them.

Hindsight Bias A friend tells you that she lost money investing in "dot-com" stocks. "I thought the Internet was the wave of the future," she says. And you reply, "I knew the boom in Internet stocks would turn into a bust." You are guilty of the **hindsight bias**, sometimes called the "I-knew-it-all-along effect" (Fischhoff, 1975; Hawkins & Hastie, 1990). Just as guilty of hindsight bias are the Monday morning quarterbacks who know what play should have been called at the crucial point in yesterday's big game. This form of distorted thinking appears after an event has occurred and people overestimate their ability to have predicted it. Hindsight bias can flaw the judgment of jurors, historians, newscasters, and anyone else who second-guesses other people's judgments after all the facts are in.

Hindsight bias The tendency, after learning about an event, to "second guess" or believe that one could have predicted the event in advance.

Unscrambled Words (from page 188)

The words you found to solve the scrambled word problem may not jibe with the ones listed here—especially the third and fourth columns. Most people, whether they are aware of it or not, develop an *algorithm* as they work on the first two columns. While the formula will work on all the words, it becomes a *mental set* that interferes with the problem solver's ability to see alternative solutions for the words in the last two columns.

linen	scarf	pears	stain
scene	sheep	talks	poles
lends	train	melon	canoe
camel	cream	colds	steel
falls	whale	shelf	meats
child	party	groan	anger
queen	mouth	gates	bleat

Anchoring Bias Ask a few of your friends, one at a time, to give a quick, off-the-top-of-the-head guess at the answer to the following simple math problem:

$$1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8 = ?$$

Make them give you an estimate without actually doing the calculation; give them only about five seconds to think about it. Then, pose the problem in reverse to some other friends:

$$8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1 = ?$$

Are the results different for the two groups?

Nobody will give precisely the right answer, of course, but it's likely that your friends will respond as volunteers did in Daniel Kahneman and Amos Tversky's (2000) experiment. It turns out that the answers to such questions, where people usually don't have a good "ballpark" answer, depend on whether the problem begins with larger or smaller numbers. Those who saw the first problem gave a lower estimate than did those who were given the second problem. In Kahneman and Tversky's study, the average answer for the first group was 512, while the average for the second group was 2250. Apparently, their "first impression"—larger or smaller numbers at the beginning of the problem—biased their responses. Incidentally, the correct answer (40,320) was larger than either group had imagined.

Kahneman and Tversky have explained the difference between the two groups on the basis of an **anchoring bias**. That is, people apparently use this flawed heuristic to "anchor" their thinking to the higher or lower numbers that appear at the beginning of the problem. The anchoring bias can affect our real-world decisions, as those who sell automobiles and real estate well know: What we ultimately decide to pay for a car or a house depends on the price and condition of the first item we are shown.

Representativeness Bias If you assume that blondes are mentally challenged or ministers are prudish or math professors are nerdish, you not only have some prejudices, but your judgment has been clouded by **representativeness bias**. One reason people succumb to such prejudices is because the representativeness bias simplifies the task of social judgment. Once something is "categorized," it shares all the features of other members in that category. The fallacy in this heuristic, of course, is that people, events, and objects do not "belong" to categories simply because we find it mentally convenient to give them labels. By relying on category memberships to organize our experiences, we risk ignoring or underestimating the tremendous diversity of individual cases and complexity of people.

When estimating the likelihood that a specific individual belongs to a certain category—"vegetarian," for example—we look to see whether the person possesses the features found in a typical category member. For example, is your new acquaintance, Holly, a vegetarian? Does she resemble your prototype of a "typical" vegetarian? Perhaps you believe that most vegetarians wear sandals, ride bicycles, and support liberal social causes. If so, you might judge that Holly represents enough of the characteristics of your concept of "vegetarians" to belong to the same group.

But such an analysis is not entirely reasonable. Although some—perhaps many—vegetarians wear sandals, ride bicycles, and hold liberal views, the opposite may not be true: Because vegetarians are a minority group in the general population, it is unlikely that any particular individual who supports liberal social causes, wears sandals, and rides a bicycle is also vegetarian. That is, by ignoring the base rate information—the probability of a characteristic occurring in the general population—you have drawn an erroneous conclusion. Holly may in fact be an omnivore like most of your acquaintances, although if you invite her to dinner she will probably accept the cheese pizza and salad you offer her

Anchoring bias A faulty heuristic caused by basing (anchoring) an estimate on a completely irrelevant quantity.

Representativeness bias A faulty heuristic strategy based on the presumption that, once people or events are categorized, they share all the features of other members in that category.

Shoppers face the **tyranny of choice** *when they must decide among similar products. Psychologist Barry Schwartz suggests quickly settling on one that is "good enough," rather than wasting time on "maximizing" a choice of little importance.*

without complaint. While your representativeness bias—judging Holly by what seems to be her "type"—may not have dire consequences in this case, the same error underlies the more serious stereotypes and prejudices that result when people classify others solely on the basis of group membership.

Availability Bias Yet another faulty heuristic comes from our tendency to judge probabilities of events by how readily examples come to mind. Psychologists call this the **availability bias**. We can illustrate this by asking you: Do more English words begin with *r* than have *r* in the third position? Most people think so because it is easier to think of words that begin with *r.* That is, words beginning with *r* are more available to us from long-term memory. Similarly, the availability bias affects people who watch a lot of violent crime on television. Why? They have violent images readily *available* in their memories. Studies show that fans of violent TV shows usually judge their chances of being murdered or mugged as being much higher than do people who watch little television (Singer et al., 1984).

The Tyranny of Choice Not all decision problems stem from faulty heuristics; they can also come from factors outside the person. To illustrate: Have you ever had trouble deciding among a bewildering array of choices—perhaps in buying a car, a computer, or even a tube of toothpaste? Too many choices can interfere with effective decision making, sometimes to the point of immobilizing us. For example, when Sheena Sethi-Iyengar and her colleagues (2004) studied the choices employees made concerning matching contributions to retirement funds, they found that too many alternatives could, in effect, make people throw away free money. If employers offered to match employees' contributions and give them only two alternatives, 75% elected to participate. But when allowed to select among 59 possibilities, the participation rate fell to 60%. Apparently some people just gave up. Psychologist Barry Schwartz (2004) calls this the **tyranny of choice**.

Schwartz says that the tyranny of choice can also become a source of stress, not to mention a big waste of time, especially for those who feel compelled to make the "correct" decision or get the very "best buy." The antidote, he says, is "satisficing," rather than "maximizing." Satisficers, says Schwartz, scan their options until they find one that is merely "good enough," while maximizers stress themselves out by trying to make certain they have made the very best choice.

Decision-Making and Critical Thinking Much of the foregoing discussion should have a familiar ring, because it involves critical thinking. In fact, one of the critical thinking questions we have posed in this book deals with the possibility of biases, such as confirmation bias, anchoring bias, and availability bias. In other words, critical thinkers are alert to the common obstacles to problem solving.

In addition, we should now add a few more items to the list of critical-thinking skills that we have discussed in previous chapters. Specifically, the critical thinker should know how to identify a problem (which is exactly what we do when we ask, "What is the issue?"), select a strategy, and apply the most common algorithms and heuristic strategies. All of these skills can help those who want to take their thinking the next level: to become an expert—or even a creative genius.

Availability bias A faulty heuristic strategy that estimates probabilities based on information that can be recalled (made available) from personal experience.

Tyranny of choice The impairment of effective decision making, when confronted with an overwhelming number of choices.

Creativity A mental process that produces novel responses that contribute to the solutions of problems.

Becoming a Creative Genius

Everyone would agree that Einstein was a creative genius. So were Aristotle and Bach. And we can make a case that Brin and Page, the Google guys, are geniuses, too. But what about your Aunt Elisa, who does watercolors? Such questions illustrate the big problem in creativity research: The experts cannot agree on an exact definition of **creativity**. Most, however, would go along with the slightly fuzzy notion that creativity is a process that produces novel responses that contribute to the solutions of problems. Most would also agree that a "genius" is someone whose insight and creativity are so great that they set that individual

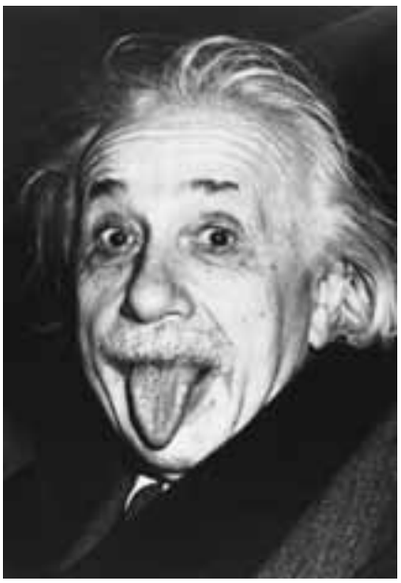
apart from ordinary folk. As with the idea of creativity, the boundary for genius is not well defined.

Let's follow the lead of psychologist Robert Weisberg, who offers a view of "genius" that goes against the commonly held assumption that geniuses are completely different from the rest of us. In brief, he argues that geniuses are merely good problem solvers who also possess certain helpful—but entirely human—characteristics.

Creative Genius as Not So Superhuman Here's how Weisberg (1986) characterized most people's assumptions about the quality we call "genius":

> Our society holds a very romantic view about the origins of creative achievements. . . . This is the genius view, and at its core is the belief that creative achievements come about through great leaps of imagination which occur because creative individuals are capable of extraordinary thought processes. In addition to their intellectual capacities, creative individuals are assumed to possess extraordinary personality characteristics which also play a role in bringing about creative leaps. These intellectual and personality characteristics are what is called "genius," and they are brought forth as the explanation for great creative achievements. (p. 1)

But, according to Weisberg and some other scholars in this area (Bink & Marsh, 2000), there is surprisingly little evidence supporting this view. In fact, the notion that creative geniuses are a breed apart may actually discourage creativity by making people feel that real creativity lies out of their reach. A more productive view, suggests Weisberg, portrays the thinking of people we call geniuses as "ordinary thought processes in ordinary individuals" (p. 11). What produces extraordinary creativity, he says, is extensive knowledge, high motivation, and certain personality characteristics—not superhuman talents.



There was no question but that Albert Einstein was bright. He also had an independent streak, a sense of humor, an intense interest in the complex problem of gravity, and a willingness to restructure the problem. And he sought the stimulation of other physicists. But he probably did not use thought processes that were altogether different from those used by other thinkers.

Knowledge and Understanding Everyone agrees with Weisberg on one point: The most highly creative individuals have *expertise,* defined as a highly developed understanding of the knowledge in their fields (Ericsson et al., 2006). In fact, you cannot become highly creative without first becoming an **expert:** having extensive and organized knowledge of the field in which you will make your creative contribution. But such mastery is not easily achieved, because it requires a high level of motivation that can sustain years of intense training and practice. Studies indicate that about ten years of work are required to master the knowledge and skills required for full competence in virtually any field, whether it be skiing, sculpture, singing, or psychology (Ericsson et al., 1993; Sternberg & Lubart, 1991, 1992). Oh, yes, and this rule also applies to the field of computing, as in the case of Google founders Brin and Page. Meanwhile, such factors as time pressures or an overly critical supervisor, teacher, or parent can suppress the creative flow (Amabile et al., 2002).

Aptitudes, Personality Characteristics, and Creativity In opposition to Weisberg, psychologist Howard Gardner (1993) argues that the extraordinary creativity that we see in the work of Freud, Einstein, Picasso, and others is a combination of several factors that include not only expertise and motivation but also certain patterns of abilities and personality characteristics. Highly creative individuals, he says, have **aptitudes**—largely innate potentialities—specific to certain domains. (These potentialities, of course, must be developed by intensive study and practice.) Freud, for example, had a special facility for creating with words and understanding people; Einstein was remarkably good at logic and spatial relationships; and Picasso's creativity arose from a combination of aptitudes comprising spatial relationships and interpersonal perceptiveness.

But at the same time, creative people usually possess a common cluster of personality traits, including the following ones (Barron & Harrington, 1981; Csikszentmihalyi, 1996):

Experts Individuals who possess well-organized funds of knowledge, including the effective problem-solving strategies, in a field.

Aptitudes Innate potentialities (as contrasted with abilities acquired by learning).

- *Independence.* Highly creative people have the ability to resist social pressures to conform to conventional ways of thinking, at least in their area of creative interest (Amabile, 1983, 1987; Sternberg, 2001). That is, they have the confidence to strike out on their own. Because of this, perhaps, some creative people describe themselves as loners.
- *Intense interest in a problem.* Highly creative individuals also must have an all-consuming interest in the subject matter with which they will be creative (Amabile, 2001). They are always tinkering, often just in their minds, with problems that fascinate them (Weisberg, 1986). External motivators, such as money or a Nobel Prize, may add to their motivation, but the main motivators are internal, otherwise they could not sustain the long-term interest in a problem necessary for an original contribution.
- *Willingness to restructure the problem.* Highly creative people not only grapple with problems, but they often question the way a problem is presented (Sternberg, 2001). (Recall our earlier discussion about identifying the problem.) For example, students from the School of the Art Institute of Chicago who later became the most successful creative artists among their class members had one striking characteristic in common: They were always changing and redefining the assignments given by their instructors (Getzels & Csikszentmihalyi, 1976).
- *Preference for complexity.* Creative people seem drawn to complexity—to what may appear messy or chaotic to others. Moreover, they revel in the challenge of looking for simplicity in complexity. Thus, highly creative people may be attracted to the largest, most difficult, and most complex problems in their fields (Sternberg & Lubart, 1992).
- *A need for stimulating interaction.* Creativity of the highest order almost always grows out of an interaction of highly creative individuals. Early in their careers, creative people usually find a mentor—a teacher who brings them up to speed in their chosen field. Highly creative individuals go on to surpass their mentors and then find additional stimulation from the ideas of others like themselves. Often, this means leaving behind family and former friends (Gardner, 1993).

So, what is the take-home message for our understanding of creativity? Those who have looked closely at this domain agree on two main points. First, creativity requires well-developed knowledge of the field in which the creative contribution will be made. Second, high-level creativity requires certain personal characteristics, such as independence and the motivation required to sustain an interest in an unsolved problem over a very long period of time. That is your formula for becoming a creative genius.

The Role of Intelligence in Creativity Is a high IQ necessary for creativity or genius? The answer is a bit complicated. Low intelligence inhibits creativity—although, we will see that there are some special cases, known as *savants,* who may have a highly developed skill, despite their mental handicaps. On the other end of the IQ spectrum, we find that having high intelligence does not necessarily mean that the individual will be creative: There are lots of very bright people who never produce anything that could be called groundbreaking or highly original and insightful. In general, we can say that intelligence and creativity are distinct abilities. We can find plodding, unimaginative persons at all IQ levels, and we can find highly creative persons with only average IQ scores.

Robert Sternberg (2001) argues that creativity lies a step beyond IQ. In his view, creativity requires a decision to go against the expectations of the crowd. This makes creativity potentially achievable for everyone who chooses to adopt a creative attitude. Most people will not do so, he says, for a variety of reasons, including an unwillingness to take the necessary risks.

But we are again getting ahead of ourselves. To understand more deeply how creativity and intelligence are different, it will be helpful to know what intelligence is and how it is measured . . . coming up in a couple of pages.

PSYCHOLOGYMATTERS

Using Psychology to Learn Psychology

Obviously, *experts* are people who know a lot about a particular subject. Unlike a novice, an expert confronting a problem does not have to start from scratch. Experts can often see a solution quickly because they have seen many similar problems before. That is, they are especially good at finding analogies.

Their secret lies in the way their knowledge is organized (Ericsson et al., 2006; Ross, 2006). Characteristically, the novice possesses knowledge that is both limited and unorganized, while experts have extensive knowledge organized into elaborate "chunks" and schemas. We can see this quite clearly in a famous study of world-class chess players.

A Study of Chess Experts Dutch psychologist Adriaan de Groot found some striking differences when he compared how well a group of grand master chess players and another group of merely good players could remember to a chess problem. When allowed five seconds to view a configuration of pieces as they might appear on a chessboard during a match, the grand masters could reproduce the pattern far more accurately than those with less proficiency (de Groot, 1965). Does that mean that the grand masters had better visual memories? No. When confronted with a random pattern of pieces on the chess board—a pattern that would never happen in a match—the grand masters did no better than the others. This suggests that the experts were better able to draw on familiar patterns in memory, rather than trying to recall individual pieces and positions.

Expertise as Organized Knowledge How do experts organize their knowledge? There is no easy formula. Through study and practice they develop both a fund of knowledge to apply to a problem and a familiarity with the field's common problems and solutions. That is, they know not only the facts but how the facts are interrelated and used (Bédard & Chi, 1992). Aside from facts and specific skills they must learn, would-be-experts must also acquire a repertoire of heuristics, also known as "tricks of the trade," that are unique to their field of expertise. These heuristics help them find solutions more quickly, without having to follow so many blind leads (Gentner & Stevens, 1983; Simon, 1992).

Practice versus Talent Are experts born, or is expertise learned? The highest levels of skilled performance requiring speed and accuracy of movement, as in athletics or music, seem to depend in part on native ability (Ackerman, 2007; Simonton, 2001). Expertise in a field requiring the mastery of a body of knowledge (think psychology, medicine, or medieval literature) clearly requires considerable study. There is evidence that people have differing aptitudes for performing at the highest levels in any given field, but it is impossible to predict in advance who has the requisite ability for a particular endeavor. At this point, the important variables seem to be motivation and practice—much as we saw with creativity (Ericsson & Charness, 1994).

Eventually, perhaps, the theories of multiple intelligences that we will study can give us some practical assistance. But for now, especially if you are at the beginning of your college career, the best advice would be to explore as many fields as you can, to find out where your passions lie. You are much more likely to do the necessarily long and hard work on something you love.

So, How Do You Become an Expert? A supportive environment, with good teachers and mentors, helps (Barab & Plucker, 2002). Beyond that, it's study and

practice! But don't just focus on the details. Learn the important schemas and problem-solving strategies in your chosen field, too. How long will it take? Research shows that achieving world-class status in any of a wide gamut of fields—from athletics to academics to chess to music—requires about ten years of intensive study and practice (Ericsson et al., 1993; Gardner, 1993).

What does this suggest for your learning of psychology and other disciplines? You can take the first steps in developing your expertise in any subject by attending to the way your professor and your text organize the information they present (Gonzalvo et al., 1994). Consider such questions as the following:

- What are the terms that your psychology professor keeps mentioning over and over? These might be such concepts as "cognitive science," "behaviorism," "developmental," or "theoretical perspectives." For you they may be, at first, unfamiliar and abstract, but for the professor they may represent the core of the course. Make sure you know what the terms mean and why they are important.
- What concepts does the course syllabus emphasize? What terms are associated with the main topics?
- Around what concepts is the textbook organized? You may be able to tell this quickly by looking at the table of contents. Alternatively, the authors may lay out the organizing points in the preface at the beginning of the book. (In this book, we have attempted to help you identify the organizing principles of each chapter in the form of Core Concepts.)

If you can identify the organizing principles for the course, they will simplify your studying. This makes sense, of course, in light of what you learned earlier about memory. Long-term memory (as you will remember!) is organized by meaningful associations. Accordingly, when you have a simple and effective way of organizing the material, you will have a framework that will help you store and retain it in long-term memory.

CheckYourUnderstanding

1. **APPLICATION:** From your own experience, give an example of an algorithm.
2. **RECALL:** Good problem solvers often use "tricks of the trade" or "rules of thumb" known as _____.
3. **APPLICATION:** Which one of the following would be an example of the confirmation bias at work?
   a. Mary ignores negative information about her favorite political candidate.
   b. Aaron agrees with Joel's taste in music.
   c. Natasha refuses to eat a food she dislikes.
   d. Bill buys a new RV, even though his wife was opposed to the purchase.
4. **RECALL:** List four personality characteristics commonly found in highly creative people.
5. **UNDERSTANDING THE CORE CONCEPT:** Heuristic strategies show that our thinking is often based on
   a. logic rather than emotion.
   b. experience rather than logic.
   c. trial and error rather than algorithms.
   d. creativity rather than genius.

Answers **1.** The mathematical formula for finding the area of a triangle is an example of an algorithm—as is any formula or procedure that always gives the correct answer. **2.** heuristics **3.** a **4.** Any four of the following are correct: independence, intense interest in a problem (high motivational level), willingness to restructure problems, preference for complexity, need for stimulating interaction. **5.** b

5.3 KEY QUESTION
HOW IS INTELLIGENCE MEASURED?

Psychologists have long been fascinated by the ways in which people differ in their abilities to reason, solve problems, and think creatively. The assessment of individual differences, however, did not begin with modern psychology. Historical records show that sophisticated mental testing methods were used in ancient China. Over 4000 years ago, the Chinese employed a program of civil service

testing that required government officials to demonstrate their competence every third year at an oral examination. Later, applicants were required to pass written civil service tests to assess their knowledge of law, the military, agriculture, and geography. British diplomats and missionaries assigned to China in the early 1800s described the selection procedures so admiringly that the British, and later the Americans, adopted modified versions of China's system for the selection of civil service personnel (Wiggins, 1973).

Unlike the historical Chinese, however, modern Americans seem to be more interested in how "smart" people are, as opposed to how much they have learned. It is the interest in this sort of "native ability" that spurred the development of intelligence testing as we know it today. But, despite the long history of mental testing and the widespread use of intelligence tests in our society, the exact meaning of the term *intelligence* is still disputed (Neisser et al., 1996). Still, most psychologists would probably agree with the general definition that we gave at the beginning of the chapter—that intelligence involves abilities to acquire knowledge, reason, and solve problems. They would also agree that a complete picture of an individual's intelligence must be obtained from measurements across a variety of tasks. However, they disagree on exactly what these abilities are or whether they are many or few in number.

Everyone does acknowledge that intelligence is a relative term. That is, an individual's level of intelligence must be defined in relation to the same abilities in a comparison group, usually of the same age range. Everyone also agrees that intelligence is also a *hypothetical construct:* a characteristic that is not directly observable but must be inferred from behavior. In practice, this means that intelligence is measured from an individual's responses on an intelligence test. The individual's scores are then compared to those of a reference group. Exactly what these tests should assess is the source of much controversy—and the focus of this section of this chapter.

Intelligence testing has a history of controversy, but most psychologists now view intelligence as a normally distributed trait that can be measured by performance on a variety of tasks.

core concept

We begin our survey of intelligence and intelligence testing by introducing you to the people who founded the field of intelligence testing.

Binet and Simon Invent a School Abilities Test

Alfred Binet *(Bi-NAY)* and his colleague Théodore Simon stepped into history in 1904. At that time, a new law required all French children to attend school, and the government needed a means of identifying those who needed remedial help. Binet and Simon were asked to design a test for this purpose. They responded with 30 problems sampling a variety of abilities that seemed necessary for school (Figure 5.8). The new approach was a success. It did, indeed, predict which children could, or could not, handle normal schoolwork.

Four important features distinguish the Binet-Simon approach (Binet, 1911):

1. They interpreted scores on their test as an estimate of *current performance* and not as a measure of innate intelligence.
2. They wanted the test scores to be used to identify children who needed special help and not merely to categorize or label them as bright or dull.
3. They emphasized that training and opportunity could affect intelligence, and they wanted to pinpoint areas of performance in which special education could help the children identified by their test.
4. They constructed the test *empirically*—based on how children were observed to perform—rather than tying the test to a particular theory of intelligence.

On the original Binet-Simon test, a child was asked to perform tasks such as the following:

- Name various common objects (such as a clock or a cat) shown in pictures.
- Repeat a 15-word sentence given by the examiner.
- Give a word that rhymes with one given by the examiner.
- Imitate gestures (such as pointing to an object).
- Comply with simple commands (such as moving a block from one location to another).
- Explain the differences between two common objects.
- Use three words (given by the examiner) in a sentence.
- Define abstract terms (such as "friendship").

FIGURE 5.8
Sample Items from the First Binet-Simon Test

Binet and Simon assessed French children of various ages with this test and computed the average for children at each age. Then, they compared each child's performance to the averages for children of various ages. Finally, they gave each child a score expressed in terms of **mental age (MA):** the average age at which individuals achieve a particular score. So, for example, when a child's score was the same as the average score for a group of 5-year-olds, the child was said to have a mental age of 5, regardless of his or her **chronological age (CA)**, the number of years since birth. Binet and Simon decided that those most needing remedial help were students whose MA was two years behind CA.

American Psychologists Borrow Binet and Simon's Idea

Less than a decade after the French began testing their school children, American psychologists imported the Binet-Simon test of school abilities and changed it into the form we now call the *IQ test*. They did this by first modifying the scoring procedure, expanding the test's content, and obtaining scores from a large normative group of people, including adults. Soon "intelligence testing" was widely accepted as a technique by which Americans were defining themselves—and each other.

The Appeal of Intelligence Testing in America

Why did tests of intelligence become so popular in the United States? Three forces changing the face of the country early in the 20th century conspired to make intelligence testing seem like an orderly way out of growing turmoil and uncertainty. First, the United States was experiencing an unprecedented wave of immigration, resulting from global economic, social, and political crises. Second, new laws requiring universal education—schooling for all children—were flooding schools with students. And third, when World War I began, the military needed a way of assessing and classifying the new recruits. Together, these events resulted in a need for large numbers of people to be assessed (Chapman, 1988). Intelligence was seen not only as a way to bring some order to the tumult of rapid social change but also as an inexpensive and democratic way to separate those who could benefit from education or military leadership training from those who could not.

One consequence of the large-scale group-testing program in America was that the public came to accept the idea that intelligence tests could accurately differentiate people in terms of their mental abilities. This acceptance soon led to the widespread use of tests in schools and industry. Another, more unfortunate, consequence was that the tests reinforced prevailing prejudices. Specifically, Army reports suggested that differences in test scores were linked to race and country of origin (Yerkes, 1921). Of course, the same statistics could have been used to demonstrate that environmental disadvantages limit the full development of people's intellectual abilities. Instead, immigrants with limited facility in English (the only language in which the tests were given) or even little understanding of how to take such tests were labeled as "morons," "idiots," and "imbeciles" (terms used at the time to specify different degrees of mental retardation).

While these problems are more obvious to us now (with the help of hindsight), at the time they were obscured by the fact that the tests did what most people wanted: They were simple to administer, and they provided a means of assessing and classifying people according to their scores. Never mind that there were

Mental age (MA) The average age at which normal (average) individuals achieve a particular score.

Chronological age (CA) The number of years since the individual's birth.

some biases and that some people were treated unfairly. In general, the public perceived that the tests were objective and democratic.

The Stanford-Binet Intelligence Scale The most respected of the new American tests of intelligence came from the laboratory of Stanford University professor Lewis Terman. His approach was to adapt the Binet and Simon test for U.S. schoolchildren by standardizing its administration and its age-level norms. The result was the Stanford-Binet Intelligence Scale (Terman, 1916), which soon became the standard by which other measures of intelligence were judged. But, because it had to be administered individually, Terman's test was less economical than the group tests. Nevertheless, it was better suited for spotting learning problems. Even more importantly, the Stanford-Binet test was designed both for children and adults.

With his new test Terman introduced the concept of the **intelligence quotient (IQ)**, a term coined originally by German psychologist William Stern in 1914. The IQ was the ratio of mental age (MA) to chronological age (CA), multiplied by 100 (to eliminate decimals):

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

Please follow us through the IQ equation with these examples: Consider a child with a chronological age of 8 years, whose test scores reveal a mental age of 10. Dividing the child's mental age by chronological age (MA/CA = 10/8) gives 1.25. Multiplying that result by 100, we obtain an IQ of 125. In contrast, another 8-year-old child who performs at the level of an average 6-year-old (MA = 6) has an IQ of $6/8 \times 100 = 75$, according to Terman's formula. Those whose mental age is the same as their chronological age have IQs of 100, which is considered to be the average or "normal" IQ.

Within a short time, the new Stanford-Binet test became a popular instrument in clinical psychology, psychiatry, and educational counseling. With the publication of this test Terman also promoted his belief that intelligence is largely innate and that his IQ test could measure it precisely. The message was that an IQ score reflected something fundamental and unchanging about people.

Although the Stanford-Binet became the "gold standard" of intelligence testing, it had its critics. The loudest objection was that it employed an inconsistent concept of intelligence because it measured different mental abilities at different ages. For example, 2- to 4-year-olds were tested on their ability to manipulate objects, whereas adults were tested almost exclusively on verbal items. Test makers heeded these criticisms; and, as the scientific understanding of intelligence increased, psychologists found it increasingly important to measure multiple intellectual abilities at all age levels. A modern revision of the Stanford-Binet now provides separate scores for several mental skills.

Problems with the IQ Formula

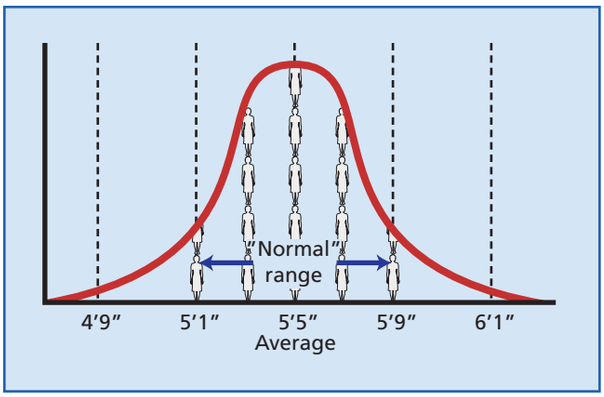
A problem in calculating IQ scores became apparent as soon as psychologists began to use their formula with adults. Here's what happens: By the mid- to late teenage years, gains in mental age scores usually level off, as people develop mentally in many different directions. Consequently, mental growth, as measured by a test, appears to slow down. As a result, Terman's formula for computing IQs makes normal children appear to become adults with mental retardation—at least as far as their test scores are concerned! Note what happens to the average 30-year-old's score if mental age, as measured by a test, stays at the same level as it was at age 15:

$$\text{IQ} = \frac{\text{Mental Age}}{\text{Chronological Age}} = \frac{15}{30} \times 100 = 50$$

Intelligence quotient (IQ) A numerical score on an intelligence test, originally computed by dividing the person's mental age by chronological age and multiplying by 100.

FIGURE 5.9
An (Imaginary) Normal Distribution of Women's Heights

The level of the curve at any point reflects the number of women with that height.



Psychologists quickly realized that this paints an erroneous picture of adult mental abilities. People do not grow less intelligent as they become adults (even though their children sometimes think so). Rather, adults develop in different directions, which their IQ scores do not necessarily reflect. Prudently, psychologists decided to abandon the original IQ formula and to find another means of calculating IQs. Their solution was similar to the familiar practice of "grading on the curve." This famous curve demands some explanation.

Calculating IQs "on the Curve"

Behind the new method for calculating IQs lay the assumption that intelligence is *normally distributed*. That is, intelligence is assumed to be spread through the population in varying degrees in such a way that only a few people fall into the high or low ranges, while most people cluster around a central average. In this respect, intelligence is presumed to be like many physical traits, including height. weight, and shoe size. If you were to measure any of these variables in a large number of people, you would probably get a set of scores that follow the same "curve" teachers use when they grade "on the curve." Let us take women's heights as an example.

Imagine that you have randomly selected a large number of adult women and arranged them in single-file columns, according to their heights (everybody 5′ tall in one column, 5′ 1″ in the next, 5′ 2″ in the next, and so on). You would find most of the women standing in the columns near the group's average height (See Figure 5.9.) Only a few would be in the columns containing extremely tall women or extremely short women. We could easily describe the number of women at each height by a curve that follows the boundary of each column. We call this bell-shaped curve a **normal distribution** (or **normal curve**).

Applying this same concept to intelligence, psychologists find that people's IQ test scores (like the women's heights we considered above) fit a normal distribution. (See Figure 5.10.) More precisely, when IQ tests are given to large numbers of individuals, the scores of those at each age level are normally distributed. (Adults are placed in their own group, regardless of age, and the distribution of their scores also fits the bell-shaped curve.) Instead of using the old IQ formula, IQs are now determined from tables that indicate where test scores fall on the normal curve. The scores are statistically adjusted so that the average for each age group is set at 100. Scores near the middle of the distribution (usually between 90 and 110) are considered to be in the **normal range.** (See Figure 5.10.) At the extreme ends of the distribution, scores below 70 are often said to be in the *mentally retarded range*, while those above 130 are sometimes said to indicate *giftedness*.

Normal distribution (or **normal curve**) A bell-shaped curve, describing the spread of a characteristic throughout a population.

Normal range Scores falling near the middle of a normal distribution.

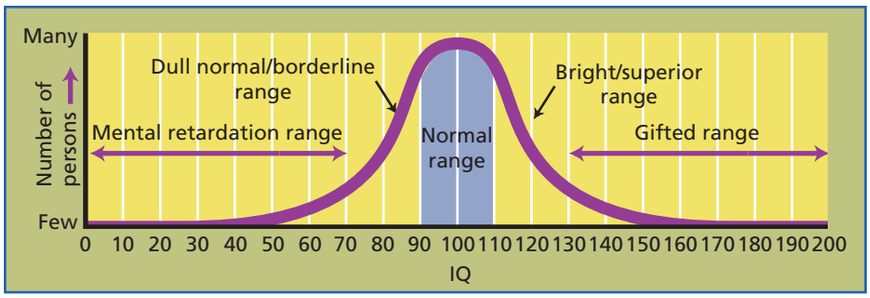


FIGURE 5.10
The Normal Distribution of IQ Scores among a Large Sample

(*Source:* from *Weschler's Measurement and Appraisal of Adult Intelligence*, 5th ed., by Joseph D. Matarazzo. Reprinted with permission of the Helen Reid Educational Foundation. Published by Heldref Publications, 1319 Eighteenth St., NW, Washington, DC 20036-1802. Copyright © 1974.)

Thus, IQ scores are no longer calculated by dividing mental age by chronological age. The concept of a "ratio" expressed as a multiple of 100 (a percentage-like number that is easy to understand) is retained, however. This solves the problem of calculating adult IQs by comparing adults with adults.

But one more problem has surfaced—and remains unsolved. Much to everyone's chagrin, James Flynn has pointed out that the average IQ score has risen gradually, at the rate of about 3 points per decade, ever since the tests were invented, a fact obscured by "renorming" of the tests every few years to keep the average IQ at 100 (Flynn, 1987). If taken at face value, this *Flynn effect* would mean that a person scoring in the average range in your great-grandparents' time might be considered to have mental retardation today! Flynn, along with most other observers, believes that such a conclusion is absurd. Yet, there is no agreed-upon explanation (Flynn, 2003; Neisser et al., 1996). The truth may well involve a combination of factors, including increasing test-taking skills, greater "complexity" of society (everything from movies, to games, to computers, to cell phones), more schooling, and better nutrition. Flynn himself (2007) points out that different components of intelligence have accelerated at different rates (with vocabulary, for example, hardly having budged at all), so part of the IQ gain can be explained in terms of societies valuing and encouraging certain factors that contribute to intelligence, such as the abstract thinking skills involved in identifying similarities: "How are a dog and a rabbit alike?" A century ago, says Flynn, the answer would have been: "You use dogs to hunt rabbits." Now, he notes, the correct answer would be "They are both mammals." Whatever the causes may be, they affect problem-solving ability more than they do general knowledge. In the meantime, test makers must keep adjusting the average scores every few years to keep up with the "IQ creep."

IQ Testing Today

The success of the Stanford-Binet test encouraged the development of other IQ tests. As a result, psychologists now have a wide choice of instruments for measuring intelligence. The most prominent of these alternatives are the Wechsler Adult Intelligence Scale (WAIS), the Wechsler Intelligence Scale for Children (WISC), and the Wechsler Preschool and Primary Scale of Intelligence (WPPSI). With these instruments, psychologist David Wechsler offers a family of tests that measure many skills that are presumed to be components of intelligence, including vocabulary, verbal comprehension, arithmetic ability, similarities (the ability to state how two things are alike), digit span (repeating a series of digits after the examiner), and block design (the ability to reproduce designs by fitting together blocks with colored sides). As our Core Concept noted, these tests measure intelligence by assessing performance on a variety of tasks.

Like the Stanford-Binet, the Wechsler tests are *individual* tests. That is, they are given to one person at a time. Also available are *group* tests of intelligence

The Stanford-Binet intelligence test kits contains objects used in assessing the intelligence of children.

that can be administered to large numbers of students simultaneously. Unlike the Stanford-Binet and the Wechsler tests, these group tests consist of paper-and-pencil measures, involving booklets of questions and computer-scorable answer sheets. The convenience of group tests—even though they are not as precise as individual tests—has made IQ testing, along with other forms of academic assessment, widespread. It is quite likely that you have taken such tests several times as you passed through grades 1 to 12, perhaps without realizing what they were. The items in the "Do It Yourself!" box are similar to items in many of these commonly used group tests of mental abilities.

What are IQ tests used for today? An IQ score assumes almost overwhelming importance in determining whether a child has "mental retardation" or is "gifted"—concepts we will examine more closely in the next Psychology Matters feature. Aside from those uses, IQ tests figure most prominently in the diagnosis of learning disabilities. The problem with that, says Dr. Jack Naglieri, is that IQ scores don't tell us much about which intervention strategies are likely to be effective with a given child (Benson, 2003a). To remedy this, Naglieri and others are developing tests that place less emphasis on a single number, such as IQ, and more on classifying people in ways that suggest helping strategies, such as identifying reading problems, perceptual problems, or attention disorders.

PSYCHOLOGYMATTERS

What Can You Do for an Exceptional Child?

As we have noted, mental retardation and giftedness lie at the opposite ends of the intelligence spectrum. As traditionally conceived, **mental retardation** occupies the IQ range below IQ 70—taking in the scores achieved by approximately 2% of the population (see Figure 5.11). Arbitrarily, **giftedness** begins 30 points above average, at 130 IQ points, comprising another 2% of the population. Now, bearing in mind all we have learned about the limitations of IQ tests, let's take a brief look at these two categories.

Mental retardation Often conceived as representing the lower 2% of the IQ range, commencing about 30 points below average (below about 70 points). More sophisticated definitions also take into account an individual's level of social functioning and other abilities.

Giftedness Often conceived as representing the upper 2% of the IQ range, commencing about 30 points above average (at about 130 IQ points).

CONNECTION • CHAPTER 2

Down's syndrome produces both physical symptoms and mental retardation; it arises from a chromosomal defect.

Mental Retardation

The most current view of mental retardation deemphasizes IQ scores by focusing on practical abilities to get along in the world (Robinson et al., 2000). In fact, the American Association of Mental Retardation now offers a definition of mental retardation that does not even mention an IQ cutoff score. According to this new perspective, mental retardation involves "significantly subaverage intellectual functioning" that becomes apparent before age 18. It also involves limitations in at least two of the following areas: "communication, self-care, home living, social skills, community use, self-direction, health and safety, functional academics, leisure and work" (Turkington, 1993, p. 26).

Causes of Mental Retardation Mental retardation has many causes (Daily et al., 2000; Scott & Carran, 1987). Some are known to be genetic because we can point to a specific genetically controlled defect. This is the case in people who have *Down's syndrome,* a chromosome disorder that produces multiple physical defects, as well as mental retardation. Some causes are purely environmental, as in *fetal alcohol syndrome,* which involves brain damage incurred before birth, resulting from the mother's abuse of alcohol during pregnancy. Other environmental causes include postnatal accidents that damage the cognitive regions of the brain. Still other causes involve conditions of deprivation or neglect, which fail to give the developing child the experiences needed for advancement up the intellectual ladder. Some cases have no known cause.

Dealing with Mental Retardation We have no cures, although research has found some preventive measures for certain types of mental retardation. For example, a simple test performed routinely on newborn babies can identify a hidden genetic disorder known as PKU. If detected early, the mental retardation usually associated with PKU can be prevented by a special diet. More generally, genetic

DO IT YOURSELF! Sample IQ Test Items

Try your hand at the following items adapted from group tests of intelligence. Some of the items are more challenging than others. You will find the correct answers at the end.

VOCABULARY: Select the best definition for each word:

1. **viable**
   a. traveled
   b. capable of living
   c. V-shaped
   d. can be bent
2. **imminent**
   a. defenseless
   b. expensive
   c. impending
   d. notorious

ANALOGIES: Examine the relationship between the first two words. Then, find an answer that has the same relationship with the word in bold letters:

3. Washington: Lincoln
   July:
   a. January
   b. April
   c. May
   d. October
4. ocean: canoe
   verse:
   a. poem
   b. pen
   c. water
   d. serve

SIMILARITIES: Which letter on the right belongs to the same category as the one on the left?

5. **J** **A M S Z T**
6. **A** **S D U V X**

SEQUENCES: Choose the answer that best completes the sequence:

7. a z b y c x d?
   e s u w f
8. 1 3 6 10 15?
   16 18 21 27 128

MATHEMATICAL REASONING

9. Portland and Seattle are actually 150 miles apart, but on a map they are two inches apart. If Chicago and Norfolk are five inches apart on the same map, what is the actual distance between those two cities?
   a. 125 miles
   b. 250 miles
   c. 375 miles
   d. 525 miles

ANSWERS: 1. b 2. c 3. d (October comes after July) 4. d (verse and serve have the same letters) 5. S (the only one with a curve in it) 6. U (the only vowel) 7. W 8. 21 9. c

counseling, pregnancy care services, and education of new parents are other preventive strategies (Scott & Carran, 1987).

Aside from prevention, special education programs can help those who develop mental retardation to learn vocational and independent living skills. Meanwhile, biological scientists hope that one day they will be able to treat genetically based forms of mental retardation with therapies that are just now being conceived. As noted in Chapter 2 genetic treatment may involve splicing a healthy gene into a benign virus that would "infect" all of the cells of a person with mental retardation and replace the defective gene. At present, genetic therapy is being tried experimentally for the treatment of certain physical diseases, but it is at least a few years away in the treatment of mental retardation.

For now, what can you do if you have a child with mental retardation? Dealing with mental retardation usually means making the best of a difficult situation. Parents of a child with mental retardation should realize that, because the nervous system is so immature at birth and because so much physical and mental development occurs during the first years of life, interventions that begin early will have the greatest payoffs. Realistically, however, the most intellectual improvement one can expect from an optimal educational program is an IQ gain of about 15 points (Robinson et al., 2000).

Psychological approaches that involve sensory stimulation and social interaction can be enormously important. In fact, an enriched environment may be just as helpful to a child with mental retardation as it is to a gifted child. Teams of special education teachers, speech therapists, educational psychologists, physicians, and other specialists can devise programs that allow persons with mental retardation to capitalize on the abilities they have, rather than being held prisoner of their disabilities (see Schroeder et al., 1987). Behavior modification programs have been especially successful. As a result, many citizens with mental retardation have learned to care for themselves and have acquired vocational skills that enable them to live independently (Landesman & Butterfield, 1987).

Giftedness At the other end of the intelligence spectrum we find the "gifted," with their especially high IQs, typically defined as being in the top 1 or 2% of

The Special Olympics offers children with mental retardation (and others with disabilities) an opportunity to capitalize on their abilities and to build self-esteem.

CONNECTION • CHAPTER 13
Behavior modification therapies are based on behavioral learning principles derived from operant and classical conditioning.

the population (Robinson et al., 2000). But, you might wonder, what do such people eventually do with their superior intellectual abilities? Does a high IQ give its owner an advantage in life? A long look at gifted individuals suggests that it does.

Terman's Studies of Giftedness The most extensive project ever undertaken to study gifted individuals began in 1921 under the direction of Lewis Terman, the same person who brought Binet and Simon's IQ test to the United States (Leslie, 2000). From a large pool of children tested in the California schools, Terman selected 1528 children who scored near the top of the IQ range. His longitudinal research program followed these children as they went through school and on into adulthood. Periodically through their lives, Terman retested them and gathered other information on their achievements and adjustment patterns. The resulting decades of data have taught us much about the nature of giftedness. Almost uniformly, Terman's gifted children excelled in school—as one might expect from the strong correlation between IQ and academic achievement. Terman also remarked on the good health and happiness of the children in his sample, although newer evidence suggests that highly gifted children are susceptible to certain physical and psychological disorders (Winner, 2000).

As they moved into adulthood, the gifted group continued on the path of success. An unusually high number of scientists, writers, and professionals emerged from its ranks. Together they published more than 2000 scientific articles, patented 235 inventions, and wrote 92 books. By middle age, more than 86% of the men in Terman's sample had entered high-status professions (Terman & Oden, 1959).

Yet, for all their achievements, no one in this high-IQ sample achieved the level of an Einstein, a Picasso, or a Martha Graham. Nor did a high IQ turn out to be a guarantee of wealth or stature. In fact, many from Terman's sample led ordinary, undistinguished lives. The ones who were most visibly successful seemed to have, in addition to their high IQs, extraordinary motivation and someone at home or at school who was especially encouraging to them (Goleman, 1980; Oden, 1968). You will remember that we previously found these same characteristics to be markers of "genius."

Dealing with Giftedness Imagine that you are the parent of a child with a very high IQ score, say 145. Which one of the following would be the best course of action?

- Enroll your child in special after-school classes.
- Hire a tutor to help the child with his or her homework.
- Send the child to a private school.
- Do nothing special.

What do the experts say? Don't rush out to enroll your child in special classes or provide other "help" because of his or her IQ score (Csikszentmihalyi et al., 1993; Wong & Csikszentmihalyi, 1991). Parents can destroy the spark of curiosity by pushing a child toward goals that do not hold the child's interest. Chances are you have already provided an environment in which your child's native ability could thrive. So do not make any rash and radical changes.

Above all, avoid making the child feel like a freak because of his or her unusual abilities and high IQ score. In part because of the personality traits common in gifted children—especially a tendency to spend time alone, working on their interests—they are more likely than other children to suffer social and emotional disorders (Winner, 2000). Nor should you feel smug about your genetic contribution to your child's intellect. Remember that intelligence involves a nature–nurture interaction—and, besides, IQ tests sample only a small fraction of human abilities. Other people's kids may have equally amazing abilities in untested regions of their intellects. In fact, many gifted individuals may go unrec-

ognized by the schools because they have an outstanding talent that shows up primarily in art or music—domains in which formal abilities testing is rarely done.

Remember, also, that a high IQ is no guarantee of high motivation, high creativity, or success in life. All it guarantees is an intellectual opportunity.

So, what should you do with a bright child? Nothing special that you would not have done before you knew the IQ score.

CheckYourUnderstanding

1. **RECALL:** One of Binet's great ideas was the concept of *mental age,* which he defined as _____ _____.
2. **APPLICATION:** You have tested a 12-year-old child and found that she has a mental age of 15. Using the original IQ formula, what is her IQ?
3. **RECALL:** A problem with the original IQ formula is that it gave a distorted picture of the intellectual abilities of
   a. adults.
   b. children.
   c. persons with mental retardation.
   d. gifted students.
4. **UNDERSTANDING THE CORE CONCEPT:** If intelligence is a normally distributed characteristic, in what part of the distribution would you expect to find most people's scores on a test of intelligence?

Answers **1.** Mental age on an IQ test is the average age at which individuals achieve a particular score. Or, in different words: Mental age is determined by the average score achieved by individuals of a particular chronological age. **2.** 125. **3.** a **4.** near the middle of the distribution

5.4 KEY QUESTION
IS INTELLIGENCE ONE OR MANY ABILITIES?

People who show aptitude in one area—language, for example—often score high on tests of other domains, such as mathematics or spatial relationships. This fact argues for the idea of a single, general intellectual ability. But there are some glaring exceptions. Persons with **savant syndrome** represent the most extreme exceptions of this sort. These rare individuals have a remarkable-but-limited talent, such as the ability to multiply numbers quickly in their heads or to determine the day of the week for any given date, even though they are mentally slow in other ways (Treffert & Wallace, 2002). Typically, they also show symptoms of autism (Winner, 2000), as you may remember from Dustin Hoffman's classic portrayal of one such person in the film *Rain Man*. Such cases raise a serious question about the whole concept of a single, general intelligence factor. Obviously, there is no simple solution to the question of one or many intelligences. Different psychologists have dealt with the issue in different ways, as our Core Concept suggests:

Some psychologists believe that intelligence comprises one general factor, *g*, while others believe that intelligence is a collection of distinct abilities.

core concept

We will first examine this issue from the viewpoint of psychologists in the *psychometric tradition:* those who have been interested in developing tests to measure mental abilities. Following that excursion, we will look at intelligence from the standpoint of cognitive psychologists who have recently brought a fresh perspective to the problem.

Savant syndrome Found in individuals having a remarkable talent (such as the ability to determine the day of the week for any given date) even though they are mentally slow in other domains.

Psychometric Theories of Intelligence

Psychometrics is the field of "mental measurements." It is the psychological specialty that has given us most of our IQ tests, achievement tests, personality tests,

the SAT, and a variety of other assessment instruments. Many pioneers in psychology carved their professional niches with contributions to psychometrics, including Alfred Binet and Lewis Terman. Yet another famous figure in this field was Charles Spearman, a psychologist who is best known for his work suggesting that intelligence is a single factor.

Spearman's *g* Factor

By the 1920s, there were many tests of intelligence available, and British psychologist Charles Spearman was able to show that individuals' scores on different tests tend to be highly correlated (1927). These correlations, he said, point to a single, common factor of general intelligence underlying performance across all intellectual domains. Spearman did not deny that some people have outstanding talents or deficits in certain areas. But, he said, these individual differences should not blind us to a single *general intelligence* factor at work behind all our mental activity. Spearman called this general intellectual ability the ***g* factor**. He assumed that this general factor is innate, and most psychologists at the time agreed with him (Tyler, 1988, p. 128).

Recently, neuroscientists have found some support for Spearman's theory. Various tests of *g* all involve certain gray-matter regions, especially in the brain's frontal lobes (Duncan et al., 2000; Haier et al., 2004). This suggests that a small group of brain modules, working together, control various forms of intelligent behavior. Could these be the loci of *g?* Although some neuroscientists think so, others believe this explanation oversimplifies both the nature of intelligence and of the brain (McArdle et al., 2002; Sternberg, 1999, 2000).

Cattell's Fluid and Crystallized Intelligence

Using sophisticated mathematical techniques, Raymond Cattell (1963) determined that general intelligence can be broken down into two relatively independent components that he called *crystallized* and *fluid intelligence*. **Crystallized intelligence**, said Cattell, consists of the knowledge a person has acquired, plus the ability to access that knowledge. Thus, crystallized intelligence relates to the person's ability to store and retrieve information from semantic memory. It is measured by tests of vocabulary, arithmetic, and general information. In contrast, Cattell proposed **fluid intelligence** as the ability to see complex relationships and solve problems—abilities that involve using algorithms and heuristics, which we discussed earlier in this chapter. Fluid intelligence is often measured by tests of block design and spatial visualization, tests that do not rely on the individual possessing certain "crystallized" background information to solve a problem. For Cattell, both types of intelligence were essential to adaptive living.

CONNECTION • CHAPTER 4
Much of our general knowledge is stored in *semantic memory*, a partition of long-term memory.

Cognitive Theories of Intelligence

Late in the 20th century, when the cognitive view emerged as a major force in psychology, it produced some radical new ideas about intelligence. In brief, the cognitive view of intelligence went well beyond the emphasis on vocabulary, logic, problem solving, and other skills that had been measured to predict school success (see Table 5.1). Intelligence, said cognitive psychologists, involves cognitive processes that contribute to success in many areas of life—not just school (Sternberg, 2000). We will focus on two of these cognitive theories.

Sternberg's Triarchic Theory

You may know someone who seems to have plenty of "book smarts" but who has never been very successful in life. Such people often don't know how to "read" others or to deal with unexpected events. Psychologist Robert Sternberg says that they lack **practical intelligence:** the ability to cope with the people and events in their environment. Practical intelligence is sometimes called "street smarts," although it applies just as well at home, on the job, or at school as it does on the street. We might even infer from one study that it can be thought of as "horse sense": Researchers found that, among regular visitors to racetracks, those who were most successful at picking winning horses had IQs no higher than those who were less successful. This suggests that the very practical ability to pick

***g* factor** A general ability, proposed by Spearman, as the main factor underlying all intelligent mental activity.

Crystallized intelligence The knowledge a person has acquired, plus the ability to access that knowledge.

Fluid intelligence The ability to see complex relationships and solve problems.

Practical intelligence According to Sternberg, the ability to cope with the environment; sometimes called "street smarts."

TABLE 5.1 Theories of Intelligence Compared

Spearman	Cattell	Sternberg	Gardner
g factor	Crystallized intelligence		
	Fluid intelligence	Analytical intelligence	Naturalistic intelligence Logical-mathematical intelligence
		Creative intelligence	Linguistic intelligence Spatial intelligence Musical intelligence Bodily-kinesthetic intelligence
		Practical intelligence	Interpersonal intelligence Intrapersonal intelligence
			Spiritual intelligence Existential intelligence

Note: Different theorists see intelligence as having different components, as shown in the columns of this table. The rows show roughly comparable components of intelligence described by various theories (although the reader should be aware that the correspondences are not exact). For example, Sternberg's practical intelligence is similar to Gardner's two components, called interpersonal intelligence and intrapersonal intelligence, while Spearman's *g* ignores these abilities.

winners is something different from the form of intelligence measured on standard IQ tests (Ceci & Liker, 1986).

In contrast with practical intelligence, Sternberg refers to the ability measured by most IQ tests as **analytical intelligence** (also called *logical reasoning*). Analytical intelligence includes the ability to think problems through and find correct answers. Your grades in college are likely to be closely related to this logical reasoning ability.

Creative intelligence, a third form of intelligence described by Sternberg's theory, helps people develop new ideas and see new relationships among concepts. Creative intelligence is what Picasso used to develop the form of painting called *Cubism* and what Einstein used to formulate his theory of relativity. It is also the form of intelligence that Sternberg used to develop his new theory of intelligence.

Sternberg's three-part formulation is often called the **triarchic theory** of intelligence, because it combines three (*tri* = three) different kinds of intelligence. For Sternberg each one in this trio of abilities—practical intelligence, analytical intelligence, and creative intelligence—is relatively independent of the others. That is, a person's ability in one of the three areas doesn't necessarily predict his or her intelligence in the other two. Each represents a different dimension for describing and evaluating human performance. This theory reminds us that it is inaccurate to think of a single IQ score as summarizing all that is important or valuable about people's mental abilities (Sternberg, 1999; Sternberg et al., 1995).

Gardner's Multiple Intelligences Like Sternberg, Harvard psychologist Howard Gardner also believes that traditional IQ tests measure only a limited range of human mental abilities. But he argues that we have at least seven separate mental abilities, which he calls **multiple intelligences** (Ellison, 1984; Gardner, 1983, 1999b):

1. *Linguistic intelligence.* Often measured on traditional IQ tests by vocabulary tests and tests of reading comprehension

Analytical intelligence According to Sternberg, the ability measured by most IQ tests; includes the ability to analyze problems and find correct answers.

Creative intelligence According to Sternberg, the form of intelligence that helps people see new relationships among concepts; involves insight and creativity.

Triarchic theory The term for Sternberg's theory of intelligence; so called because it combines three ("tri-") main forms of intelligence.

Multiple intelligences A term used to refer to Gardner's theory, which proposes that there are seven (or more) forms of intelligence.

2. *Logical-mathematical intelligence.* Also measured on most IQ tests with analogies, math problems, and logic problems
3. *Spatial intelligence.* The ability to form mental images of objects and to think about their relationships in space
4. *Musical intelligence.* The ability to perform, compose, and appreciate musical patterns, including patterns of rhythms and pitches
5. *Bodily-kinesthetic intelligence.* The ability for controlled movement and coordination, such as that needed by a dancer or a surgeon
6. *Interpersonal intelligence.* The ability to understand other people's intentions, emotions, motives, and actions, as well as to work effectively with others
7. *Intrapersonal intelligence.* The ability to know oneself, to develop a satisfactory sense of identity, and to regulate one's life

Each of these intelligences arises from a separate module in the brain, Gardner claims. The latter two, interpersonal and intrapersonal intelligence, are similar to a capacity that some psychologists call *emotional intelligence* (sometimes referred to as "EQ"). People who are high in emotional intelligence are good at "reading" other people's emotional states, as well as being especially aware of their own emotional responses.

CONNECTION • CHAPTER 9

Emotional intelligence involves the ability to understand and use emotions effectively.

In addition to these, Gardner's book *Intelligence Reframed* (1999a) proposes three more intelligences. *Naturalistic intelligence* allows people to classify living things as members of diverse groups (e.g., dogs, petunias, bacteria). *Spiritual intelligence* involves the ability to think in abstract spiritual terms and to put oneself in a spiritual frame of mind. And, finally, *existential intelligence* permits individuals to think about the largest and smallest components of the universe, the purpose of existence, and the meaning of death, and to deal with profound emotional experiences such as love. The evidence that these latter three involve independent abilities based in specific brain modules, however, is not as strong as for the previous seven intelligences.

Assessing these newly recognized kinds of intelligence demands more than the usual paper-and-pencil tests. Gardner's approach requires that examinees be observed and assessed in a variety of life situations. On its face, the notion of multiple intelligences appears to be sound, but it awaits verification through tests that are still in the process of development.

Cultural Definitions of Intelligence

Like Sternberg, Gardner sees each component of intelligence as equally important. Yet the value of each is also culturally determined, according to what is needed by, useful to, and prized by a given society. Gardner notes that Western society (including those from the Euro-American traditions) promotes the first two intelligences, while many other societies value one or more of the other kinds of intelligence. For example, in small isolated communities, people often place a high value on getting along with others (Gardner's *interpersonal ability*). In these restricted social settings, people have no place to go if they get into a quarrel and want to escape or part ways. In such societies, people generally avoid quarrels by recognizing potential problems at an early stage and modifying behaviors to solve problems quickly.

If you had been socialized in a Pacific island culture, which would matter more, your SAT scores or your ability to navigate a boat on the open ocean? With such examples, cross-cultural psychologists have called our attention to the notion that "intelligence" can have quite different meanings in different cultures (Sternberg, 2000, 2004). In fact, many languages have no word at all for intelligence as we conceive of it: the mental processes associated with logic, vocab-

The popular TV show, **Survivor,** *emphasizes practical intelligence. This scene is from the sixth episode in Micronesia.*

ulary, mathematical ability, abstract thought, and academic success (Matsumoto, 1996).

African Concepts of Intelligence Still, people in all cultures prize certain mental abilities—although those abilities are not the same in different cultures. In rural Kenya, Robert Sternberg found that children with the greatest practical intelligence skills actually scored lower on traditional IQ tests that measure academic success. Sternberg says, "In Kenya, good grades don't get you anywhere. You're better off getting an apprenticeship or learning to mine or fish—those will allow you to support a family" (Winerman, 2005b). So, the kids with the best minds don't learn academic skills, but concentrate on practical skills that will get them ahead in life.

Western cultures typically associate intelligence both with school success and with quick solutions to problems. This contrasts with the Buganda people in Uganda, who associate intelligence with slow and thoughtful responses. Yet another view is found among the Djerma-Sonhai in Niger (West Africa), who think of intelligence as a combination of social skills and good memory. And for the Chinese, intelligence involves, among other things, extensive knowledge, determination, social responsibility, and ability for imitation.

A Native American Concept of Intelligence John Berry (1992) has extensively studied the kinds of mental abilities considered valuable among Native Americans. He began by asking adult volunteers among the Cree in northern Ontario to provide him with Cree words that describe aspects of thinking, starting with examples like "smart" or "intelligent." The most frequent responses translate roughly to "wise, thinks hard, and thinks carefully."

Although Cree children attend schools introduced by the dominant Anglo (English-European) culture, the Cree themselves make a distinction between "school" intelligence and the kind of "good thinking" valued in the Cree culture. Such thinking seems to center on being "respectful." As one respondent explained, intelligence "is being respectful in the Indian sense. You need to really know the other person and respect them for what they are" (Berry, 1992, p. 79). This attitude of "respect for others" is widespread in Native American cultures, Berry found.

For this Native American teacher and his students, "intelligence" may have a different meaning from that used by Anglo Americans. In the Cree culture, intelligence involves wisdom and respect for others.

One term Berry's respondents offered as an example of the opposite of intelligence translates as "lives like a white." This refers disparagingly to behaviors the Cree have observed among some Anglo people. The Cree define "lives like a white" as a combination of being "stupid" and having "backwards knowledge." A "stupid" person does not know the necessary skills for survival and does not learn by respecting and listening to elders. One who has "backwards knowledge" disrupts relationships, creating disharmony instead of encouraging smooth interactions with others. Such disruption is not necessarily intentional or malicious. For example, an English teacher may ask Cree students to write an essay that would persuade others to change certain behaviors. However, in the Cree culture the concept of "persuading" can interfere with the traditional Cree value of "accepting others as they are." By encouraging such questioning of elders and traditions—a common practice in Anglo education—the teacher promotes disruption, which may be a path to "wisdom" in Anglo culture, but is "backward" in Cree views of intelligence.

As you can see from these examples, different cultures may define intelligence quite differently. To understand and cooperate with people of diverse heritages, we would be most "intelligent" if we resisted the impulse to impose our own definition of "intelligence" on others. Within psychology, cross-cultural psychologists have led the way in urging us to see what is valued—and devalued—in other people's experience.

Animals Can Be Intelligent—But Do They Think?

Animals can be taught to perform amazing tricks, as anyone who has ever been to the circus can attest. In the wild, groups of wolves or lions or a pod of killer whales commonly cooperate in making a kill—or in raising their young. And even your cat may sometimes seem to be acting with skill and cunning as she herds you toward the kitchen in the apparent hope of being fed. But do animals really *think?*

Speaking of cats, you may remember that Thorndike's cats were rather clever, when it came to escaping from his "puzzle boxes." Likewise, the rats in Tolman's lab developed *cognitive maps* of his mazes and were sometimes purported (in a sarcastic remark by one of Tolman's adversaries) to be "lost in thought." And, of course, in a lab on the island of Tenerife, Wolfgang Köhler's chimpanzees solved problems in flashes of "insight."

CONNECTION • CHAPTER 3
Thorndike, Tolman, and Köhler showed that animals can learn to solve complex problems.

Despite such evidence, many scientists dismissed the idea of animal cognition as a mere trained-animal tricks—until some startling new reports came trickling in from scientists like Jane Goodall. Willing to risk her career in the jungles of Tanzania, Goodall spent 30 years watching and recording the behavior of wild chimpanzees, a highly intelligent species about whose behavior in the wild very little was known (1986). And her career gamble paid off handsomely. To give just one example from the long list of her discoveries, Goodall reported that chimps would strip leaves from twigs and use them to extract tasty morsels from a termites nest. And why was that amazing? She had discovered that chimpanzees could make and use tools! Previously, tool-making was an ability believed to set humans apart from the rest of the animal kingdom. So, Goodall's work raised the question of human uniqueness. (You can learn more about this work at the Jane Goodall Institute at www.janegoodall.org/).

What Abilities Make Humans Unique?

If not tool-making, what distinctive cognitive abilities might we humans possess? One possibility is a **theory of mind:** the ability to know that our own thoughts may be different from someone else's thoughts. For example, a poker player uses a theory of mind when bluffing. So does a child who tells a lie about raiding the cookie jar. But recent animal research shows

Theory of mind An awareness that other people's behavior may be influenced by beliefs, desires, and emotions that differ from one's own.

that the lowly Western scrub jay (a relative of the crow) also shows signs of having a theory of mind. Amazingly, a scrub jay that sees another bird watching while it is hiding a grub for a later meal will return later and rehide the grub in another location (Dally et al., 2005). So much for human-only theory of mind conjecture!

So, perhaps it is *language* that distinguishes humans from animals. But alas for human pride! Animal behaviorist Karl Von Fritsch (1974) showed that a honeybee discovering a new source of nectar uses a language consisting of a "waggle dance," performed along a wall inside the hive, that conveys the direction and distance of the food. Other scientists pointed out that many other animals use distinctive sounds to communicate different "ideas," such as the approach of a predator. But such animal communications have a limited repertoire: Do they qualify as true language?

Language of the Apes An answer to that question came from Allen and Beatrice Gardner, who decided to take a 10-month-old chimpanzee named Washoe into their home and raise it like a human child. The crux of their experiment, however, was an attempt to teach Washoe to communicate. Because chimps do not have the vocal apparatus required for complex spoken language—but they do have excellent finger dexterity—the Gardners (1969) attempted to communicate with Washoe using American Sign Language. Remarkably, by the time Washoe was 5, she had learned some 160 signs. Eventually she learned about 250. Even more remarkably, she was able to put the signs together to make phrases or even "sentences," as when she would declare, "Me Washoe" or request, "Please tickle more." Some of her signs were even novel, as when she first saw a swan and signed "water bird."

Washoe's remarkable accomplishments were followed during the next decade by a parade of other primates that communicated with sign language, with plastic tokens of various shapes, and even with computers. Some outstripped Washoe by achieving vocabularies of up to 500 words (Savage-Rumbaugh, 1990). Kanzi, a pygmy chimp, demonstrated an understanding of spoken words—even sentences that he had not heard before (Rumbaugh & Savage-Rumbaugh, 1994; Savage-Rumbaugh & Lewin, 1994). Sarah, another articulate chimp, was able to construct complex sentences like these: "If Sarah take apple, then Mary give Sarah chocolate. If Sarah take banana, then Mary no give Sarah chocolate." And a gorilla named Koko has been caught signing lies (Patterson & Linden, 1981). On occasion, Koko has even "sworn" at her handler in ASL, making the signs for "dirty toilet."

The work on ape language was not enthusiastically accepted by everyone, however. Chief skeptic Herbart Terrace (1979, 1985), who also trained a chimp to use sign language, concluded that chimps can learn to use signs, but that they imitate without real understanding and that many cases of so-called novel expressions might be most charitably ascribed to impressions in their handlers' minds, rather than real language in the minds of apes. Koko's nasty outbursts notwithstanding, Terrace claims that most apes merely ape what they have seen, repeating sequences of gestures that they have learned.

The pro-chimp-language people, to their credit, paid attention to their critics and have since taken care to make their experiments more objective. And, although the issue is still not settled to everyone's satisfaction, most observers are convinced that chimpanzees have learned at least the rudiments of language, perhaps at the level of a 2½-year-old human.

In the meantime, channels of communication have reportedly been opened to a variety of species. Dolphins have been taught to interpret and respond to complex strings of gestures and sounds. An African gray parrot, who answered to the name of Alex, could not only speak but could count up to six objects and give the correct answers to simple problems ("Which one is bigger?"). And, not to be outdone, a border collie named Rico has learned to fetch some 200 different objects by name (Kaminski et al., 2004).

Pigeons have remarkable problem-solving abilities. Here a pigeon moves a block so that it can reach a food reward—much like Köhler's chimpanzee Sultan.

Alex, an African gray parrot, could count up to six objects and solve simple problems posed by his trainer, Dr. Irene Pepperberg.

What Are the Lessons of Research on Animal Language and Intelligence? Without doubt, animals are capable of intelligent behavior, and all but the strictest of behaviorists would say that many animals are capable of cognition—thought. But we must see these abilities in an evolutionary perspective: Most animals are exquisitely adapted to a particular biological niche, which makes them very intelligent about certain things (hunting down an antelope, catching a salmon, or protecting a clutch of eggs) but not so well adapted to other tasks, such as arithmetic or language. The main exception seems to be humans, who have become generalists.

Nevertheless, the study of language in nonhuman animals has pulled us down from our self-constructed pedestal by demonstrating that other creatures are capable of using language at a surprising level of sophistication. Those who worry about maintaining our feelings of species superiority can take comfort in this fact: Human language displays far more grammatical structure and productivity than do the languages of other animals. More than anything else, our language abilities have allowed us to grapple with abstract problems and to pass our solutions on to other members of our species.

But then, Washoe has taught her adopted son to use sign language.

PSYCHOLOGYMATTERS

Test Scores and the Self-Fulfilling Prophecy

If you have ever been called "dumb" or "slow," "shy," "plain," "bossy," or "uncoordinated," you know, first hand, the powerful effect that labels and expectations can have. An IQ score is a label, too; and, in our test-conscious society, an IQ score can alter the course of a life. As a nation of test takers, we sometimes forget that test scores are, at best, statistical measures of current functioning. People too often think of themselves as being "an IQ of 110" or "a B student," as if scores or grades were labels stamped permanently on their brains. Such labels may become barriers to advancement, as people come to believe that their mental and personal qualities are unchangeable—that they dictate their lot in life. Two classic studies will bring this fact into stark relief.

Expectations Influence Rat Performance Robert Rosenthal and Lenore Jacobson (1968a,b) asked psychology students to run rats through a maze and record their times. The experimenters told some students that their rats were especially bright; other students heard that their rats were slow learners. (In fact, Rosenthal and Jacobson had randomly assigned rats to the "bright" and "dull" groups.) Amazingly, the students' data showed that rats that were believed to be bright outperformed their supposedly duller littermates. Obviously, expectations had influenced the students' observations.

Expectations Also Influence Student Performance After seeing the results of their experiment with rats, Rosenthal and Jacobson wondered: Could a teacher's expectations similarly affect evaluations of a student's performance in school? To find out, they arranged to give grade school teachers erroneous information about the academic potential of about 20% of their students (approximately five in each classroom). Specifically, the teachers heard that some students had been identified by a standardized test as "spurters," who would blossom academically during the coming year. In fact, testing had revealed no such thing; the "spurters" had been randomly selected by the experimenters.

Knowing what happened with the rats, you can guess what happened in the classroom. Those children whom the teachers expected to blossom did so. Rosenthal and Jacobson didn't watch what actually happened to the children, although it seems likely that the teachers were more attentive and supportive of the students who were supposed to become "spurters." The data merely showed that

teachers rated the "spurters" as being more curious and having more potential for success in life than the other children. Socially, the teachers saw these children as happier, more interesting, better adjusted, more affectionate, and needing less social approval. Significantly, when the children again took the original test (actually an IQ test) a year later, the children in the experimental group (who had been arbitrarily assigned a high expectation of mental growth) made substantial gains in IQ points. The gains were especially pronounced among first and second graders. Rosenthal and Jacobson call this effect a **self-fulfilling prophecy**. You can see it operating anywhere that people live up to the expectations of others—or of themselves.

The Effects of Negative Expectations Did the self-fulfilling prophecy apply to the students not labeled as possible academic "spurters"? Many of these children also gained IQ points during the year of the experiment, but they gained fewer points, and they were rated less favorably by their teachers. Apparently, not receiving a promising prophecy can create negative expectations, just as a positive label can create positive expectations.

CheckYourUnderstanding

1. **APPLICATION:** In Cattell's theory, the ability to use algorithms and heuristics would be called _____ intelligence.
2. **APPLICATION:** A friend tells you that he has found a way to improve his grades by stopping by his psychology professor's office once a week to ask questions about the reading. In Sternberg's triarchic theory, which of the three kinds of intelligence is this?
3. **RECALL:** Name one of Gardner's seven intelligences that is also measured on standard IQ tests.
4. **RECALL:** Why does a self-fulfilling prophecy come true?
5. **UNDERSTANDING THE CORE CONCEPT:** Sternberg, Gardner, and others maintain that there are multiple intelligences. What is the position taken by Spearman and others on the opposite side of this argument?

Answers **1.** fluid **2.** practical intelligence **3.** Either linguistic intelligence or logical-mathematical intelligence would be correct. (Some intelligence tests also assess spatial intelligence.) **4.** Expectations: We frequently observe what we expect to see, even when our expectations are erroneous. So, if we expect someone to be smart (obnoxious, stupid, pleasant, lazy, and so on), the chances are good that this "prophecy" will fulfill itself. **5.** Although they do not deny that different abilities exist, Spearman and others have argued intelligence involves a single general, or *g*, factor underlying all these special abilities.

5.5 KEY QUESTION
HOW DO PSYCHOLOGISTS EXPLAIN IQ DIFFERENCES AMONG GROUPS?

While we can find the full range of IQ scores in every ethnic group, we also find differences among groups in average IQ scores (Rushton & Jensen, 2005). In the United States, Americans of Asian extraction score higher, on the average, than do Euro-Americans. Hispanics, African Americans, and Native Americans—again, on the average—score lower. Curiously, children from middle-income homes also score higher on IQ tests than do their counterparts from low-income homes (Jensen & Figueroa, 1975; Oakland & Glutting, 1990). Nobody disputes that these differences exist. What the experts disagree about are the causes of these IQ discrepancies. As we will see, the disagreement is another example of the nature–nurture controversy. Our Core Concept describes the issue this way:

While most psychologists agree that both heredity and environment affect intelligence, they disagree on the source of IQ differences among racial and social groups.

core concept

The controversy over the source of intelligence is potentially of great importance for people's lives—and a politically hot issue. And when race becomes involved, such issues can become even hotter. Never mind that the concept of

Self-fulfilling prophecy Observations or behaviors that result primarily from expectations.

distinct human "races" has no precise biological meaning, but rather a social one (Cooper, 2005; Sternberg et al., 2005)

If we assume that intelligence is primarily the result of innate (hereditary) factors, we will most likely conclude that it is fixed and unchangeable. This easily leads some to the conclusion that a group (usually a "racial" group) having low IQ scores must be innately inferior and, perhaps, should be treated as second-class citizens. On the other hand, if we conclude that intelligence is shaped largely by experience (environment), we are more likely to make a range of educational opportunities available for everyone and to view people of all ethnic, cultural, and economic groups as equals. Either way, our conclusion may become a self-fulfilling prophecy.

In actuality, neither the hereditarian nor environmentalist view is completely right. Repeatedly in this text we have seen that psychologists now recognize that both heredity and environment play a role in all our behavior and mental processes. But there is more to the issue of group differences than this. In this chapter, we will add another important complication to the heredity–environment interaction: While each *individual's* intelligence is determined, in part, by heredity, this fact does not mean that the IQ differences *among groups* have some biological basis. On the contrary, many psychologists have argued that group differences are totally environmental—although this, too, is disputed, as our Core Concept suggests. As we will see, however, the idea that group differences stem from biology has historically garnered the most support.

Intelligence and the Politics of Immigration

In the early 1900s, Henry Goddard, an influential psychologist who believed that intelligence is a hereditary trait, proposed mental testing of all applicants for immigration and the exclusion of those who were found to be "mentally defective" (Strickland, 2000). With encouragement from Goddard and some other assessment-minded psychologists, Congress passed the 1924 Immigration Restriction Act, designed to restrict immigration of groups and nationalities in which people had been "proven" to be of inferior intellect—based largely on Goddard's data. Among the groups restricted were Jews, Italians, and Russians. What Goddard and the U.S. Congress ignored was the fact that the tests were given in English—often to people with little familiarity with the English language and the culture in which the tests were conceived. Of course many of these immigrants received low scores!

Today we are more aware of the shortcomings of intelligence tests. We also know that, while heredity has an effect on an individual's intelligence, experience does, too. And we know that Goddard used faulty reasoning when he concluded that heredity accounts for group differences in intelligence. To understand how heredity could affect individual differences but not group differences, we need to look first at the evidence supporting the hereditarian and environmentalist arguments.

What Evidence Shows That Intelligence Is Influenced by Heredity?

Many lines of research point to a hereditary influence on intelligence. Studies comparing the IQ scores of identical twins with fraternal twins and other siblings show a strong genetic correlation. But the gold standard for differentiating the effects of heredity and environment involves looking at children who have not been raised by their biological parents. This means studying adopted children and the rare instances of twins who have been separated at birth. Such studies reveal that the correlation between the IQs of children and their biological parents is greater than that with their adoptive parents (Plomin & DeFries, 1998). Work coming out of the Human Genome Project has also lent support

TABLE 5.2 Correlation of IQ Scores with Genetic Relationship

Genetic relationship	Correlation between IQ scores
Identical twins	
Reared together	0.86
Reared apart	0.72
Fraternal twins	
Reared together	0.60
Siblings	
Reared together	0.47
Reared apart	0.24
Parent/child	0.40
Foster parent/child	0.31
Cousins	0.15

Note: A correlation shows the degree of association between variables—in this case, between the IQs of pairs of individuals. The closer to 1.0, the closer the connection. For example, we can see that the IQ scores of identical twins reared together are more closely correlated (.86) than the IQs of mere siblings reared together (.47). The data strongly suggest a genetic component that contributes to intelligence.

(*Source:* From Bouchard and McGue, 1981, "Familial Studies of Intelligence: A Review," in *Science,* Vol. 212, pp. 1055–1059. Adapted with permission from AAAS.)

to the notion that intelligence has a genetic component. Scientists are careful to point out, however, that the genetic basis of intelligence is complex because it involves the interaction of many genes (Chorney et al., 1998). In general, however, the closer the genetic relationship—from cousins to siblings to twins—the closer the relationship of IQ scores, as Table 5.2 shows. In fact, studies of twins and adopted children reveal genetic influences on a whole range of attributes as diverse as heart functioning (Brown, 1990), personality traits (Tellegen et al., 1988), hypnotizability (Morgan et al., 1970), and intelligence (Sternberg et al., 2005).

While psychologists agree that heredity plays an important part in determining an individual's IQ scores, they also agree that it remains difficult to estimate the relative weights of heredity and environment (Sternberg et al., 2005). One reason for this is that children who live in the same family setting do not necessarily share precisely the same psychological environment. First-born children, for example, are treated differently from the youngest. You probably are aware of this fact if you have siblings.

What Evidence Shows That Intelligence Is Influenced by Environment?

The evidence that the environment influences intellectual development is persuasive, too. This is seen in a longitudinal study of 110 children from impoverished homes, done over a period of about 10 years (Farah, 2008). The researchers assessed children on both language ability and memory (two important aspects of intelligence). They also assessed the children's home environment on two factors: (a) How stimulating was it? (judged by the child's access to such things as books and musical instruments) and (b) How nurturing was it? (rated according to observations of positive emotional climate, along with attention and praise given by parents). What the study revealed was a combination of the expected and the unexpected:

- A strong association between a stimulating environment and language ability (but not memory)
- An unexpected association between nurturance and memory (but not language ability)

How can we explain these results? The answer is not clear. But, says Martha Farah, lead author of the study, "Our results show that poverty affects different neurocognitive systems in different ways."

The effects of environment show themselves even when we look for genetic effects: We find greater similarities of IQ among people who have been reared together than those reared apart. And, in laboratory animals, a stimulus-enriched habitat early in life results in a more complex, complete development of brain cells and cortical regions. The superior performance of these animals on a range of tasks persists through life. In other experiments, we find that young monkeys who are trained to solve problems and are also offered the companionship of other monkeys display more active curiosity and higher intelligence than those reared without this environmental stimulation.

Such findings in animals hint that we might boost the intellectual functioning of human infants by enriching their environments. Indeed, we will see that early intervention programs can raise children's IQ scores (Barlow, 2008). Schooling also may boost IQ scores. In fact, the total amount of schooling children receive correlates well with their IQ scores (Ceci & Williams, 1997). Even in adulthood, environmental factors, such as the cognitive complexity and intellectual demands of one's job, can influence mental abilities throughout life (Dixon et al., 1985).

Recently, William Dickens and James Flynn reported the first evidence that the black–white IQ gap is narrowing—solid evidence that environment rather than heredity is the culprit. Citing data from large groups on four different IQ tests over the past three decades, they find that the gap has narrowed by up to 50%—which translates into nearly eight IQ points (Dickens & Flynn, 2006, Krakovsky, 2007.) Meanwhile, the hereditarians have not conceded, arguing that the research ignored data showing no change. Dickens and Flynn have rebutted these charges, but some critics remain unconvinced.

There is more evidence for the environmental side of the nature–nurture debate about intelligence, but to understand that evidence we must pause to explore a most important—and often misunderstood—concept: *heritability*.

Heritability (not *Heredity*) and Group Differences

Let us acknowledge that intelligence has a hereditary component. But, just because intelligence can be influenced by heredity—perhaps even by a substantial amount—does not mean that the environment has no impact (Dickens & Flynn, 2001; Neisser et al., 1996). Moreover, the influence of heredity on intelligence does not mean that heredity accounts for the differences we observe *between* groups. To understand why this is so, we need to distinguish *heredity* from another important term: *heritability*. Specifically, **heritability** refers to the amount of trait variation within a group that can be attributed to genetic differences.

Heritability The amount of trait variation within a group, raised under the same conditions, that can be attributed to genetic differences. Heritability tells us nothing about between-group differences.

To illustrate, suppose that we examine a group of children who were all raised in an intellectually stimulating environment, with devoted parents who spent lots of time interacting with them and reading to them—things we know improve intellectual abilities. Among these children, we would find variation in intellectual abilities. Because they were all treated in essentially the same fashion, however, we could attribute much of the differences in their IQ scores to the effects of heredity. *In this group, IQ would have high heritability.*

In contrast, suppose that we examine a group of children who had been raised under conditions of neglect—given mere custodial care in an orphanage, with no intellectual stimulation from their caregivers. We would most likely find that

these children have relatively little variability among their IQ scores because they are all intellectually stunted. *For this group, IQ would have low heritability*—because the poor environment did not offer an opportunity for these children's genetic potential to be realized.

Now, what about the differences *between* the two groups? The IQ differences would be real. But—this is the important part—*our observations could tell us nothing about the genetic differences (if any) between the groups.* For all we know they might have the same genetic potential. But because the environments were so different we cannot tell what role genetics played in determining the differences in their IQ scores.

In view of the fact that people are exposed to different cultural traditions and experience different levels of wealth or discrimination, you can see that we have no way to evaluate what proportion of the differences *between* the groups should be attributed to heredity or to environment. To reiterate: *Heritability* is a concept that refers to within-group differences, not between-group differences. Thus, it is important to realize that *we can speak of heritable differences only within a group of individuals who have shared essentially the same environment* (Sternberg et al., 2005).

And finally, we must reiterate another important point: Biologists tell us that "race" is not a valid biological concept (Cooper, 2005; Sternberg et al., 2005). There are no biological boundaries defining different races. And even if we use a social definition, where people define their own racial group, the differences between the gene pools of people who claim to be of different racial groups are very small compared to the genetic differences among individual members of the same group (Bamshad & Olson, 2003). For all these reasons, then, we can*not* say that the evidence supports the notion of genetic differences producing the IQ discrepancies we observe among "racial" groups.

The Jensen Controversy Despite the concerns we have just cited, some psychologists remain unconvinced that environment can account for group differences in IQ (Nisbett, 2005; Rushton & Jensen, 2005). The most recent controversy has its roots in the contention by Harvard psychologist Arthur Jensen (1969) that racial differences in IQ have a substantial genetic basis. We can boost IQ scores to some extent, said Jensen, by helping the poor and disadvantaged, but there are limits imposed by heredity.

In support of his thesis, Jensen cited several studies showing a strong influence of heredity on IQ. He also presented a complex statistical argument that showed only a weak environmental effect on IQ and achievement. Then, turning his attention to government programs that had attempted to give extra help to disadvantaged black children, Jensen claimed that, while most had shown some positive effects, none had erased racial differences in performance. What remained must be a genetic difference in abilities, he maintained.

Over the next five years more than 100 published articles responded to Jensen's challenge. Sometimes it seemed that the Jensen controversy had generated far more heat than light. The protest occasionally became ugly, with charges of bigotry and racism nearly drowning the scientific debate. Nevertheless, it did have the positive effect of stimulating a new wave of research and theory aimed at gaining greater understanding of black–white IQ differences.

Critics pointed out several factors that Jensen had minimized or ignored, including the effects of racism, lower teacher expectations for black children, lack of opportunity, low self-esteem, and a white, middle-class bias built into IQ and achievement tests (Neisser, 1997; Neisser et al., 1996). While Jensen holds to his original position (Jensen, 1998, 2000), many (but not all) psychologists now agree that a combination of environmental factors can explain the differences on which Jensen built his case. Let us now look at some of the post-Jensen discoveries, beginning with a study of children whose environment had been altered by adoption.

The Scarr and Weinberg Adoption Study A monumental study by Sandra Scarr and Richard Weinberg confronted the issue head-on by comparing black and white children who had been adopted into similar home environments (1976, 1978). Their research focused on educational records and IQ test scores from both the biological families and the adoptive families of 115 white children and 176 black children who had been adopted in Minnesota during the 1950s. All the children had been adopted into white families. For both groups of children, the biological parents had average IQ scores (near 100), while the adoptive parents' IQs were somewhat higher, averaging above 115.

What did Scarr and Weinberg find when they reexamined the IQ scores of these two groups of adoptees in late adolescence? There were no differences! Both the black group and the white group of adoptees had scores that averaged about 110, significantly higher than their biological parents, although not quite as high as their adoptive parents. Such results testify to a powerful effect of the environment on IQ. The results also contradict Jensen's claim that group differences are genetic.

Social Class and IQ Research on the relationship between social class and IQ shows similar environmental effects. Socioeconomic class (as reflected in an individual's financial status and lifestyle) clearly correlates with IQ. While affluence is associated with higher IQ scores, groups with the lowest average IQ scores are those for whom poverty, illiteracy, and hopelessness are most widespread. Supporters of the environmental position claim that racism and discrimination initially landed many minorities in impoverished neighborhoods, and these same factors continue to keep them there today.

How does social class affect IQ? The relationship is not a simple one: The negative effects of growing up in a disadvantaged home far outweigh the benefits of growing up in a wealthy family (Turkheimer et al., 2003). In fact, poverty creates circumstances that limit individual potential in many ways, particularly in terms of nutrition, health care, and education (Brown & Pollitt, 1996; Neisser et al., 1996). Poverty also means less-adequate health care, so it should not surprise you that researchers have traced poor health during pregnancy and low birth weight to low mental ability in children. Research also shows that a significant proportion of children with low IQs have been adversely affected by "environmental insults," such as living in homes with lead-based paint chips peeling from walls, causing toxic lead levels in children who ingest this material (Needleman et al., 1990). And poverty also means less of other factors known to promote intellectual development. Poor nutrition, lack of access to books and computers, and job schedules that leave parents little time to stimulate a child's intellect all correlate with poverty and can be detrimental to performance on tasks such as those demanded by IQ tests (for example, vocabulary or sentence comprehension).

Poverty has other crippling effects, too. In most parts of the United States, public schools are funded by revenue from local property taxes. Thus, wealthy neighborhoods can provide bigger and better school facilities and amenities, while poorer districts may suffer from crowding, physically deteriorating structures, threats to personal safety, poorly prepared teachers, and lack of access to computers. In such environments, even children with the aptitude to learn may find it difficult to rise above their circumstances. Proponents of the view that environment has a strong influence on intelligence usually support equal-opportunity legislation, better schools, and intervention programs that help disadvantaged children build self-confidence and learn the skills necessary to succeed in school (Tirozzi & Uro, 1997).

Head Start: A Successful Intervention Program One such intervention program is *Head Start*, originally implemented some 40 years ago to provide educational enrichment for disadvantaged children. It grew from the assumption that many children from deprived families need an intellectual boost to prepare them for school. The program is intended to head off problems on several fronts by serving

children's physical as well as mental needs with nutritional and medical support, plus a year or two of preschool education. Wisely, Head Start also involves parents in making policy, planning programs, working in classrooms, and learning about parenting and child development. Head Start centers around the country currently serve about 800,000 children yearly—estimated to be 40% of the number who need it (Ripple et al., 1999).

Does it work? Again, there is some controversy (Jensen, 1969; Kantrowitz, 1992), although a great deal of research suggests that Head Start does, indeed, help disadvantaged children get ready for school (Garces et al., 2002; Ripple & Zigler, 2003). Children who were enrolled in the program score higher on IQ tests and have higher school achievement during the early grades than a matched control group who received no such intervention (Zigler & Styfco, 1994). More important, their head start lasts. Although the differences between the Head Start children and the control group diminish over time, the effects are still detectable in adolescence. Among other things, Head Start children are less likely to be placed in special education classes, less likely to fail a grade, more likely to graduate from high school, and less likely to have trouble with the law.

It now appears, however, that such attempts to raise IQ by special environmental interventions may not start early enough. Studies indicate that early educational intervention, starting in the first months of life, can raise infants' scores on intelligence tests by as much as 30% compared to control groups (Ramey & Ramey, 1998a,b; Wickelgren, 1999). Although the gains may diminish with time, especially if supportive programs are withdrawn, significant differences remain when intervention starts in infancy. The best way to summarize these and other relevant findings is to say that the earlier the individual is immersed in an enriched environment, the stronger the effects.

Test Biases and Culture-Fair Tests Still other forces influence IQ scores and contribute to differences among groups. A portion of the difference between the average IQ scores of black and white children may reside in problems with the IQ tests themselves. Many psychologists have argued that IQ test questions have built-in biases toward a middle- or upper-class background—biases that favor the white child (Helms, 1992). For an opposing view, however, that holds that test bias does *not* contribute to group differences in IQ scores, see Jensen (2000) and Reynolds (2000).

One source of possible bias stems from the fact that most IQ tests rely heavily on vocabulary level. This gives a big advantage to children who have been read to and who are encouraged to read. We can see a related bias in a well-known IQ test that asks for a definition of *opulent* (rich), a term one is far less likely to hear in a poor household. To their credit, however, test makers have been working hard to rid their tests of items that discriminate against people of minority cultural backgrounds (Benson, 2003).

Yet another source of bias has to do with the examiner. Not only does the examiner's attitude influence IQ scores, but so do his or her gender and race. Studies have found that black children receive higher scores when tested by a black examiner (Bodmer & Cavalli-Sforza, 1970; Sattler, 1970). In brief, test takers do best when they perceive the examiner to be similar to themselves.

Finally, Janet Helms (1992) has pointed out that the attempt to explain why African American children deviate from the Caucasian norm may, itself, rest on the biased assumption that one culture is superior to another. Specifically, she says, it "assumes that white-American culture defines the most intellectually rich environment" (p. 1086). Seldom do we ask how well white children learn the norms of other cultures. Helms asks: Why should the Caucasian American norm be the standard by which everyone else is judged?

Psychologists realize that a culture-free test of ability or achievement is an impossibility. Nevertheless, most agree that we should strive for *culture-fair* tests that minimize cultural biases, insofar as possible. Many of the built-in biases in ability and achievement tests arise from language. After all, how could we expect

most people to perform well on a test in their nonnative language? To get around this problem, several attempts have been made to develop nonverbal intelligence tests involving mazes and the manipulation of shapes.

Critics of culture-fair tests make two main points. First, not all minority groups do poorly on traditional intelligence tests. For example, we have seen that Asian-Americans often do better than Americans of European ancestry (Sue & Okazaki, 1990). Second, culture-fair tests do a poorer job of predicting academic success, which is the main strength of traditional IQ tests (Aiken, 1987; Humphreys, 1988). The main reason that culture-fair tests are relatively poor predictors of academic success is that they deemphasize verbal skills, which are an important component of success in school.

***The Bell Curve:* Another Hereditarian Offensive** The dispute over causes of racial differences in IQ flared again in 1994. At issue was a book, *The Bell Curve: Intelligence and Class Structure in American Life,* by Richard Herrnstein and Charles Murray. The name echoes the bell-shaped "normal distribution" of IQ scores (see shape of the graph in Figure 5.11). In this volume, Herrnstein and Murray argued that racial differences in IQ have a strong genetic basis. If these innate differences were accepted, the nation could move on to more enlightened and humane social policies, they said. Critics immediately identified not only a racist bias but pointed to questionable science at the core of *The Bell Curve*.

How is *The Bell Curve*'s argument flawed? The answer will be familiar to you by now: While there is no doubt that heredity influences individual intelligence, Herrnstein and Murray, like hereditarians before them, have offered no proof that differences *between groups* exposed to different environments have a hereditary basis (see Coughlin, 1994; Fraser, 1995). Further, much of the "evidence" they offer is suspect (Kamin, 1994). One study cited by Herrnstein and Murray claimed to document the low IQs of black Africans, but it employed tests given in English—a language in which the Zulu subjects of the study were not fluent (Kamin, 1995). The test used in that study also assumed that subjects were familiar with electrical appliances found in urban middle-class homes (rather than Zulu villages) and equipment, such as microscopes, not typically found in Zulu schools.

Compounding the problems in their analysis of the evidence, Herrnstein and Murray commit another critical thinking error that we have emphasized in this book: They confuse correlation with causation. In fact, the Herrnstein and Murray argument is just as plausible when turned around: Poverty and all of the social and economic disadvantages that go with it could just as well be important causes of low IQ scores.

Despite its flaws, *The Bell Curve* has struck a chord with many Americans. It resonates with the preference for simple genetic "causes" for behavior rather than more complex explanations. But not every culture holds this viewpoint. We can see a different perspective in a study that asked Americans and Asians to account for a child's academic success: American respondents emphasized "innate ability," whereas Asian respondents emphasized the importance of "studying hard" (Stevenson et al., 1993). Thus, the idea that individual differences, as well as group differences, in performance have an innate basis is a widespread belief in American culture. In fact, Carol Dweck's (2007/2008) work shows that the parents and teachers who adopt an approach similar to the Asian view find that their children are more interested in school, learn more, and achieve higher grades.

PSYCHOLOGYMATTERS

Stereotype Threat

Can you get smarter? Or is your IQ a fixed number? As we have seen, many people believe that their level of "smarts" is a given. But, as Shakespeare once

observed, there's the rub: If you think your intelligence is fixed, you will probably live up to your expectations. This is, of course, the expectancy bias and the self-fulfilling prophecy at work.

Psychologists have argued that members of some groups harbor low expectations about the abilities of everyone in their group. These expectations, as you might guess, can adversely affect IQ scores, especially when people are reminded of the stereotype (Schwartz, 1997). Psychologist Claude Steele calls this **stereotype threat**, and he has amassed a lot of evidence that it has a negative effect on many members of minority groups, particularly in academic situations (Steele, 1997; Steele et al., 2002). One study found that merely being asked to identify their race resulted in lower scores for minority students on a test of academic abilities (Steele, 1997). In another study, a group of black women taking an IQ test were told that white women usually do better on the test. As a result of this stereotype threat, these black women received scores that averaged a full 10 points lower than a comparison group who were told that black women usually receive high scores (Thomas, 1991).

Stereotype threat is not necessarily a racial or ethnic issue. We find it also in the domain of gender, where girls may learn to feel inferior in science and math, or boys may be taught that they have lesser verbal skills. Stereotype threat can also intimidate older persons who worry about memory failure or that as "old dogs" they cannot learn "new tricks." Anyone who believes that he or she is part of an inferior group is vulnerable to these feelings of anxiety, intimidation, and inferiority.

Is there a way to combat stereotype threat? Social psychologist Joshua Aronson and his colleagues (2001) found that grades improved for college students who were encouraged to think of intelligence as being influenced by experience and expectations, rather than a fixed trait. The grades of African American students actually rose more than those of white students and those in a control group. Apparently, those who may have felt themselves targets of stereotype threat reaped the most benefits from this program. It remains to apply Aronson's findings to stereotype threat in the domains of gender and aging.

More information on intelligence and on stereotype threat is available under "Education" on the American Psychological Association's "Psychology Matters" website at www.psychologymatters.org/education.html.

Stereotype threat An expectation of being judged by the standard of a negative stereotype. Such expectations can adversely affect performance.

CheckYourUnderstanding

1. **RECALL:** Did Goddard's view of intelligence place more emphasis on nature (heredity) or nurture (environment)?
2. **ANALYSIS:** What is the position taken by most modern psychologists with regard to intelligence and the heredity-environment issue?
3. **APPLICATION:** Cite one piece of evidence showing that intelligence is influenced by heredity and one piece of evidence that intelligence is influenced by the environment.
4. **RECALL:** Put the words *between* and *within* in the appropriate places in the following statement: Heritability may account for differences _____ groups but not for differences _____ groups.
5. **APPLICATION:** Give an example of the conditions under which you would you expect stereotype threat to occur.
6. **UNDERSTANDING THE CORE CONCEPT:** Although everyone agrees that heredity produces differences in intelligence among individuals, there is no evidence that it accounts for differences among _____.

Answers **1.** Goddard, along with most of the early American psychologists interested in intelligence, believed that heredity was the most powerful influence on intelligence. **2.** Neither heredity nor environment acts alone: intelligence involves an interaction of heredity and environmental factors. **3.** Evidence for hereditary influence includes: twin studies and correlations of IQs among biological relatives. Evidence for environmental influence includes: comparison of siblings reared together versus those reared apart, animals reared in stimulus-rich environments, the correlation of IQ scores with amount of schooling, and the recent narrowing of the black–white IQ discrepancy. **4.** Heritability may account for differences within groups, but not for differences between groups. **5.** Stereotype threat occurs any time people have low expectations of the group to which they belong, especially when they are reminded of those expectations. One example involves women who believe that they have low aptitude for math and who are taking a math class, particularly if the teacher raises the issue of gender differences in math. **6.** racial or ethnic groups

Critical Thinking Applied: The Question of Gender Differences

In June of 2006 Dr. Larry Summers, the president of Harvard University, lost his job, in part because he opined that factors other than socialization—most notably innate intellectual differences—may account for the undisputed fact that men outnumber women in most scientific fields. (Psychology, incidentally, is an exception!) So, what is really going on? A look at the evidence requires some interpretation—based on your critical thinking skills.

What Is the Issue?

It's the nature–nurture controversy: Are the undisputed gender differences we see the result of different ways men and women are socialized? Are they the result of prejudice, discrimination, and lack of opportunity for women who go into science? Or are they the result of different ways that men's and women's brains process information?

What Critical Thinking Questions Should We Ask?

Certainly the first thing that comes to mind is the possibility of bias—on both sides of the issue. In addition to potential problems of "political correctness," we all have a vested interest in making sure that our gender doesn't come off looking less smart than the other.

Beyond bias, we should be willing to judge the evidence on its merits and, perhaps, be willing to look at the issue from multiple perspectives. After all, it may be that both sides have a piece of the truth.

The Evidence from the "Nature" Perspective After an extensive review of the literature on gender, Janet Shibley Hyde (2007) points out that men and women are far more similar than different on nearly all dimensions studied—a view that she calls the *gender similarities hypothesis*. The similarities include such diverse characteristics as mathematical ability, problem-solving, reading comprehension, leadership effectiveness, and moral reasoning. But there are a few exceptions, most of which won't surprise you. These include greater male aggression, acceptance of casual sex, and throwing velocity—differences that she allows may have biological roots. In general, however, Hyde favors an explanation that emphasizes the different ways that males and females are socialized. One factor may be the whole set of expectations (and limitations) that society offers girls as they are growing up. Hyde says that the few physical differences between men and women "are important mainly because they are amplified by cultural beliefs and roles."

Further, Hyde cautions, many people tend to believe that any male–female differences we may find in the brains of men and women are "hard wired" and unchangeable. Instead, she urges us to see such differences as rooted in the brain's *plasticity,* by which the very fabric of the brain is altered by experience. In fact, brains seem to be changing: The number of women entering scientific fields has surged dramatically in the last decade, with women now making up, for example, half of the graduating classes at U.S. medical schools (Halpern et al., 2007/2008).

The Evidence from the "Nature" Perspective Taking quite a different approach, Roy Baumeister (2007) calls our attention to a different set of facts. He notes that men, as a group, are more *variable* and *extreme* than women—with more men lying at the opposite poles of virtually all mental and behavioral dimensions. Men, he says, seem to outnumber women among both the biggest losers and the biggest winners. Thus, we find more men than women in prisons and homeless shelters and among those with mental retardation—as well as among jazz musicians, scientists (except in psychology), members of Congress, and people whom we call "geniuses." If men go to extremes more than women, says Baumeister, we would find these gender differences, *and yet the averages could be the same.*

Baumeister is quick to point out that he doesn't see one gender as being better than the other—merely that evolution selected different traits in men and women. In general, he says, cultures give the highest payoffs to men who take risks and have the most extreme skills. These extremists, the risk-takers, are also the ones who tend to have the most children, who perpetuate the trend. The situation is quite different for women, Baumeister argues. The evolutionary pressures for women have emphasized playing it safer than men do—which is the smart thing when your opportunities for leaving offspring are biologically much more limited than are men's.

What Conclusions Can We Draw?

Which side to believe? As we noted earlier, both sides may have part of the truth. Both agree that the gender differences in abilities are small. Baumeister suggests that the gender differences have more to do with motivation (particularly the male willingness to take risks) than with ability, while Hyde maintains that the differ-

ences are mainly cultural and, therefore, can be shaped. You will have to decide the issue for yourself, but we urge you, as a critical thinker, to be mindful of your own biases. In the end, this issue may have to be seen from multiple perspectives—rather like the changing views of the Necker cube.

Chapter Summary

5.1 What Are the Components of Thought?

Core Concept 5.1: Thinking is a cognitive process in which the brain uses information from the senses, emotions, and memory to create and manipulate mental representations, such as concepts, images, schemas, and scripts.

Cognitive scientists often use the **computer metaphor** to conceive of the brain as an information-processing organ. Thinking is a mental process that forms new mental representations by transforming available information coming from various sources, including the senses, emotions, and memory. **Natural concepts** and **artificial concepts** are building blocks of thinking; they are formed by identifying properties that are common to a class of objects or ideas. Concepts are often arranged in *hierarchies*, ranging from general to specific, but the way they are organized varies across cultures.

Other mental structures that guide thinking include **schemas, scripts,** visual imagery, and cognitive maps. In recent years, neuroscientists have used brain imaging techniques to learn about the connections between thought processes and the brain—particularly the frontal lobes. At the same time, other scientists have emphasized the role of emotions in thinking, especially in **intuition.** Schemas and scripts assume special importance in understanding thought because they are mental structures that organize concepts, helping us make sense of new information and events—and underlie a sense of humor. Our schemas and scripts are influenced by culture.

Artificial concepts (p. 179)
Computer metaphor (p. 177)
Concept hierarchies (p. 179)
Concepts (p. 178)
Event-related potentials (p. 182)
Intelligence (p. 177)
Intuition (p. 183)
Natural concepts (p. 179)
Prototype (p. 179)
Script (p. 185)

MyPsychLab Resources 5.1:

Simulation: Intuition and Discovery in Problem Solving

Simulation: Schemas

5.2 What Abilities Do Good Thinkers Possess?

Core Concept 5.2: Good thinkers not only have a repertoire of effective strategies, called algorithms and heuristics, they know how to avoid the common impediments to problem solving and decision making.

Two of the most crucial thinking skills involve *identifying the problem* and *selecting a problem-solving strategy.* Useful strategies include **algorithms,** which produce a single correct answer, and **heuristics,** or "rules of thumb." Among the most useful heuristics are *working backward, searching for analogies,* and *breaking a bigger problem into smaller problems.* Common obstacles to problem solving include **mental set, functional fixedness,** and *self-imposed limitations.*

Judgment and *decision making* can be flawed by biases and faulty heuristics. These include the *confirmation bias,* **hindsight bias, anchoring bias, representativeness bias,** and **availability bias.** Judgment can also be affected by factors outside the person, such as the **tyranny of choice.** In general, good decision makers are those who use good critical thinking skills.

People who are often called "creative geniuses" are highly motivated **experts** who often have a certain cluster of traits, such as independence and a need for stimulating interaction. They appear, however, to use ordinary thinking processes, although the role of natural talent is the subject of dispute.

Algorithms (p. 186)
Anchoring bias (p. 191)
Aptitudes (p. 193)
Availability bias (p. 192)
Creativity (p. 192)
Expert (p. 193)
Functional fixedness (p. 188)
Heuristics (p. 187)
Hindsight bias (p. 190)
Mental set (p. 188)
Representativeness bias (p. 191)
Tyranny of choice (p. 192)

MyPsychLab Resources 5.2:

Simulation: Discovery
Explore: Two-String Problem

5.3 How Is Intelligence Measured?

Core Concept 5.3: Intelligence testing has a history of controversy, but most psychologists now view intelligence as a normally distributed trait that can be measured by performance on a variety of tasks.

The measurement of *intelligence* is both common and controversial. Assessment of mental ability has an ancient human history but was not based on scientific practice until the 20th century. In 1904, Binet and Simon developed the first workable test of intelligence, based on the assumption that education can modify intellectual performance.

In America, IQ testing became widespread for the assessment of Army recruits, immigrants, and schoolchildren. The original IQ calculation was abandoned in favor of standard scores based on the **normal distribution.** Today, IQ tests come in both individual and group forms. They are typically used to diagnose learning disabilities and to assess whether a child is eligible for special education classes. In particular, IQ scores are a key ingredient in identifying **mental retardation** and **giftedness,** which are often seen as occupying the extremes of the IQ distribution.

Chronological age (CA) (p. 198)
Giftedness (p. 202)
Intelligence quotient (IQ) (p. 199)
Mental age (MA) (p. 198)
Mental retardation (p. 202)
Normal distribution or normal curve (p. 200)
Normal range (p. 200)

MyPsychLab Resources 5.3:

SImulation: The Normal Curve
Watch: Giftedness: Robert Sternberg

5.4 Is Intelligence One or Many Abilities?

Core Concept 5.4: Some psychologists believe that intelligence comprises one general factor, *g*, while others believe that intelligence is a collection of distinct abilities.

Among the first *psychometric theories* of intelligence, Spearman's analysis emphasized a single, common factor known as ***g***. Later, Cattell separated *g* into two components: **fluid intelligence** and **crystallized intelligence.** Modern cognitive psychologists have conceived of intelligence as a combination of several abilities.

In particular, Gardner and Sternberg have taken the lead in extending the definition of intelligence beyond school-related tasks. Sternberg's **triarchic theory** proposes **analytic, creative,** and **practical intelligences,** while Gardner's theory of **multiple intelligences** has claimed seven components of intelligence—and possibly three more. Meanwhile, cross-cultural psychologists have shown that "intelligence" has different meanings in different cultures. A century of research shows that animals, too, are capable of intelligent behavior, as in chimpanzees that make tools and use language. Recent work also shows that certain birds have a rudimentary **theory of mind.**

In the United States much emphasis is placed on mental tests. In such a climate, however, a big danger lies in test scores becoming mere labels that influence people's behavior through the **self-fulfilling prophecy.**

Analytical intelligence (p. 207)
Creative intelligence (p. 207)
Crystallized intelligence (p. 206)
Fluid intelligence (p. 206)
***g* factor** (p. 206)
Multiple intelligences (p. 207)
Practical intelligence (p. 206)
Savant syndrome (p. 205)
Self-fulfilling prophecy (p. 213)
Theory of mind (p. 210)
Triarchic theory (p. 207)

MyPsychLab Resources 5.4:

Explore: Sternberg's Triarchic Theory of Intelligence
Simulation: Gardner's Theory of Intelligence
Watch: Cultural Influences: Robert Sternberg

5.5 How Do Psychologists Explain IQ Differences among Groups?

Core Concept 5.5: While most psychologists agree that both heredity and environment affect intelligence, they disagree on the source of IQ differences among racial and social groups.

Hereditarian arguments maintain that intelligence is substantially influenced by genetics, a belief endorsed at one time by the U.S. government, which used IQ tests to restrict immigration early in the 20th century. *Environmental* approaches argue that intelligence can be dramatically shaped by influences such as health, economics, and education. While most psychologists now agree that intelligence is *heritable,* they also know that **heritability** refers to variation within a group and does not imply that between-group differences are the result of hereditary factors.

The dispute over the nature and nurture of group differences in intelligence flared again in 1969, when Jensen argued that the evidence favored a strong genetic influence. This argument was echoed in the 1994 book *The Bell Curve*. Critics have pointed out that much of the research cited by those taking the extreme hereditarian position is flawed. In addition, intelligence testing itself may be biased in favor of those with particular language and cultural experiences. Hereditarian claims, however, have stimulated much research, such as Scarr and Weinberg's research on adopted children and follow-up studies of the Head Start program. This research suggests that the racial and class differences in IQ scores can be attributed to environmental differences and to the influence of low expectations and negative stereotypes, as found in stereotype threat.

Heritability (p. 216) **Stereotype threat** (p. 221)

MyPsychLab Resources 5.5:

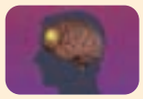
Watch: Demographics and Intelligence Testing: Robert Guthrie

Watch: Gender Difference: Robert Sternberg

Watch: Correlations Between IQ Scores of Persons of Varying Relationships

Discovering Psychology Viewing Guide

Watch the following videos by logging into MyPsychLab (www.mypsychlab.com). After you have watched the videos, complete the activities that follow.



PROGRAM 10: COGNITIVE PROCESSES

PROGRAM 11: JUDGEMENT AND DECISION MAKING

PROGRAM 16: TESTING AND INTELLIGENCE

PROGRAM REVIEW

1. Michael Posner's work on brain imaging showed
   a. major differences between the brains of young and old adults, with cognitive processes more localized in brains of the elderly.
   b. that blood flow decreases in the brain as thinking becomes more efficient.
   c. that electrical stimulation of the brain can enhance performance on logic puzzles reliably.
   d. that patterns of brain activity differ in predictable ways when people see words, versus read them aloud, versus name the function of the objects to which they refer.
2. A cognitive psychologist would be most interested in which one of the following issues?
   a. how you decide which answer is correct for this question
   b. how pain stimuli are processed
   c. maturation of the efferent system
   d. how to distinguish mania from schizophrenia
3. What is one's prototype of a tree most likely to be similar to?
   a. a maple tree
   b. a palm tree
   c. a Christmas tree
   d. a dead tree
4. According to the program, why do people assume that Montreal is farther north than Seattle?

a. because we have learned it
b. because we are less familiar with Montreal than with Seattle
c. because Canada is north of the United States in our mental maps
d. because we are not good at making such judgments

5. What is one way in which human problem solving appears to be quite different from the way computers solve problems?
   a. Humans can solve problems that don't involve numbers.
   b. Humans are more logical in their approach to problems.
   c. Humans have trouble when content is unfamiliar.
   d. Humans are less likely to be misled by bias.
6. What is a cognitive illusion?
   a. a mental map that we can scan for information
   b. a biased mental strategy
   c. a concept formed on the basis of a perceptual illusion
   d. a decision motivated by emotion
7. How did Freud explain the fact that human beings sometimes make irrational decisions?
   a. They are driven by primitive needs.
   b. They are influenced by the emotions of the crowd.
   c. They are basing their decisions on availability.
   d. They are using standard human mental processes.
8. Why would smokers be likely to underestimate the chance of developing lung cancer?
   a. They do not dread the disease.
   b. It is an unfamiliar risk.
   c. It is not representative.
   d. It represents a delayed consequence.
9. Irving Janis studied how the decision to invade Cuba was made during the Kennedy administration. What advice does Janis offer to promote better decision making?
   a. Encourage groupthink by team-building exercises.
   b. Appoint one group member to play devil's advocate.
   c. Restrict the size of the group.
   d. Assume that silence means consent on the part of all group members.
10. How does cognitive dissonance make us feel?
    a. We are so uncomfortable that we try to reduce the dissonance.
    b. We enjoy it so much that we actively seek dissonance.
    c. Our reaction to dissonance depends largely on personality.
    d. It creates boredom, which we try to overcome.
11. You read the following sentences: "Mary heard the ice cream truck. She remembered her birthday money and ran into the house." What allowed you to understand how these sentences are related?
    a. a cognitive illusion
    b. reasoning by analogy
    c. a schema
    d. the anchoring heuristic
12. According to Robert Glaser, intelligence
    a. is a skill and can be developed.
    b. is genetically determined.
    c. is a myth.
    d. is no higher in humans than it is in chimpanzees and bonobos.
13. Greg is visiting a foreign country that is known for its current political unrest, and he has seen news reports over the past week about tourists being kidnapped. Although his chances of being killed in a car accident during his vacation are higher than his chances of being killed by terrorists, he believes the opposite. What cognitive process is behind his error?
    a. representativeness heuristic
    b. availability heuristic
    c. anchoring and adjustment heuristic
    d. framing heuristic
14. What is the goal of psychological assessment?
    a. to derive a theory of human cognition
    b. to see how people vary in ability, behavior, and personality
    c. to measure the stages of growth in intellectual abilities
    d. to diagnose psychological problems
15. What was Binet's aim in developing a measure of intelligence?
    a. to identify children in need of special help
    b. to show that intelligence was innate
    c. to weed out inferior children
    d. to provide an empirical basis for a theory of intelligence
16. What formula did Terman create to express intelligence?
    a. MA/CA = IQ
    b. MA × CA = IQ
    c. CA/MA × 100 = IQ
    d. MA/CA × 100 = IQ
17. The attempt by neuroscientists to find biologically based measures of intelligence rests on the assumption that intelligence involves
    a. multiple factors.
    b. cultural learning.
    c. speed of adaptation.
    d. high excitability.
18. The growing practice of "teaching for tests" creates the possibility of
    a. lessened ecological validity (i.e., the test doesn't tell us how the subject might perform in the real world).
    b. eliminating stereotype threat.
    c. lowered reliability.
    d. eliminating genetic influences on intelligence.
19. Standardized intelligence tests typically
    a. overvalue verbal ability.
    b. give too much value to creative problem solving.
    c. are biased to give exceptionally high scores to people from other cultures.

d. are the best available predictors of life success.

20. What we have learned about intelligence over the years is that it is not
    a. complex.
    b. influenced by environment.
    c. a singular process.
    d. culturally defined.

QUESTIONS TO CONSIDER

1. Think of all the ways you can categorize people (e.g., by their gender, their age, their ethnicity, their intelligence, their taste in music, etc.). Do you have different schemas for people who belong to these various groups? How does your schema influence your behavior toward people?
2. Knowing about problem-solving strategies and using them are two different things. Based on the information in the program and in your text, what are some of the pitfalls you need to avoid in both day-to-day problem solving and decision making about major life changes? How optimistic are you that you can really learn to consistently avoid these pitfalls?
3. How might cognitive heuristics, such as representativeness and availability, perpetuate ethnic stereotypes?
4. Does evidence of a genetic basis for intelligence mean that intelligence is unchangeable?
5. Does it seem reasonable that you can score very high on one type of intelligence and very low on others? Does that change your view of what it means to be "intelligent"?

ACTIVITIES

1. All of us tend to categorize the world into convenient units and to use common labels for our categories. Often those labels become permanent, and we tend to view our world in a rigid or stereotypical way. When this stops us from producing new ideas, it is called functional fixedness. Can you overcome it? Try this: How many uses can you think of for an empty milk carton, a brick, a sock with a hole in it, a paper clip, a bandanna, or another ordinary household object? After you feel you've exhausted all possibilities, list as many attributes of the object as possible. Draw a picture of the object from various points of view. Then see if you can generate any new uses.
2. Go to a busy intersection and observe pedestrian street-crossing behavior. Observe the kinds of risks people take when crossing the street. What do you consider risky behavior? Who is most likely to engage in it? Why do you suppose certain people take more risks than others?
3. Consider the possibility that intelligence could be improved. Design a one-year plan to improve your intelligence. What would be the most important components of your plan? Would the plan you devised work equally well for someone else?