Psychology in the News

Ig Nobel Prize Winners Announced

CAMBRIDGE, MA, October 2, 2009. The Nineteenth First Annual Ig Nobel ceremony was held last night in Harvard University's Sanders Theatre. The Ig Nobel Prizes are sponsored by the organization Improbable Research, whose goal is to honor achievements that "first make people laugh, then make them think."

Like the real Nobels, the Ig Nobels are awarded in diverse areas, ranging from public health to peace to biology. The sponsors explain that the prizes "are intended to celebrate the unusual, honor the imaginative—and spur people's interest in science, medicine, and technology." This year's winners include:

- *Public Health:* Elena Bodnar and her colleagues, for inventing a bra that in an emergency can quickly be transformed into a pair of protective face masks—one for the wearer and one for another person.
- *Veterinary Medicine:* Catherine Douglas and Peter Rowlinson of Britain's Newcastle University, for showing that cows that are given names produce more milk than cows without names.
- *Medicine:* Donald L. Unger, of Thousand Oaks, California, for investigating arthritis of the fingers by cracking the knuckles of his left hand (but not his right hand) every day for 50 years. Contrary to what his mother had warned him, knuckle cracking did not lead to arthritis.
- *Mathematics:* Gideon Gono, governor of Zimbabwe's Reserve Bank, for having his bank print bank notes ranging from one cent to one hundred trillion dollars, as a way of helping people learn to cope with a wide range of numbers.
- *Literature:* Ireland's police service, for writing and presenting more than 50 traffic tickets to the most frequent driving offender in the country, Prawo Jazdy. The Irish police, faced with a sudden influx of Polish immigrants, had failed to learn a little basic Polish—namely, that "prawo jazdy" is Polish for "driving license."
- *Biology:* Fumiaki Taguchia and four colleagues at Kitasato University, for showing that kitchen refuse can be reduced more than 90 percent by using bacteria extracted from the feces of giant pandas.

The Improbable Research organization depends on volunteers in many countries and an editorial board of some 50 eminent scientists, including several Nobel (and Ig Nobel) Prize winners. The group publishes a magazine, a newsletter, a newspaper column, books, and a daily blog. But it is best known for the Ig Nobel awards, which the British journal *Nature* calls "arguably the highlight of the scientific calendar."

Dr. Elena Bodnar, the Ig Nobel prizewinner in public health, demonstrates her patented "Emergency Bra" that can quickly be converted into a pair of gas masks—one for the brassiere wearer and one to be given to a needy bystander. Behind her, two colleagues are wearing the bras as protective face masks.

CHAPTER

7

Thinking and Intelligence

The Ig Nobel awards may seem a little off the wall, but they reflect the human mind's love of wordplay, wit, parody, and imagination. Indeed, the mind is an amazing thing. Each day, in the course of ordinary living, we make decisions, draw inferences about other people's behavior, try to understand our motives, laugh at something that strikes us as funny, and organize and reorganize the contents of our mental world. Descartes' famous declaration "I think, therefore I am" could just as well have been reversed: "I am, therefore I think." Our powers of thought and intelligence have inspired humans to immodestly call ourselves *Homo sapiens*, Latin for wise or rational man.

Think for a moment about what thinking does for you. It frees you from the confines of the immediate present: You can think about a trip taken three years ago, a party next Saturday, or the War of 1812. It carries you beyond the boundaries of reality: You can imagine unicorns and utopias, Martians and magic. You can make plans far into the future and judge the probability of events, both good and bad. Because you think, you do not need to grope your way blindly through your problems but can apply knowledge and reasoning to solve them intelligently and creatively.

Yet just how "sapiens" are we, really? In Florida, a woman driving to see her boyfriend decided to shave her bikini line while her passenger, her remarkably tolerant ex-husband, held the steering wheel. They crashed. In Berlin, Germany, a radio station decided to find out how easily people could be manipulated on the Internet by posting an obviously fake video on YouTube, purportedly showing the recently deceased Michael Jackson emerging from a coroner's van—alive. In a single day, the video got 880,000 hits, and the rumor that Jackson was alive and well quickly spread around the globe. We could go on.

The human mind, which has managed to come up with poetry, penicillin, and panty hose, is a miraculous thing; but the human mind has also managed to come up with traffic jams, spam, and war. To better understand why the same species that figured out how to get to the moon is also capable of breathtaking bumbling here on earth, we will examine in this chapter how people reason, solve problems, and grow in intelligence, as well as some sources of their mental shortcomings.

YOU are about to learn...

- **the basic elements of thought.**
- **whether the language you speak affects the way you think.**
- **how subconscious thinking, nonconscious thinking, and mindlessness help us—and can also cause trouble.**

Thought: Using What We Know

Many cognitive psychologists liken the human mind to an information processor, analogous to a computer but far more complex. Information-processing approaches capture the fact that the brain does not passively record information but actively alters and organizes it. When we take action, we physically manipulate the environment; when we think, we *mentally* manipulate internal representations of objects, activities, and situations.

concept A mental category that groups objects, relations, activities, abstractions, or qualities having common properties.

basic concepts Concepts that have a moderate number of instances and that are easier to acquire than those having few or many instances.

prototype An especially representative example of a concept.

The Elements of Cognition

One type of mental representation is the **concept**, a mental category that groups objects, relations, activities, abstractions, or qualities having common properties. The instances of a concept are seen as roughly similar: *Golden retriever*, *cocker spaniel*, and *border collie* are instances of the concept *dog*; and *anger*, *joy*, and *sadness* are instances of the concept *emotion*. Concepts simplify and summarize information about the world so that it is manageable and so that we can make decisions quickly and efficiently. You may never have seen a *basenji* or a *schnoodle*, but if you know that these are both instances of *dog*, you will know, roughly, how to respond (and perhaps be curious enough to learn that a schnoodle is a schnauzer-poodle mix).

Basic concepts have a moderate number of instances and are easier to acquire than those having either few or many instances (Rosch, 1973). The concept *apple* is more basic than *fruit*, which includes many more instances and is more abstract. It is also more basic than *McIntosh apple*, which is quite specific. Similarly, *book* is more basic than either *publication* or *novel*. Children seem to learn basic-level concepts earlier than others, and adults use them more often than others, because basic concepts convey an optimal amount of information in most situations.

The qualities associated with a concept do not necessarily all apply to every instance: Some apples are not red; some dogs do not bark; some birds do not fly. But all the instances of a concept do share a family resemblance. When we need to decide whether something belongs to a concept, we are likely to compare it to a **prototype**, a representative example of the concept (Rosch, 1973). For instance, which dog is doggier, a golden retriever or a Chihuahua? Which fruit is more fruitlike, an apple or a pineapple? Which activity is more representative of sports, football or weight lifting? Most people



Some instances of a concept are more representative or prototypical than others. TV heartthrob Chace Crawford clearly qualifies as a "bachelor," an unmarried man. In fact, in 2009, *People* put him on its cover as "Summer's Hottest Bachelor." But is the Pope a bachelor? What about Elton John, who celebrated a civil union ceremony in England with his longtime male partner?

within a culture can easily tell you which instances of a concept are most representative, or *prototypical*.

The words used to express concepts may influence or shape how we think about them. Many decades ago, Benjamin Lee Whorf (1956), an insurance inspector by profession and a linguist and anthropologist by inclination, proposed that language molds cognition and perception. His most famous example was that because English has only one word for snow and Eskimos (the Inuit) have many (for powdered snow, slushy snow, falling snow …), the Inuit notice differences in snow that English speakers do not. He also argued that grammar—the way words are formed and arranged to convey tense and other concepts—affects how we think about the world.

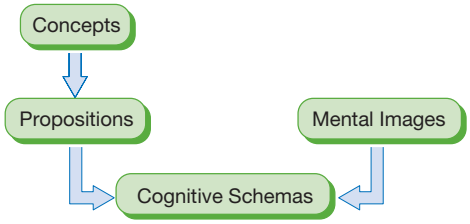
Whorf's theory was popular for a while and then fell from favor; English speakers can see all those Inuit kinds of snow, after all, and they have plenty of adjectives to describe the different varieties. But Whorf's ideas are once again getting attention. Some researchers are finding that vocabulary and grammar do affect how we perceive the location of objects, think about time, attend to shapes and colors, and remember events (Boroditsky, 2003; Gentner & Goldin-Meadow, 2003). A language spoken by a group in Papua, New Guinea, refers to blue and green with one word, but distinct shades of green with two separate words. On perceptual discrimination tasks, New Guineans who speak this language handle green contrasts better than blue–green ones, whereas the reverse holds true for English speakers (Roberson, Davies, & Davidoff, 2000).

Here's another example: In many languages, speakers must specify whether an object is linguistically masculine or feminine. (In Spanish, *la cuenta*, the bill, is feminine but *el cuento*, the story, is masculine.) It seems that labeling a concept as masculine or feminine affects the attributes that native speakers ascribe to it. Thus, a German speaker will describe a key (masculine in German) as hard, heavy, jagged, serrated, and useful, whereas a Spanish speaker is more likely to describe a key (feminine in Spanish) as golden, intricate, little, lovely, and shiny. German speakers will describe a bridge (feminine in German) as beautiful, elegant, fragile, peaceful, and slender, whereas Spanish speakers are more likely to describe a bridge (masculine in Spanish) as big, dangerous, strong, sturdy, and towering (Boroditsky, Schmidt, & Phillips, 2003).

Concepts are the building blocks of thought, but they would be of limited use if we merely stacked them up mentally. We must also represent their relationships to one another. One way we accomplish this may be by storing and using **propositions**, units of meaning that are made up of concepts and that express a unitary idea. A proposition can express nearly any sort of knowledge ("Hortense raises border collies") or belief ("Border collies are smart"). Propositions, in turn, are linked together in complicated networks of knowledge, associations, beliefs, and expectations. These networks, which psychologists call **cognitive schemas**, serve as mental models of aspects of the world. People have schemas about cultures, occupations, animals, geographical locations, and many other features of the social and natural environment; gender schemas represent a person's beliefs and expectations about what it means to be male or female (see Chapter 3). Simulate

Mental images—especially visual images, pictures in the mind's eye—are also important in thinking and in the construction of cognitive schemas. One method of studying them is to measure how long it takes people to rotate an image in their imaginations, scan from one point to another in an image, or read off some detail from an image. The results suggest that visual images are much like images on a computer screen: We can manipulate them, they occur in a mental space of a fixed size, and small ones contain less detail than larger ones (Kosslyn, 1980; Shepard & Metzler, 1971). Most people also report auditory images (for instance, a song, slogan, or poem you can hear in your "mind's ear"), and many report images in other sensory modalities as well—touch, taste, smell, or pain.

Here, then, is a visual summary of the elements of cognition:



How Conscious Is Thought?

When we think about thinking, we usually have in mind those mental activities that are carried out in a deliberate way with a conscious goal in mind, such as solving a problem, drawing up plans, or making calculated decisions. However, not all mental processing is conscious.

Subconscious Thinking Some cognitive processes lie outside of awareness but can be brought into consciousness with a little effort when necessary. These **subconscious processes** allow us to handle more information and to perform more

proposition A unit of meaning that is made up of concepts and expresses a single idea.

cognitive schema An integrated mental network of knowledge, beliefs, and expectations concerning a particular topic or aspect of the world.

mental image A mental representation that mirrors or resembles the thing it represents; mental images occur in many and perhaps all sensory modalities.

subconscious processes Mental processes occurring outside of conscious awareness but accessible to consciousness when necessary.

Simulate **Schemas** at **mypsychlab.com**

nonconscious processes Mental processes occurring outside of and not available to conscious awareness.

implicit learning Learning that occurs when you acquire knowledge about something without being aware of how you did so and without being able to state exactly what it is you have learned.

complex tasks than if we depended entirely on conscious, deliberate thought. Many automatic routines are performed "without thinking," though they might once have required careful, conscious attention: knitting, typing, driving a car, or decoding the letters in a word to read it.

Because of the capacity for automatic processing, people can eat lunch while reading a book or drive a car while listening to music. In such cases, one of the tasks has become automatic and does not require much executive control from the brain's prefrontal cortex. But in daily life, multitasking is usually inefficient. In fact, far from saving time, toggling between two or more tasks increases the time required to complete them; stress goes up, errors increase, reaction times lengthen, and memory suffers (Lien, Ruthruff, & Johnston, 2006). This is *especially* true for people who consider themselves to be accomplished multitaskers and who are heavy users of electronic information. In a series of experiments designed to test the supposed skills of such multitaskers, their performance on each of the tasks was impaired by interference from the other tasks (Ophir, Nass, & Wagner, 2009). "The shocking discovery of this research," said one of the investigators, is that high multitaskers "are lousy at everything that's necessary for multitasking. They're suckers for irrelevancy. Everything distracts them."

Multitasking can even be hazardous to your health. Cell phone use greatly impairs a person's ability to drive, even when the phone is hands-free. The driver's attention is diverted far more by a phone conversation than by listening to music on the car radio (Strayer & Drews, 2007). Other distractions are equally dangerous; remember that driver shaving her bikini line? She is hardly alone in foolishness. A government study caught other drivers on camera checking their stocks, fussing with MP3 players, drinking beer, reading emails, applying makeup, flossing their teeth, and putting in contact lenses, all while hurtling down the highway at high speeds (Klauer et al., 2006). Of course, there's also texting: In 2008, a commuter train's engineer violated company policy by texting while on the job, and never saw an oncoming freight train. The resulting collision killed 25 people, including the engineer himself.

Some well-learned skills do not require much conscious thought and can be performed while doing other things, but multitasking can also get you into serious trouble. It's definitely not a good idea to talk on your cell phone, eat, and try to drive all at the same time.

Even when multitasking doesn't put you at risk of an accident, it can be a bad idea. When you do two things at once, brain activity devoted to each task decreases. And while you are switching between tasks, your prefrontal cortex, which prioritizes tasks and enables higher-order thinking, becomes relatively inactive (Jiang, Saxe, & Kanwisher, 2004; Just et al., 2001). That's why we hope you are not trying to learn these facts while you're also watching TV and texting your friends.

Nonconscious Thinking

Other kinds of thinking, **nonconscious processes**, remain outside of awareness. You undoubtedly have had the odd experience of having a solution to a problem pop into mind after you have given up trying to find one. With sudden insight, you see how to solve an equation, assemble a cabinet, or finish a puzzle without quite knowing how you managed to find the solution. Similarly, people will often say they rely on intuition—hunches and gut feelings—rather than conscious reasoning to make judgments and decisions.

Insight and intuition involve several stages of mental processing (Bowers et al., 1990; Kounios & Beeman, 2009). First, clues in the problem automatically activate memories or knowledge. You begin to see a pattern or structure in the problem, although you cannot yet say what it is; possible solutions percolate in your mind. This nonconscious processing guides you toward a hunch or a hypothesis. Eventually, your thinking becomes conscious, and you become aware of a probable solution. At this stage, you may feel that a sudden revelation has popped into your mind from nowhere ("Aha, now I see!"), but considerable nonconscious mental work has already occurred. Cognitive neuroscientists are now working on establishing links between changes in the brain and the steps involved in insightful problem solving (Kounios & Beeman, 2009; Sheth, Sandkühler, & Bhattacharya, 2009).

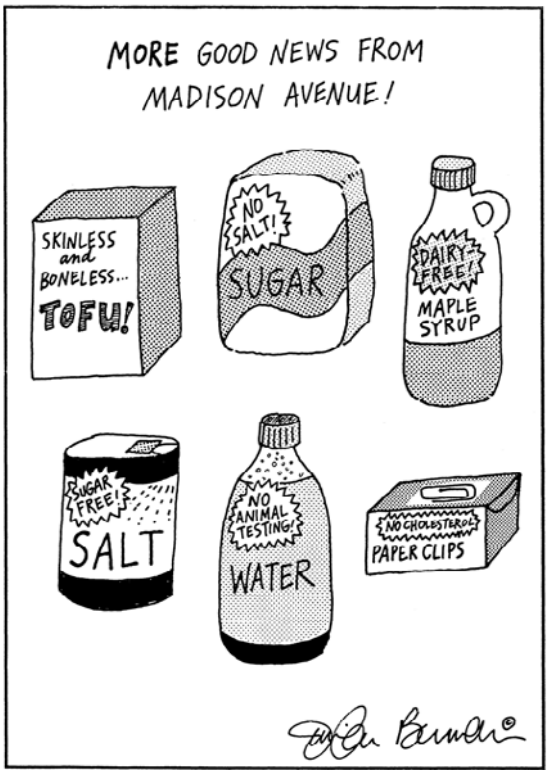
Sometimes people solve problems or learn new skills without experiencing the conscious stage at all. For example, some people discover the best strategy for winning a card game without ever being able to consciously identify what they are doing (Bechara et al., 1997). Psychologists call this phenomenon **implicit learning**: You learn a rule or an adaptive behavior, either with or without a

conscious intention to do so, but you don't know how you learned it and you can't state, either to yourself or to others, exactly what it is you have learned (Frensch & Rünger, 2003; Lieberman, 2000). Many of our abilities, from speaking our native language properly to walking up a flight of stairs, are the result of implicit learning.

Mindlessness Even when our thinking is conscious, often we are not thinking very *hard*. We may act, speak, and make decisions out of habit, without stopping to analyze what we are doing or why we are doing it. This sort of *mindlessness*—mental inflexibility, inertia, and obliviousness to the present context—keeps people from recognizing when a change in a situation requires a change in behavior.

In a classic study of mindlessness, a researcher approached people as they were about to use a photocopier and made one of three requests: "Excuse me, may I use the Xerox machine?" "Excuse me, may I use the Xerox machine, because I have to make copies?" or "Excuse me, may I use the Xerox machine, because I'm in a rush?" Normally, people will let someone go before them only if the person has a legitimate reason, as in the third request. In this study, however, people also complied when the reason sounded like an authentic explanation but was actually meaningless ("because I have to make copies"). They heard the form of the request but they did not hear its content, and they mindlessly stepped aside (Langer, Blank, & Chanowitz, 1978).

Multitasking, mindlessness, and operating on automatic pilot have their place; life would be impossible if we had to think carefully about every little thing we do, see, or hear. But they can also lead to errors and mishaps, ranging from the trivial (misplacing your keys) to the serious (walking into traffic because you're daydreaming). Cognitive psychologists have, therefore, devoted a great deal of study to mindful, conscious thought and the capacity to reason.



Advertisers sometimes count on mindlessness in consumers.

Quick Quiz

Stay mindful while taking this quiz.

1. Which concept is most basic: *furniture, chair,* or *high chair*?
2. Which example of the concept *chair* is prototypical: *high chair, rocking chair,* or *dining room chair*?
3. What two findings in the previous section support Whorf's theory that language affects perception and cognition?
4. In addition to concepts and images, _____, which express a unitary idea, have been suggested as a basic form of mental representation.
5. Peter's mental representation of Thanksgiving includes associations (e.g., to turkeys), attitudes ("It's a time to be with relatives"), and expectations ("I'm going to gain weight from all that food"). They are all part of his _____ for the holiday.
6. Zelda discovers that she has called her boyfriend's number instead of her mother's, as she intended. Her error can be attributed to _____.

Answers:

1. chair **2.** A plain, straight-backed dining room chair will be prototypical for most people. **3.** Color terms can affect how people respond to colors on visual discrimination tasks, and the linguistic gender of a word can affect people's descriptions of the concept it represents. **4.** propositions **5.** cognitive schema **6.** mindlessness

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YOU are about to learn...

- why algorithms and logic can't solve all of our problems.
- the difference between deductive and inductive reasoning.
- the importance of heuristics and dialectical reasoning in solving real-life problems.
- how cognitive development affects the ways in which people reason and justify their views.

Reasoning Rationally

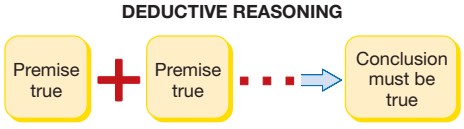
Watch the Video on Deductive Reasoning at mypsychlab.com

Reasoning is purposeful mental activity that involves operating on information to reach conclusions. Unlike impulsive or nonconscious responding, reasoning requires us to draw specific inferences from observations, facts, or assumptions.

Formal Reasoning: Algorithms and Logic

In *formal reasoning problems*—the kind you might find, say, on an intelligence test or a college entrance exam—the information needed for drawing a conclusion or reaching a solution is specified clearly, and there is a single right (or best) answer. Established methods usually exist for solving the problem, and you usually know when it has been solved (Galotti, 1989).

In some formal problems and well-defined tasks, all you have to do is apply an **algorithm**, a set of procedures guaranteed to produce a solution even if you do not really know how it works. To solve a problem in long division, you apply a series of operations that you learned in elementary school. To make a cake, you apply an algorithm called a recipe. For other formal problems, the rules of formal logic are crucial tools to have in your mental toolbox. One such tool is **deductive reasoning**, in which a conclusion *necessarily* follows from a set of observations or propositions (*premises*):



For example, if the premises "All human beings are mortal" and "I am a human being" are true, then the conclusion "I am mortal" must also be true. Watch

reasoning The drawing of conclusions or inferences from observations, facts, or assumptions.

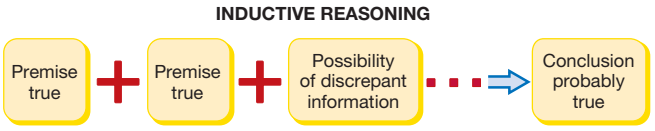
algorithm A problem-solving strategy guaranteed to produce a solution even if the user does not know how it works.

deductive reasoning A form of reasoning in which a conclusion follows necessarily from given premises; if the premises are true, the conclusion must be true.

inductive reasoning A form of reasoning in which the premises provide support for a conclusion, but it is still possible for the conclusion to be false.

heuristic A rule of thumb that suggests a course of action or guides problem solving but does not guarantee an optimal solution.

In contrast, in **inductive reasoning**, a conclusion *probably* follows from the given premises but could conceivably be false:



For example, if your premises are "I had a delicious meal at Joe's restaurant on Monday" and "I had a delicious meal again at Joe's on Tuesday," you might reasonably reach the conclusion that "Joe's restaurant consistently serves good food." But those meals could have been a fluke; maybe the regular cook, who is terrible, was on vacation and those great meals were made by a visiting chef.

Science depends heavily on inductive reasoning, because scientists make careful observations and then draw conclusions from those observations that they think are probably true. But in inductive reasoning, no matter how much supporting evidence you gather, it is always possible that new information will turn up to show you are wrong and that your previous conclusions were faulty and must therefore be revised or modified.

Informal Reasoning: Heuristics and Dialectical Thinking

Useful as they are, algorithms and logical reasoning cannot solve all, or even most, of life's problems. In *informal reasoning problems*, there is often no clearly correct solution. Many approaches, viewpoints, or possible solutions may compete, and you may have to decide which one is most reasonable. Further, the information at your disposal may be incomplete, or people may disagree on what the premises should be. Your position on the controversial issue of abortion will depend on your premises about when meaningful human life begins, what rights an embryo has, and what rights a woman has to control her own body. People on opposing sides of this issue even disagree on how the premises should be phrased, because they have different emotional reactions to terms such as "rights," "meaningful life," and "control her own body."

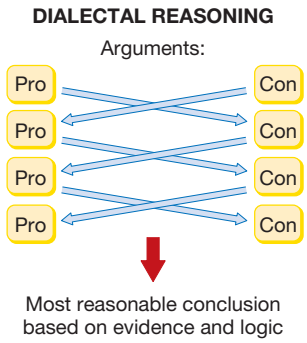
Formal and informal problems usually call for different approaches. Whereas formal problems can often be solved with an algorithm, informal problems often call for a **heuristic**, a rule of thumb that suggests a course of action without guaranteeing an optimal solution. Anyone who has ever played chess or a card game is familiar with heuristics (e.g., "Get rid of high cards first"). In these games, working out

Get Involved! Practice Your Dialectical Reasoning

Choose a controversial topic, such as whether marijuana should be legalized or the death penalty should be revoked. First list all the arguments you can to support your own position. Then list all the arguments you can on the other side of the issue. You do not have to agree with these arguments; just list them. Do you feel a mental block or emotional discomfort while doing this? Can you imagine how opponents of your position would answer your arguments? Having strong opinions is fine; you should have an informed opinion on matters of public interest. But does that opinion get in the way of even imagining a contrary point of view or of altering your view if the evidence warrants a change?

all the possible sequences of moves would be impossible. Heuristics are also useful to an investor trying to predict the stock market, a doctor trying to determine the best treatment for a patient, and a factory owner trying to boost production: All are faced with incomplete information on which to base a decision and may therefore resort to rules of thumb that have proven effective in the past.

In thinking about real-life problems, a person must also be able to use **dialectical reasoning**, the process of comparing and evaluating opposing points of view to resolve differences. Philosopher Richard Paul (1984) once described dialectical reasoning as movement "up and back between contradictory lines of reasoning, using each to critically cross-examine the other":



Dialectical reasoning is what juries are supposed to do to arrive at a verdict: consider arguments for and against the defendant's guilt, point and counterpoint. It is also what voters are supposed to do when thinking about whether the government should raise or lower taxes, or about the best way to improve public education.

Reflective Judgment

Many adults clearly have trouble thinking dialectically; they take one position, and that's that. When do people develop the ability to think critically—to question assumptions, evaluate and integrate evidence, consider alternative interpretations, and reach conclusions that can be defended as most reasonable?

To find out, Patricia King and Karen Kitchener (1994, 2002, 2004) provided adolescents and adults, representing a wide variety of backgrounds, with statements describing opposing viewpoints on various topics. Each person then had to answer these questions: What do you think about these statements? How did you come to hold that point of view? On what do you base your position? Can you ever know for sure that your position is correct? From the responses of thousands of participants, gathered over more than a quarter of a century, King and Kitchener have identified seven cognitive stages on the road to what they call *reflective judgment* (and what we have called critical thinking). At each stage, people make different assumptions about how things are known and use different ways of justifying or defending their beliefs.

dialectical reasoning
A process in which opposing facts or ideas are weighed and compared, with a view to determining the best solution or resolving differences.

Talk-radio shows do not exactly encourage reflective judgment!

In general, people in two *prereflective stages* tend to assume that a correct answer always exists and that it can be obtained directly through the senses ("I know what I've seen") or from authorities ("They said so on the news"; "That's what I was brought up to believe"). If authorities do not yet have the truth, prereflective thinkers tend to reach conclusions on the basis of what "feels right" at the moment. They do not distinguish between knowledge and belief or between belief and evidence, and they see no reason to justify a belief. One respondent at this stage, when asked about evolution, said: "Well, some people believe that we evolved from apes and that's the way they want to believe. But I would never believe that way and nobody could talk me out of the way I believe because I believe the way that it's told in the Bible."

During three *quasi-reflective stages*, people recognize that some things cannot be known with absolute certainty, and they realize that judgments should be supported by reasons, yet they pay attention only to evidence that fits what they already believe. They seem to think that because knowledge is uncertain, any judgment about the evidence is purely subjective. Quasi-reflective thinkers will defend a position by saying, "We all have a right to our own opinion," as if all opinions are created equal. One college student at this stage, when asked whether one opinion on the safety of food additives was right and others were wrong, answered: "No. I think it just depends on how you feel personally because people make their decisions based upon how they feel and what research they've seen. So what one person thinks is right, another person might think is wrong. If I feel that chemicals cause cancer and you feel that food is unsafe without it, your opinion might be right to you and my opinion is right to me."

In the last two stages, people become capable of reflective judgment. They understand that although some things can never be known with certainty, some judgments are more valid than others because of their coherence, their fit with the available evidence, and their usefulness. People at these *reflective stages* are willing to consider evidence from a variety of sources and to reason dialectically. This interview with a graduate student illustrates reflective thinking:

Interviewer: Can you ever say you know for sure that your point of view on chemical additives is correct?

Student: No, I don't think so [but] I think that we can usually be reasonably certain, given the information we have now, and considering our methodologies . . . it might be that the research wasn't conducted rigorously enough. In other words, we might have flaws in our data or sample, things like that.

Interviewer: How then would you identify the "better opinion"?

Student: One that takes as many factors as possible into consideration. I mean one that uses the higher percentage of the data that we have, and perhaps that uses the methodology that has been most reliable.

Interviewer: And how do you come to a conclusion about what the evidence suggests?

Student: I think you have to take a look at the different opinions and studies that are offered by different groups. Maybe some studies offered by the chemical industry, some studies by the government, some private studies. . . . You have to try to interpret people's motives and that makes it a more complex soup to try to strain out.

Most people show no evidence of reflective judgment until their middle or late twenties, if ever. However, when students get support for thinking reflectively and have opportunities to practice it in their courses, their thinking tends to become more complex, sophisticated, and well-grounded (Kitchener et al., 1993). You can see why, in this book, we emphasize thinking about and evaluating psychological findings, and not just memorizing them.

One reason that Auguste Rodin's *The Thinker* became world famous and has been much imitated is that it captures so perfectly the experience of thinking reflectively.

Quick Quiz

Reflect on the answers to these questions.

1. Most of the holiday gifts Mervin bought this year cost more than they did last year, so he concludes that inflation is increasing. Is he using inductive, deductive, or dialectical reasoning?
2. Yvonne is arguing with Henrietta about whether real estate is a better investment than stocks. "You can't convince me," says Yvonne. "I just know I'm right." Yvonne needs training in _____ reasoning.
3. Seymour thinks the media have a liberal political bias, and Sophie thinks they are too conservative. "Well," says Seymour, "I have my truth and you have yours. It's purely subjective." Which of King and Kitchener's stages of thinking describes Seymour's statement?

Answers:

1. inductive 2. dialectical 3. quasi-reflective

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- how biases in reasoning impair the ability to think rationally and critically.
- why people worry more about vivid but rare disasters than about dangers that are far more likely.
- how the way a decision is framed affects the choices people make.
- why people often value fairness above rational self-interest.
- how the need to justify the expenditure of time, money, and effort affects how people think about a group they joined or a product they bought.

Barriers to Reasoning Rationally

Although most people have the capacity to think logically, reason dialectically, and make judgments reflectively, it is abundantly clear that they do not always do so. One obstacle is the need to be right; if your self-esteem depends on winning arguments, you will find it hard to listen with an open mind to competing views. Other obstacles include limited information and a lack of time to reflect carefully. But human thought processes are also tripped up by many predictable, systematic biases and errors. Psychologists have studied dozens of these cognitive pitfalls (Kahneman, 2003). Here we describe just a few.

Thinking Critically about Why We Don't Always Think Critically

Exaggerating the Improbable (and Minimizing the Probable)

One common bias is the inclination to exaggerate the probability of rare events. This bias helps to explain why so many people enter lotteries and buy disaster insurance, and why some irrational fears persist. As we discuss in Chapter 9, evolution has equipped us to fear natural dangers, such as snakes. However, in modern life, many of these dangers are no longer much of a threat; the risk of a renegade rattler sinking its fangs into you in Chicago or New York is pretty low! Yet the fear lingers on, so we overestimate the danger. Evolution has also given us brains that are terrific at responding to an immediate threat or to acts that provoke moral outrage even though they pose no threat to the survival of the species. Unfortunately, our brains were not designed to become alarmed by serious *future* threats that do not seem to pose much danger right now, such as global warming (Gilbert, 2006).

When judging probabilities, people are strongly influenced by the **affect heuristic**: the tendency to consult their emotions (affect) to judge the "goodness" or "badness" of a situation instead of judging probabilities objectively (Slovic & Peters, 2006; Slovic et al., 2002). Emotions can often help us make decisions by narrowing our options or by allowing us to act quickly in an ambiguous or dangerous situation. But emotions can also mislead us by preventing us from accurately assessing risk. One unusual field study looked at how people in France responded to the "mad cow" crisis that occurred a few years ago. (Mad cow disease affects the brain and can be contracted by eating meat from contaminated cows.) Whenever many newspaper articles reported the dangers of "mad cow disease," beef consumption fell

affect heuristic The tendency to consult one's emotions instead of estimating probabilities objectively.

Because of the affect and availability heuristics, many of us overestimate the chances of suffering a shark attack. Shark attacks are extremely rare, but they are terrifying and easy to visualize.

during the following month. But when news articles, reporting the same dangers, used the technical names of the disease—Creutzfeldt-Jakob disease, or bovine spongiform encephalopathy—beef consumption stayed the same (Sinaceur, Heath, & Cole, 2005). The more alarming labels caused people to reason emotionally and to overestimate the danger. (During the entire period of the supposed crisis, only six people in France were diagnosed with the disease.)

Our judgments about risks are also influenced by the **availability heuristic**, the tendency to judge the probability of an event by how easy it is to think of examples or instances of it (Tversky & Kahneman, 1973). The availability heuristic often works hand in hand with the affect heuristic. Catastrophes and shocking accidents evoke a strong emotional reaction in us, and thus stand out in our minds. They are more available mentally than other kinds of negative events. (An image of a "mad cow"—that sweet, placid creature running amok!—is highly available.) This is why people overestimate the frequency of deaths from tornadoes and underestimate the frequency of deaths from asthma, which occur more than 20 times as often but do not make headlines.

availability heuristic The tendency to judge the probability of a type of event by how easy it is to think of examples or instances.

Avoiding Loss

In general, people try to avoid or minimize the risk of incurring losses when they make decisions. That strategy is rational enough, but people's perceptions of risk are subject to the **framing effect**: the tendency for choices to differ, depending on how the choice is presented. When a choice is framed in terms of the risk of losing something, people will respond more cautiously than when the very same choice is framed in terms of gain. They will choose a ticket that has a 1 percent chance of winning a raffle but reject one that has a 99 percent chance of losing. Or they will rate a condom as effective when they are told it has a 95 percent success rate in protecting against the AIDS virus, but not when they are told it has a 5 percent failure rate—which of course is exactly the same thing (Linville, Fischer, & Fischhoff, 1992).

Suppose you had to choose between two health programs to combat a disease expected to kill 600 people. Which would you prefer: a program that will definitely save 200 people, or one with a one-third probability of saving all 600 people and a two-thirds probability of saving none? (Problem 1 in Figure 7.1

framing effect The tendency for people's choices to be affected by how a choice is presented or framed, such as whether it is worded in terms of potential losses or gains.

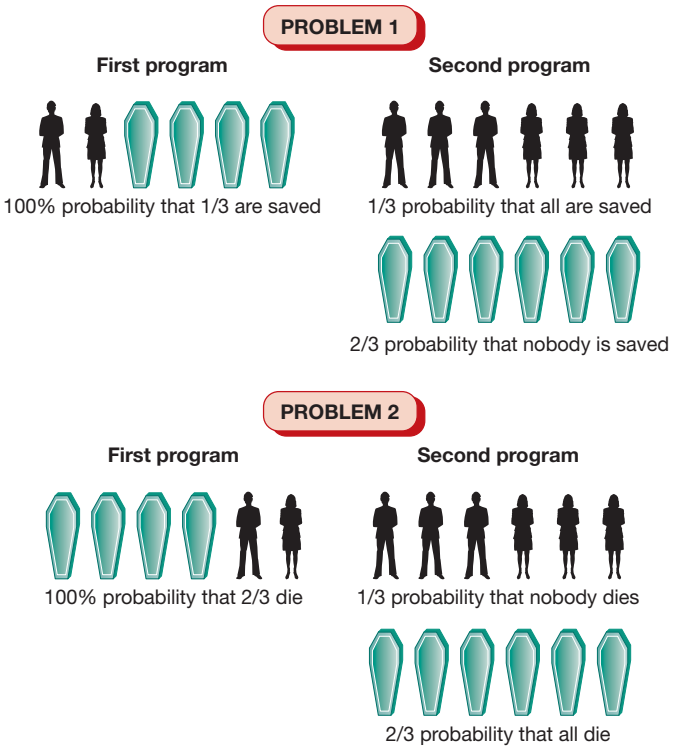


FIGURE 7.1
A Matter of Wording
The decisions we make often depend on how the alternatives are framed. When asked to choose between the two programs in Problem 1, which are described in terms of lives saved, most people choose the first program. When asked to choose between the programs in Problem 2, which are described in terms of lives lost, most people choose the second program. Yet the alternatives in the two problems are actually identical.

illustrates this choice.) When asked this question, most people, including physicians, say they would prefer the first program. In other words, they reject the riskier though potentially more rewarding solution in favor of a sure gain. However, people will take a risk if they see it as a way to *avoid loss*. Suppose now that you have to choose between a program in which 400 people will definitely die and a program in which there is a one-third probability of nobody dying and a two-thirds probability that all 600 will die. If you think about it, you will see that the alternatives are exactly the same as in the first problem; they are merely worded differently (see Problem 2 in Figure 7.1). Yet this time, most people choose the second solution. They reject risk when they think of the outcome in terms of lives saved, but they accept risk when they think of the outcome in terms of lives lost (Tversky & Kahneman, 1981).

Few of us will have to face a decision involving hundreds of lives, but we may have to choose between different medical treatments for ourselves or a relative. Our decision may be affected by whether the doctor frames the choice in terms of chances of surviving or chances of dying.

The Fairness Bias

Interestingly, in some circumstances we do not try to avoid loss altogether, because we are subject to a *fairness bias*. Imagine that you are playing a two-person game called the *Ultimatum Game*, in which your partner gets $20 and must decide how much to share with you. You can choose to accept your partner's offer, in which case you both get to keep your respective portions, or you can reject the offer, in which case neither of you gets a penny. How low an offer would you accept?

If you think about it, you'll see that it makes sense to accept any amount at all, no matter how paltry, because then at least you will get *something*. But that is not how people respond when playing the Ultimatum Game. If the offer is too low, they are likely to reject it. In industrial societies, offers of 50 percent are typical and offers below 20 or 30 percent are commonly rejected, even when the absolute sums are large. In other societies, the amounts offered and accepted may be higher or lower, but there is always some amount that people consider unfair and refuse to accept (Henrich et al., 2001). People may be competitive and love to win, but they are also powerfully motivated to cooperate and to see fairness prevail.

Using the Ultimatum Game and other laboratory games, scientists are exploring how a sense of fairness often takes precedence over rational self-interest when people make economic choices. Their work, which belongs to a field called *behavioral economics*, verifies and extends the pioneering work of Nobel Prize winner Herbert Simon (1955), who first showed that economic decisions are not always rational. Psychologist Daniel Kahneman also won a Nobel for his work on the irrational processes of decision making, but because there is (as yet) no Nobel Prize in psychology, he won it in economics. This was a delicious irony, because many economists still have a difficult time accepting the evidence of human irrationality.

Why does a desire for fair play sometimes outweigh the desire for economic gain? Evolutionary theorists believe that cooperative tendencies and a desire for fairness and reciprocity evolved because they were beneficial to our forbears (Fehr & Fischbacher, 2003; Trivers, 2004).

The idea that the Golden Rule has a basis in biology has gained support from research with nonhuman primates. In one study, capuchin monkeys received a token that they could then exchange for a slice of cucumber. The monkeys regarded this exchange as a pretty good deal—until they saw a neighboring monkey exchanging tokens for an even better reward, a grape. At that point, they began to refuse to exchange their tokens, even though they were then left with no reward at all (Brosnan & de Waal, 2003). Sometimes they even threw the cucumber slice on the ground in apparent disgust!

Some behavioral economists are using MRI scans to examine brain activity when people play variations of the Ultimatum Game (Camerer, 2003; Sanfey et al., 2003). While a person is deciding whether to accept a low offer, two brain areas are active: a part of the prefrontal cortex linked to rational problem solving and an area that is associated with disgust and other unpleasant feelings. According to economist Colin Camerer, "Basically the brain toggles between 'Yes, money is good' and 'Ugh, this guy is treating me like crap'" (quoted in D'Antonio, 2004). Some people choose the money, and others go for respect. Which choice do you think you would make?

The Hindsight Bias

There is a reason for the observation that the vision of hindsight is 20/20. When people learn the outcome of an event or the answer to a question, they are often sure that they "knew it all along." They see the outcome that actually occurred as inevitable, and they overestimate their ability to have predicted what happened beforehand (Fischhoff, 1975; Hawkins & Hastie, 1990). This **hindsight bias** shows up all the time in evaluating relationships ("I always knew their marriage wouldn't

hindsight bias The tendency to overestimate one's ability to have predicted an event once the outcome is known; the "I knew it all along" phenomenon.

confirmation bias The tendency to look for or pay attention only to information that confirms one's own belief.

last"), medical judgments ("I could have told you that mole was cancerous"), and military opinions ("The generals should have known that the enemy would attack").

The hindsight bias can be adaptive. When we try to make sense of the past, we focus on explaining just one outcome, the one that actually occurred, because explaining outcomes that did not occur can be a waste of time. Then, in light of current knowledge, we reconstruct and misremember our previous judgment (Hoffrage, Hertwig, & Gigerenzer, 2000). But as Scott Hawkins and Reid Hastie (1990) wrote, "Hindsight biases represent the dark side of successful learning and judgment." They are the dark side because when we are sure that we knew something all along, we are also less willing to find out what we need to know to make accurate predictions in the future. In medical conferences, when doctors are told what the postmortem findings were for a patient who died, they tend to think the case was easier to diagnose than it actually was ("I would have known it was a brain tumor"), and so they learn less from the case than they should (Dawson et al., 1988).

Perhaps you feel that we are not telling you anything new because you have always known about the hindsight bias. If so, you may just have a hindsight bias about the hindsight bias!

The Confirmation Bias

When people want to make the most accurate judgment possible, they usually try to consider all of the relevant information. But as we saw in Chapter 1, when they are thinking about an issue they already feel strongly about, they often succumb to the **confirmation bias**, paying attention only to evidence that confirms their belief and finding fault with evidence or arguments that point in a different direction (Edwards & Smith, 1996; Nickerson, 1998). You rarely hear someone say, "Oh, thank you for explaining to me why my lifelong philosophy of child rearing (or politics, or investing) is wrong. I'm so grateful for the facts!" The person usually says, "Oh, buzz off, and take your cockamamie ideas with you."

Once you start looking for it, you will see the confirmation bias everywhere. Politicians brag about economic reports that confirm their party's position and dismiss counterevidence as biased or unimportant. Police officers who are convinced of a suspect's guilt take anything the suspect says or does as evidence that confirms it, including the suspect's claims of innocence (Davis, 2010). Many jury members, instead of weighing possible verdicts against the evidence, quickly construct a story about what happened at the start of the trial and then consider only the evidence that supports it (Kuhn, Weinstock, & Flaton, 1994). We bet you can see the confirmation bias in your own reactions to what you are learning in psychology. In thinking critically, most of us apply a double standard; we think most critically about results we dislike. That is why the scientific method can be so difficult: It forces us to consider evidence that disconfirms our beliefs.

Get Involved! Confirming the Confirmation Bias

Suppose someone deals out four cards, each with a letter on one side and a number on the other. You can see only one side of each card:

Your task is to find out whether the following rule is true: "If a card has a vowel on one side, then it has an even number on the other side." Which two cards do you need to turn over to find out?

The vast majority of people say they would turn over the E and the 6, but they are wrong. You do need to turn over the E (a vowel), because if the number on the other side is even, it confirms the rule, and if it is odd, the rule is false. However, the card with the 6 tells you nothing. The rule does *not* say that a card with an even number must always have a vowel on the other side. Therefore, it doesn't matter whether the 6 has a vowel or a consonant on the other side. The card you do need to turn over is the 7, because if it has a vowel on the other side, that fact disconfirms the rule.

People do poorly on this problem because they are biased to look for confirming evidence and to ignore the possibility of disconfirming evidence. Don't feel too bad if you missed it. Most judges, lawyers, and people with Ph.D.s do, too.

Mental Sets

Another barrier to rational thinking is the development of a **mental set**, a tendency to try to solve new problems by using the same heuristics, strategies, and rules that worked in the past on similar problems. Mental sets make human learning and problem solving efficient; because of them, we do not have to keep reinventing the wheel. But mental sets are not helpful when a problem calls for fresh insights and methods. They cause us to cling rigidly to the same old assumptions and approaches, blinding us to better or more rapid solutions.

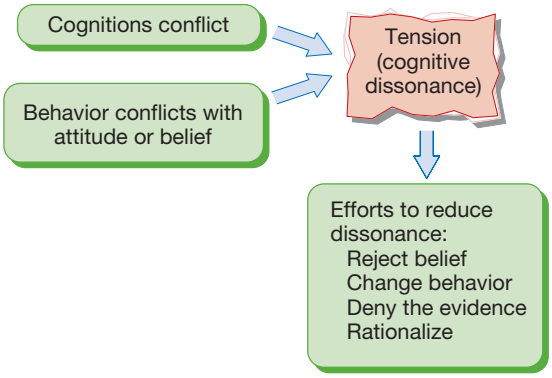
One general mental set is the tendency to find patterns in events. This tendency is adaptive because it helps us understand and exert some control over what happens in our lives. But it also leads us to see meaningful patterns even when they do not exist. For example, many people with arthritis think that their symptoms follow a pattern dictated by the weather. They suffer more, they say, when the barometric pressure changes or when the weather is damp or humid. Yet when researchers followed 18 arthritis patients for 15 months, no association whatsoever emerged between weather conditions and the patients' self-reported pain levels, their ability to function in daily life, or a doctor's evaluation of their joint tenderness (Redelmeier & Tversky, 1996). Of course, because of the confirmation bias, the patients refused to believe the results.

The Need for Cognitive Consistency

Mental sets and the confirmation bias cause us to avoid evidence that contradicts our beliefs. But what happens when disconfirming evidence finally smacks us in the face, and we cannot ignore or discount it any longer? Consider the popularity of doomsday predictions, which have been made throughout history and continue to the present: "The world will end on (fill in the date)!" When these predictions fail, how come we never hear believers say, "Boy, what a fool I was"?

According to the theory of **cognitive dissonance**, people will resolve such conflicts in predictable, though not always obvious, ways (Festinger, 1957). *Dissonance*, the opposite of consistency (*consonance*), is a state of tension that occurs when you hold either two cognitions (beliefs, thoughts, attitudes) that are psychologically inconsistent with one another or a belief that is incongruent with your behavior. This tension is uncomfortable, so you will be motivated to reduce it. You may do this by rejecting or modifying one of those inconsistent beliefs, changing your behavior, denying the evidence, or rationalizing:

COGNITIVE DISSONANCE



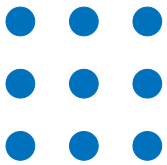
Many years ago, in a famous field study, Leon Festinger and two associates explored people's reactions to failed prophecies by infiltrating a group of people who thought the world would end on

mental set A tendency to solve problems using procedures that worked before on similar problems.

cognitive dissonance A state of tension that occurs when a person holds two cognitions that are psychologically inconsistent, or when a person's belief is incongruent with his or her behavior.

Get Involved! Connect the Dots

Copy this figure, and try to connect the dots by using no more than four straight lines without lifting your pencil or pen. A line must pass through each point. Can you do it?



Most people have difficulty with this problem because they have a mental set to interpret the arrangement of dots as a square. They then assume that they can't extend a line beyond the apparent boundaries of the square. Now that you know this, you might try again if you haven't yet solved the puzzle. Some solutions are given at the end of this chapter.

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December 21 (Festinger, Riecken, & Schachter, 1956). The group's leader, whom the researchers called Marian Keech, promised that the faithful would be picked up by a flying saucer and whisked to safety at midnight on December 20. Many of her followers quit their jobs and spent all their savings, waiting for the end to come. What would they do or say, Festinger and his colleagues wondered, to reduce the dissonance between "The world is still muddling along on the 21st" and "I predicted the end of the world and sold off all my worldly possessions"?

The researchers predicted that believers who had made no public commitment to the prophecy, who awaited the end of the world by themselves at home, would simply lose their faith. Those who had acted on their conviction by selling their property and waiting with Keech for the spaceship, however, would be in a state of dissonance. They would have to *increase* their religious belief to avoid the intolerable realization that they had behaved foolishly and others knew it. That is just what happened. At 4:45 a.m., long past the appointed hour of the saucer's arrival, the leader had a new vision. The world had been spared, she said, because of the impressive faith of her little band.

postdecision dissonance In the theory of cognitive dissonance, tension that occurs when you believe you may have made a bad decision.

Cognitive-dissonance theory predicts that in more ordinary situations as well, people will resist or rationalize information that conflicts with their existing ideas, just as the people in the arthritis study did. Cigarette smokers are often in a state of dissonance, because smoking is dissonant with the fact that smoking causes illness. Smokers may try to reduce the dissonance by trying to quit, by rejecting evidence that smoking is bad, by persuading themselves that they will quit later on, by emphasizing the benefits of smoking ("A cigarette helps me relax"), or by deciding that they don't want a long life, anyhow ("It will be shorter but sweeter").

You are particularly likely to reduce dissonance under three conditions (Aronson, 2008):

1 When you need to justify a choice or decision that you freely made. All car dealers know about buyer's remorse: The second that people buy a car, they worry that they made the wrong decision or spent too much, a phenomenon called **postdecision dissonance**. You may try to resolve this dissonance by deciding that the car you chose (or the toaster, or house, or spouse) is really, truly the best in the world. *Before* people make a decision, they can be open-minded, seeking information on the pros and cons of the choice at hand. *After* they make that choice, however, the confirmation bias will kick in, so that they will now notice all the good things about their decision and overlook or ignore evidence that they might have been wrong.

2 When you need to justify behavior that conflicts with your view of yourself. If you consider yourself to be honest, cheating will put you in a state of dissonance. To avoid feeling like a hypocrite, you will try to reduce the dissonance by justifying your behavior ("Everyone else does it"; "It's just this once"; "I had to do it to get into med school and learn to save lives"). Or if you see yourself as a kind person and you harm someone, you may reduce your dissonance by blaming the person you have victimized ("She brought it on herself"; "It's his fault") (Tavris & Aronson, 2007).

3 When you need to justify the effort put into a decision or choice. The harder you work to reach a goal, or the more you suffer for it, the more you will try to convince yourself that you value the goal, even if the goal turns out to be not so great after all (Aronson & Mills, 1959). This explains why hazing, whether in social clubs, on athletic teams, or in the military, turns new recruits into loyal members (see Figure 7.2). You might think that people would hate the group that caused them pain and embarrassment. But the cognition "I went through a lot of awful stuff to join this group" is dissonant with the cognition "only to find I hate the group." Therefore, people must decide either that the hazing was not so bad or that they really like the

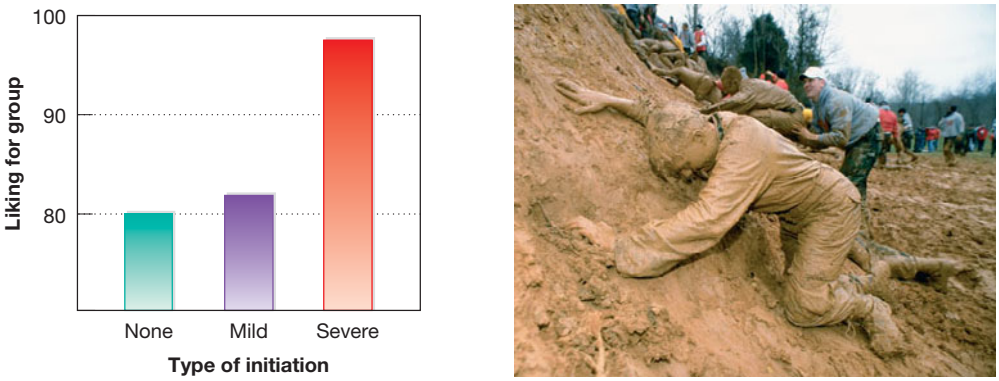

FIGURE 7.2
The Justification of Effort
The more effort you put into reaching a goal, the more highly you are likely to value it. As you can see in the graph on the left, after people listened to a boring group discussion, those who went through a severe initiation to join the group rated it most highly (Aronson & Mills, 1959). In the photo on the right, new cadets at the Virginia Military Institute are forced to crawl through mud until they are covered from head to toe. They will probably become devoted to the military.

group. This mental reevaluation is called the **justification of effort**, and it is one of the most popular methods of reducing dissonance.

Some people are secure enough to own up to their mistakes instead of justifying them, and individuals and cultures vary in the kinds of experiences that cause them to feel dissonance. For example, Americans are more likely to experience dissonance following a decision that makes them doubt their competence, whereas the Japanese feel more dissonance when a decision evokes worry about social approval or possible rejection (Kitayama et al., 2004). However, the need for cognitive consistency in those beliefs that are most central to our sense of self and our values is universal (Tavris & Aronson, 2007).

Overcoming Our Cognitive Biases

Our mental biases have survived because often they are helpful. The ability to reduce cognitive dissonance following a decision helps preserve our self-confidence and avoid sleepless nights second-guessing ourselves; having a sense of fairness keeps us from behaving like self-centered louts; having mental sets keeps us from having to reinvent solutions to problems we could otherwise solve quickly. But our mental biases can also get us into trouble. The confirmation bias, the justification of effort, and postdecision dissonance reduction permit people to stay stuck with decisions that eventually prove to be self-defeating, harmful, or incorrect. Physicians may stick with outdated methods, district attorneys may overlook evidence that a criminal suspect might be innocent, and managers may refuse to consider better business practices.

To make matters worse, most people have a "bias blind spot": They acknowledge that *other* people have biases that distort reality, but they think that they themselves are free of bias and see the world as it really is (Pronin, Gilovich, & Ross, 2004; Ross, 2010). This blind spot is itself a bias! And it is a dangerous one, because it can prevent individuals, nations, ethnic groups, and religious groups from resolving conflicts with others. Each side thinks that its own proposals for ending a conflict, or its own analyses of political events, are reasonable and fair but the other side's are biased. Fortunately, once we understand a bias, we may, with some effort, be able to reduce or eliminate it, especially if we make an active, mindful effort to do so and take time to think carefully (Kida, 2006).

Some people, of course, seem to think more mindfully and rationally than others; we call them "intelligent." Just what is intelligence, and how can we measure and improve it? We take up these questions next.

justification of effort
The tendency of individuals to increase their liking for something that they have worked hard or suffered to attain; a common form of dissonance reduction.

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Quick Quiz

In hindsight, will you say this quiz was easy?

1. In 2001, an unknown person sent anthrax through the United States post office, causing the deaths of five people. Many people became afraid to open their mail, although the risk for any given individual was extremely small. What heuristics help to explain this reaction?
2. *True or false:* Research on the Ultimatum Game shows that people usually act out of rational self-interest.
3. Stu meets a young woman at the student cafeteria. They hit it off and eventually get married. Says Stu, "I knew when I woke up that morning that something special was about to happen." What cognitive bias is affecting his thinking, charmingly romantic though it is?
4. In a classic experiment on cognitive dissonance, students did some boring, repetitive tasks and then had to tell another student, who was waiting to participate in the study, that the work was interesting and fun (Festinger & Carlsmith, 1959). Half the students were offered $20 for telling this lie and the others only $1. Based on what you have learned about cognitive dissonance reduction, which students do you think decided later that the tasks had been fun after all? Why?

Answers:

1. the affect and availability heuristics **2.** false **3.** the hindsight bias **4.** The students who got only $1 were more likely to say that the task had been fun. They were in a state of dissonance because "The task was as dull as dishwater" is dissonant with "I said I enjoyed it—and for a mere dollar, at that." Those who got $20 could rationalize that the large sum (which really was large in the 1950s) justified the lie.

YOU are about to learn...

- **both sides of the debate about whether a single thing called "intelligence" actually exists.**
- **how the original purpose of intelligence testing changed when IQ tests came to America.**
- **the difficulties of designing intelligence tests that are free of cultural influence.**

intelligence An inferred characteristic of an individual, usually defined as the ability to profit from experience, acquire knowledge, think abstractly, act purposefully, or adapt to changes in the environment.

psychometrics The measurement of mental abilities, traits, and processes.

factor analysis A statistical method for analyzing the intercorrelations among various measures or test scores; clusters of measures or scores that are highly correlated are assumed to measure the same underlying trait, ability, or aptitude (factor).

g factor A general intellectual ability assumed by many theorists to underlie specific mental abilities and talents.

Measuring Intelligence: The Psychometric Approach

Intelligent people disagree on just what intelligence is. Some equate it with the ability to reason abstractly, others with the ability to learn and profit from experience in daily life. Some emphasize the ability to think rationally, others the ability to act purposefully. These qualities are all probably part of what most people mean by **intelligence**, but theorists weigh them differently.

The traditional approach to intelligence, the **psychometric** approach, focuses on how well people perform on standardized aptitude tests, which are designed to measure the ability to acquire skills and knowledge. A typical intelligence test asks you to do several things: provide a specific bit of information, notice similarities between objects, solve arithmetic problems, define words, fill in the missing parts of incomplete pictures, arrange pictures in a logical order, arrange blocks to resemble a design, assemble puzzles, use a coding scheme, or judge what behavior would be appropriate in a given situation. A statistical method called **factor analysis** identifies clusters of correlated items on the test that seem to be measuring some common ability, or factor.

Most psychometric psychologists believe that a general ability, or **g factor**, underlies the various abilities and talents measured by intelligence tests (Gottfredson, 2002; Jensen, 1998; Lubinski, 2004; Spearman, 1927; Wechsler, 1955). They marshal a century of research to support their view (Lubinski, 2004). Tests of *g* do a good job of predicting not

A psychologist gives a student an intelligence test.

only academic achievement but also the cognitive complexity of people's work, occupational success, and eminence in many fields (Kuncel, Hezlett, & Ones, 2004; Schmidt & Hunter, 2004; Simonton & Song, 2009).

However, others dispute the existence of a global quality called "intelligence," observing that a person can excel in some kinds of reasoning and problem solving yet do poorly in others (Gardner, 1983; Gould, 1994; Guilford, 1988). This disagreement over how to define intelligence has generated enormous debate among psychologists and has led some writers to argue, only half-jokingly, that intelligence is "whatever intelligence tests measure."

The Invention of IQ Tests

The first widely used intelligence test was devised in 1904, when the French Ministry of Education asked psychologist Alfred Binet (1857–1911) to find a way to identify children who were slow learners so they could be given remedial work. The ministry was reluctant to let teachers identify such children because the teachers might have prejudices about poor children, or might assume that shy or disruptive children were mentally impaired. The government wanted a more objective approach.

Binet's Brainstorm Wrestling with the problem, Binet had a great insight: In the classroom, the responses of "dull" children resembled those of ordinary children of younger ages. Bright children, on the other hand, responded like children of older ages. The thing to measure, then, was a child's **mental age (MA)**, or level of intellectual development relative to that of other children. Then instruction could be tailored to the child's capabilities.

The test devised by Binet and his colleague, Théodore Simon, measured memory, vocabulary, and perceptual discrimination. Items ranged from those that most young children could do easily to those that only older children could handle, as determined by the testing of large numbers of children. A scoring system developed later by others used a formula in which the child's mental age was divided by the child's chronological age to yield an **intelligence quotient**, or **IQ** (a quotient is the result of division). Thus a child of 8 who performed like the average 10-year-old would have a mental age of 10 and an IQ of 125 (10 divided by 8, times 100). All average children, regardless of age, would have an IQ of 100 because mental age and chronological age would be the same.

However, this method of figuring IQ had serious flaws. At one age, scores might cluster tightly around the average, whereas they might be more dispersed at another age. As a result, the score necessary to be in the top 10 or 20 or 30 percent of your age group varied, depending on your age. Also, the IQ formula did not make sense for adults; a 50-year-old who scores like a 30-year-old does not have low intelligence! Today, therefore, intelligence tests are scored differently. The average is usually set arbitrarily at 100, and tests are constructed so that about two-thirds of all people score between 85 and 115. Individual scores are computed from tables based on established norms. These scores are still informally referred to as IQs, and they still reflect how a person compares with other people, either children of a particular age or adults in general. At all ages, the distribution of scores approximates a normal bell-shaped curve, with scores near the average (mean) more common than high or low scores (see Figure 7.3).

The IQ Test Comes to America In the United States, Stanford psychologist Lewis Terman revised Binet's test and established norms for American children. His version, the *Stanford–Binet Intelligence Scale*, was first published in 1916, and has been updated several times since. The test asks a person to perform a variety of tasks, such as filling in missing words in sentences, answering questions requiring general knowledge, predicting how a folded paper will look when unfolded, measuring a quantity of

mental age (MA) A measure of mental development expressed in terms of the average mental ability at a given age.

intelligence quotient (IQ) A measure of intelligence originally computed by dividing a person's mental age by his or her chronological age and multiplying the result by 100; it is now derived from norms provided for standardized intelligence tests.

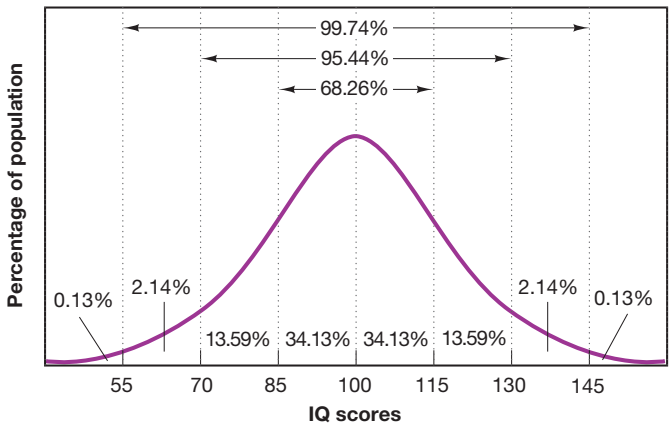


FIGURE 7.3
Expected Distribution of IQ Scores
In a large population, IQ scores tend to be distributed on a normal (bell-shaped) curve. On most tests, about 68 percent of all people will score between 85 and 115; about 95 percent will score between 70 and 130, and about 97.7 percent will score between 55 and 145. In any actual sample, however, the distribution will depart somewhat from the theoretical ideal.

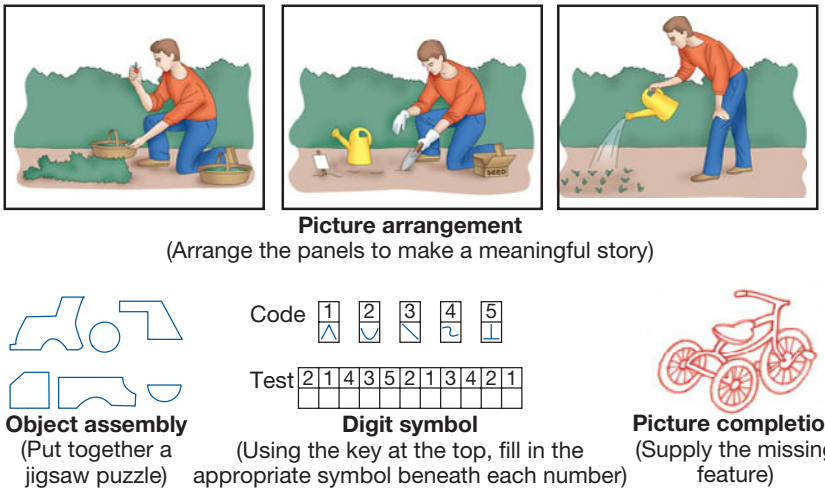


FIGURE 7.4
Performance Tasks on the Wechsler Tests
Nonverbal items such as these are particularly useful for measuring the abilities of those who have poor hearing, are not fluent in the tester's language, have limited education, or resist doing classroom-type problems. A large gap between a person's verbal score and performance on nonverbal tasks such as these sometimes indicates a specific learning problem (adapted from Cronbach, 1990).

water using two containers of different sizes, and distinguishing concepts that are similar but not exactly the same (such as *vigor* and *energy*). The older the test taker is, the more the test requires in the way of verbal comprehension and fluency, spatial ability, and reasoning.

Two decades later, David Wechsler designed another test expressly for adults, which became the *Wechsler Adult Intelligence Scale (WAIS)*; it was followed by the *Wechsler Intelligence Scale for Children (WISC)*. Although the Wechsler tests produced a general IQ score, they also provided specific scores for different kinds of ability. Verbal items tested vocabulary, arithmetic abilities, immediate memory span, ability to recognize similarities (e.g., "How are books and movies alike?"), and general knowledge and comprehension (e.g., "Who was Thomas Jefferson?" "Why do people who want a divorce have to go to court?"). Performance items tested nonverbal skills, such as the ability to re-create a block design within a specified time limit and to identify a part missing from a picture. The current versions of the Wechsler tests have more subtests and, in addition to an overall IQ score, they yield separate scores for verbal comprehension, perceptual reasoning, processing speed, and working memory (the ability to hold information in mind so it can be used for a task). (See Figure 7.4 for some sample items.)

Watch the Video Are Intelligence Tests Valid? on mypsychlab.com

Binet had emphasized that his test merely *sampled* intelligence and did not measure everything covered by that term. A test score, he said, could be useful, along with other information, for predicting school performance, but it should not be confused with intelligence itself. The tests were designed to be given individually, so that the test giver could tell when a child was ill or nervous, had poor vision, or was unmotivated. The purpose was to identify children with learning problems, not to rank all children. But when intelligence testing was brought from France to the United States, its original purpose got lost at sea. In America, IQ tests became widely used not to bring slow learners up to the average, but to categorize people in school and in the armed services according to their presumed "natural ability." The testers overlooked the fact that in America, with its many ethnic groups, people did not all share the same background and experience (Gould, 1996). Watch

Culture and Intelligence Testing Intelligence tests developed between World War I and the 1960s favored city children over rural ones, middle-class children over poor ones, and white children over

nonwhite children. One item asked whether the Emperor Concerto was written by Beethoven, Mozart, Bach, Brahms, or Mahler. (The answer is Beethoven.) Critics complained that the tests did not measure the kinds of knowledge and skills that indicate intelligent behavior in a minority neighborhood or in the hills of Appalachia. They feared that because teachers thought IQ scores revealed the limits of a child's potential, low-scoring children would not get the educational attention or encouragement they needed.

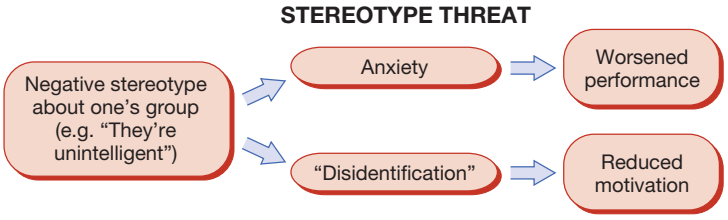
Test makers responded by trying to construct tests that were unaffected by culture or that incorporated knowledge and skills common to many different cultures. But these efforts were disappointing. One reason was that cultures differ in the problem-solving strategies they emphasize (Serpell, 1994). In the West, white, middle-class children typically learn to classify things by category—to say that an apple and a peach are similar because they are both fruits, and that a saw and a rake are similar because they are both tools. But children who are not trained in middle-class ways of sorting things may classify objects according to their sensory qualities or functions; they may say that an apple and a peach are similar because they taste good. We think that's a charming and innovative answer, but it is one that test administrators have interpreted as less intelligent (Miller-Jones, 1989).

Testing experts also discovered that cultural values and experiences affect many things besides responses to specific test items. These include a person's general attitude toward exams, motivation, rapport with the test giver, competitiveness, comfort in solving problems independently rather than with others, and familiarity with the conventions for taking tests (Anastasi & Urbina, 1997; López, 1995; Sternberg, 2004).

Moreover, people's performance on IQ and other mental-ability tests depends in part on their own expectations about how they will do, and those expectations are affected by cultural stereotypes. Stereotypes that portray women, old people, poor people, or members of ethnic minorities as unintelligent, or "naturally" inferior to white men on some cognitive skill such as visual-spatial ability, can actually depress the performance of people in those groups (Campbell & Collaer, 2009). You might think that a woman would say, "So sexists think women are dumb at math? I'll show them!" or that an African American would say, "So racists believe that blacks aren't as smart as whites? Just give me that exam." But often that is not what happens.

On the contrary, such individuals commonly feel a burden of doubt about their abilities that Claude Steele (1992, 1997) has labeled **stereotype threat**. The threat occurs when people believe that if they do not do well, they will confirm the stereotypes about their group. Negative thoughts intrude and disrupt their concentration ("I hate this test," "I'm no good at math") (Cadinu et al., 2005). The resulting anxiety may then worsen their performance or kill their motivation to even try to do well.

stereotype threat A burden of doubt a person feels about his or her performance, due to negative stereotypes about his or her group's abilities.



More than 300 studies have shown that stereotype threat can affect the test performance of many African Americans, Latinos, low-income people, women, and elderly people, all of whom perform better when they are not feeling self-conscious about themselves as members of negatively stereotyped groups (e.g., J. Aronson, 2010; Brown & Josephs, 1999; Inzlicht & Ben-Zeev, 2000; Levy, 1996; Quinn & Spencer, 2001; Steele & Aronson, 1995). Anything that increases the salience of group stereotypes can increase stereotype threat and affect performance, including taking the test in a setting where you are the only member from your group, or being asked to state your race, ethnicity, or age before taking the test.

Whether or not you feel "stereotype threat" depends on what category you are identifying with at the time. Asian women do worse on math tests when they see themselves as "women" (stereotype = poor at math) rather than as "Asians" (stereotype = good at math) (Shih, Pittinsky, & Ambady, 1999).

What can be done to reduce stereotype threat? One possibility is simply to tell people about it, which often inoculates them against its effects (Schmader, 2010). When students taking introductory statistics were given a difficult test, with no mention of stereotype threat, women did worse than men. But when students were informed about stereotype threat, the sex difference disappeared (Johns, Schmader, & Martens, 2005). (See how helpful psychology can be?) Listen

Although stereotype threat is thus an important contributing factor for group differences in test performance, it is not the only one (Sackett, Hardison, & Cullen, 2004). Sometimes, for any number of reasons, groups do differ, on average, in some skill or ability. And that fact points to a

Listen to **Stereotype Threat** on **mypsychlab.com**

triarchic [try-ARE-kick] theory of intelligence A theory of intelligence that emphasizes information-processing strategies, the ability to creatively transfer skills to new situations, and the practical application of intelligence.

metacognition The knowledge or awareness of one's own cognitive processes.

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dilemma at the heart of intelligence and mental-ability testing. Intelligence and other mental-ability tests put some groups of people at a disadvantage, yet they also measure skills and knowledge useful in the classroom and on the job. How can psychologists and educators recognize and accept cultural differences and, at the same time, promote the mastery of the skills, knowledge, and attitudes that can help people succeed in school and in the larger society?

Quick Quiz

What's your Quiz Quotient (QQ)?

1. What was Binet's great insight?
2. *True or false:* IQ tests designed to avoid cultural bias have failed to eliminate average group differences in IQ scores.
3. Hilda, who is 68, is about to take an IQ test, but she is worried because she knows that older people are often assumed to have diminished mental abilities. Hilda is being affected by _____.

Answers:

1. Mental age does not necessarily correspond to chronological age. 2. true 3. stereotype threat

YOU are about to learn...

- **which kinds of intelligence are not measured by standard IQ tests.**
- **the meaning of "emotional intelligence" and why it might be as important as IQ.**
- **some reasons that Asian children perform much better in school than American students do.**

Explore Sternberg's Triarchic Theory of Intelligence on mypsychlab.com

Dissecting Intelligence: The Cognitive Approach

Critics of standard intelligence tests point out that such tests tell us little about *how* a person goes about answering questions and solving problems. Nor do the tests explain why people with low scores often behave intelligently in real life, making smart consumer decisions, winning at the racetrack, and making wise choices in their relationships instead of repeating the same dumb patterns. Some researchers, therefore, have rejected the psychometric approach in favor of a *cognitive approach*, which assumes that there are many kinds of intelligence and emphasizes the strategies people use when thinking about a problem and arriving at a solution.

Thinking Critically about What It Means to be Smart

The Triarchic Theory

One well-known cognitive theory is Robert Sternberg's **triarchic theory of intelligence** (1988) (*triarchic* means "three-part"). Sternberg (2004) defines intelligence as "the skills and knowledge needed for success in life, according to one's own definition of success, within one's sociocultural context." He distinguishes three aspects of intelligence: Explore

1 **Componential intelligence** refers to the information-processing strategies you draw on when you are thinking intelligently about a problem. These mental components include recognizing and defining the problem, selecting a strategy for solving it, mastering and carrying out the strategy, and evaluating the result.

Some of the operations in componential intelligence require not only analytic skills but also **metacognition**, the knowledge or awareness of your own cognitive processes and the ability to monitor and control those processes. Students who are weak in metacognition fail to notice when a passage in a textbook is difficult, and they do not always realize that they haven't understood what they've been reading. As a result, they spend too little time on difficult material and too much time on material they already know. They are overconfident about their comprehension and memory, and are surprised when they do poorly on exams (Dunlosky & Lipko, 2007). In contrast, students who are strong

in metacognition check their comprehension by restating what they have read, testing themselves, backtracking when necessary, and questioning what they are reading. When time is limited, they first tackle fairly easy material (where the payoff will be great), and then move on to more difficult material; as a result, they learn better (Metcalfe, 2009).

It works in the other direction, too: The kind of intelligence that enhances academic performance can also help you develop metacognitive skills. Students with poor academic skills typically fail to realize how little they know; they think they're doing fine (Dunning, 2005). The very weaknesses that keep them from doing well on tests or in their courses also keep them from realizing their weaknesses. In one study, students in a psychology course estimated how well they had just done on an exam relative to other students. As you can see in Figure 7.5, those who had performed in the bottom quartile greatly overestimated their own performance (Dunning et al., 2003). In contrast, people with strong academic skills tend to be more realistic. Often they even underestimate slightly how their performance compares with the performance of others.

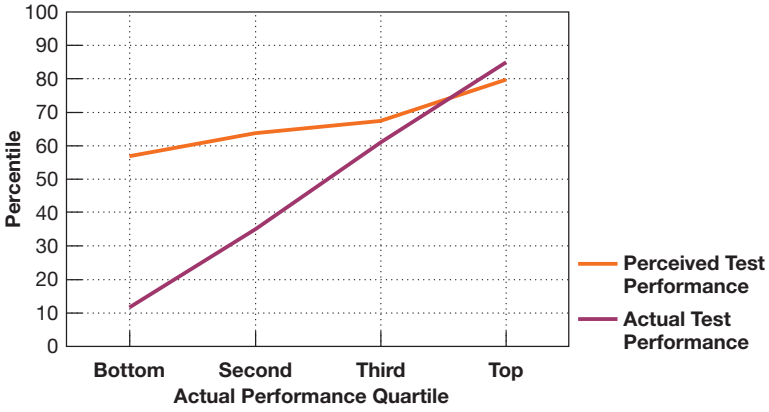

FIGURE 7.5
Ignorance Is Bliss
In school and in other settings, people who perform poorly often have poor metacognitive skills and therefore fail to recognize their own lack of competence. As you can see, the lower that students scored on an exam, the greater the gap between how they thought they had done and how they actually had done (Dunning et al., 2003).

2 **Experiential or creative intelligence** refers to your creativity in transferring skills to new situations. People with experiential intelligence cope well with novelty and learn quickly to make new tasks automatic. Those who are lacking in this area perform well only under a narrow set of circumstances. Students may do well in school, where assignments have specific due dates and feedback is immediate, but be less successful after graduation if the job requires them to set their own deadlines and no one tells them how they are doing.

3 **Contextual or practical intelligence** refers to the practical application of intelligence, which requires you to take into account the different contexts in which you find yourself. If you are strong in contextual intelligence, you know when to adapt to the environment (you are in a dangerous neighborhood, so you become more vigilant). You know when to change environments (you had planned to be a teacher but discover that you dislike working with kids, so you switch to accounting). And you know when to fix the situation (your marriage is rocky, so you and your spouse go for counseling).


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"You're wise, but you lack tree smarts."

Contextual knowledge allows you to acquire **tacit knowledge**—practical, action-oriented strategies for achieving your goals that usually are not formally taught or even verbalized but must instead be inferred by observing others. Among college students, tacit knowledge about how to be a good student actually predicts academic success as well as entrance exams do (Sternberg et al., 2000).

Emotional Intelligence

One of the most important kinds of nonintellectual "smarts" may be **emotional intelligence**, the ability to identify your own and other people's emotions accurately, express your emotions clearly, and manage emotions in yourself and others (Mayer & Salovey, 1997; Salovey & Grewal, 2005). People with high emotional intelligence, popularly known as "EQ," use their emotions to motivate themselves, to spur creative thinking, and to deal empathically with others. People who are lacking in emotional intelligence are often unable to identify their own emotions; they may insist that they are not depressed when a relationship ends, but meanwhile they start drinking too much, become extremely

tacit knowledge
Strategies for success that are not explicitly taught but that instead must be inferred.

emotional intelligence
The ability to identify your own and other people's emotions accurately, express your emotions clearly, and regulate emotions in yourself and others.

People with emotional intelligence are skilled at reading nonverbal emotional cues. Which of these children do you think feels the most confident and relaxed, which one is shyest, and which feels most anxious? What cues are you using to answer?

irritable, and stop going out with friends. They may express emotions inappropriately, perhaps by acting violently or impulsively when they are angry or worried. They often misread nonverbal signals from others; they will give a long-winded account of all their problems even when the listener is obviously bored.

Some psychologists believe that emotional intelligence is not a special cognitive ability but a collection of ordinary personality traits, such as empathy and extroversion (Matthews, Zeidner, & Roberts, 2003). Wherever it comes from, it may have a biological basis. Neuroscientist Antonio Damasio (1994) has studied patients with prefrontal-lobe damage that makes them incapable of experiencing strong feelings. Although they score in the normal range on conventional mental tests, these patients persistently make "dumb," irrational decisions in their lives because they cannot assign values to different options based on their own emotional reactions and cannot read emotional cues from others. As we discuss in Chapter 13, feeling and thinking are not as incompatible as many people assume; in fact, one often requires the other.

Broadening the notion of intelligence has been useful for several reasons. It has forced us to think more critically about what we mean by intelligence and to consider how different abilities help us function in our everyday lives. It has generated research on tests that provide ongoing feedback to the test taker so that the person can learn from the experience and improve performance. The cognitive approach has also led to a focus on teaching children strategies for improving their abilities in reading, writing, doing homework, and taking tests (Sternberg, 2004; Sternberg et al., 1995). Most important, new approaches to intelligence encourage us to overcome the mental set of assuming that the only kind of abilities necessary for a successful life are the kind captured by IQ tests.

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Quick Quiz

A good strategy for improving your own test performance is to take the quizzes in this book.

1. What goals do cognitive theories of intelligence have that psychometric theories do not?
2. Logan understands the material in his statistics class, but on tests he spends the entire period on the most difficult problems and never even gets to the problems he can solve easily. According to the triarchic theory of intelligence, which aspect of intelligence does he need to improve?
3. Tracy has an average IQ, but at work she is quickly promoted because she knows how to set priorities, communicate with management, and make others feel valued. Tracy has _____ knowledge about how to succeed on the job.
4. What is wrong with defining intelligence as "whatever intelligence tests measure"?

Answers:

1. to understand people's strategies for solving problems and use this information to improve mental performance 2. componential intelligence (specifically, metacognition) 3. tacit 4. This definition implies that a low score must be entirely the scorer's fault rather than the fault of the test. But the test taker may be intelligent in ways that the test fails to measure, and the test may be measuring traits other than intelligence.

YOU are about to learn...

- the extent to which intelligence may be heritable.
- a common error in the argument that one group is genetically smarter than another.
- how the environment nurtures or thwarts mental ability.

The Origins of Intelligence

"Intelligence," as we have seen, can mean many things. But however we define or measure it, clearly some people think and behave more intelligently than others. What accounts for these differences?

Genes and Individual Differences Behavioral geneticists approach this question by doing heritability studies, focusing mainly on the kind of intelligence measured by IQ tests. In Chapter 2, we saw that **heritability** is the proportion of the total variance in a trait within a group that is attributable to genetic variation within the group. This proportion can have a maximum value of 1.0, which means that the trait is completely heritable—although most traits, including height, are not perfectly heritable; genes interact constantly with the environment throughout our lives (Johnson et al., 2009). (You might review pages 51–53 to refresh your memory about heritability.)

Behavioral-genetic studies show that the kind of intelligence that produces high IQ scores is highly heritable. For children and adolescents, heritability estimates average around .40 or .50; that is, about half of the variance in IQ scores is explainable by genetic differences (Chipuer, Rovine, & Plomin, 1990; Devlin, Daniels, & Roeder, 1997; Plomin, 1989). For adults, most estimates are even higher—in the .60 to .80 range (Bouchard, 1995; McClearn et al., 1997; McGue et al., 1993). That is, the genetic contribution becomes relatively larger and the environmental one relatively smaller with age. This finding surprises many people who think of heritability as a fixed, permanent number. It is not, precisely because it depends on how varied the environment is for the group being studied.

Nonetheless, in studies of twins, the scores of identical twins are always much more highly correlated than those of fraternal twins. In fact, the scores of identical twins reared *apart* are more highly correlated than those of fraternal twins reared *together*, as you can see in Figure 7.6. In adoption studies, the scores of adopted children are more highly correlated with those of their birth parents than with those of their biologically unrelated adoptive parents; the higher the birth parents' scores, the higher the child's score is likely to be. As adopted children grow into adolescence, the correlation between their IQ scores and those of their biologically unrelated family members diminishes, and in adulthood, the correlation falls to *zero* (Bouchard, 1997b; Scarr, 1993; Scarr & Weinberg, 1994). Of course, adoption often has positive effects; as a group, adopted children score higher on IQ tests than do birth siblings who were not adopted, probably because adoptees grow up in a more enriched environment (van IJzendoorn et al., 2005).

How might genes affect intelligence? One possibility is by influencing the number of nerve cells in the brain or the number of connections among them, as reflected by the total volume of gray matter. Two brain-scan studies, conducted in Holland and Finland, have reported a moderately strong association between general intelligence and gray-matter volume. The amount of gray matter was strongly correlated in identical twins—over 80 percent, compared to only about 50 percent in fraternal twins—indicating that gray-matter volume is highly heritable (Posthuma et al., 2002; Thompson et al., 2001).

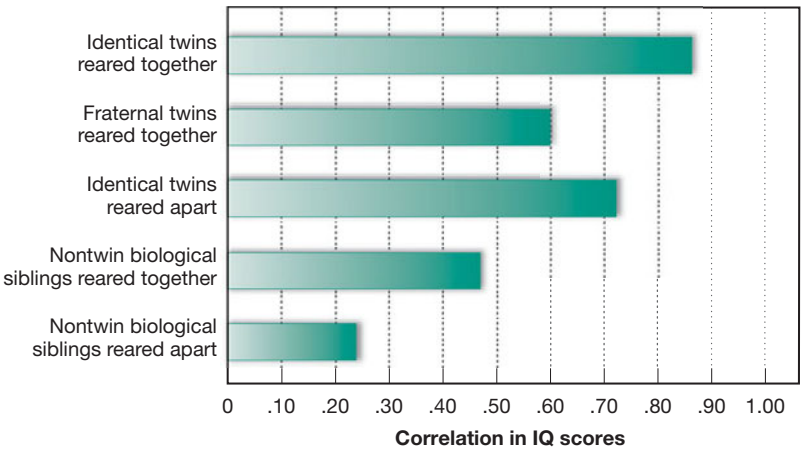


FIGURE 7.6
Correlations in Siblings' IQ Scores
The IQ scores of identical twins are highly correlated, even when they are reared apart. The figures represented in this graph are based on average correlations across many studies (Bouchard & McGue, 1981).

The Question of Group Differences If genes influence individual differences in intelligence, do they also help account for differences *between* groups, as many people assume? Because this question has enormous political and social importance, we are going to examine it closely.

Most of the focus has been on black–white differences in IQ, because African-American children score lower, on average, than do white children. (We are talking about *averages;* the distributions of scores for black children and white children overlap considerably.) A few psychologists have proposed a genetic explanation of this difference and conclude that there is little point in spending money on programs that try to raise the IQs of low-scoring children, of whatever race (Murray, 2008; Rushton & Jensen, 2005). Genetic explanations of group differences, however, have a fatal flaw, and we want to explain what it is. This flaw may seem pretty technical at first, but it is really not too difficult to understand, so stay with us.

Thinking Critically about Group Differences in IQ

Consider, first, not people but tomatoes. (Figure 7.7 will help you visualize the following "thought experiment.") Suppose you have a bag of tomato seeds that vary genetically; all things being equal, some will produce tomatoes that are puny

heritability A statistical estimate of the proportion of the total variance in some trait that is attributable to genetic differences among individuals within a group.

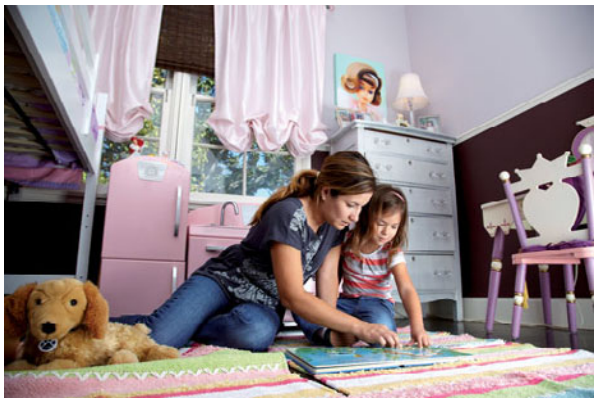
FIGURE 7.7
The Tomato Plant Experiment
In the hypothetical experiment described in the text, even if the differences among plants within each pot were due entirely to genetics, the average differences between pots could be environmental. The same general principle applies to individual and group differences among human beings.

and tasteless, and some will produce tomatoes that are plump and delicious. Now you take a bunch of these seeds in your left hand and another bunch from the same bag in your right hand. Although one seed differs genetically from another, there is no *average* difference between the seeds in your left hand and those in your right. You plant the left hand's seeds in pot A, with some enriched soil that you have doctored with nitrogen and other nutrients, and you plant the right hand's seeds in pot B, with soil from which you have extracted nutrients. You sing to pot A and put it in the sun; you ignore pot B and leave it in a dark corner.

When the tomato plants grow, they will vary *within* each pot in terms of height, the number of tomatoes produced, and the size of the tomatoes, purely because of genetic differences. But there will also be an average difference between the plants in pot A and those in pot B: The plants in pot A will be healthier and bear more tomatoes. This difference *between* pots is due entirely to the different soils and the care that has been given to them, even though the heritability of the *within*-pot differences is 100 percent (Lewontin, 1970, 2001).

The principle is the same for people as it is for tomatoes. Although intellectual differences *within* groups are at least partly genetic in origin, that does not mean differences *between* groups are genetic. Blacks and whites do not grow up, on the average, in the same "pots" (environments). Because of a long legacy of racial discrimination and de facto segregation, black children, as well as Latino and other minority children, often receive far fewer nutrients—literally, in terms of food, and figuratively, in terms of education, encouragement by society, and intellectual opportunities (Nisbett, 2009). And, as we have seen, negative stereotypes about ethnic groups may cause members of these groups to doubt their own abilities, become anxious and self-conscious, and perform more poorly on tests than they otherwise would.

Doing good research on the origins of group differences in IQ is extremely difficult in the United States, where racism has affected the lives of even many affluent, successful African Americans. However, the few studies that have overcome past methodological problems fail to support a genetic explanation. Children fathered by black and white American soldiers in Germany after World War II and reared in similar German communities by similar families did not differ significantly in IQ (Eyferth, 1961). Contrary to what a genetic theory would predict, degree of African ancestry (which can be roughly estimated from skin color, blood analysis, and genealogy) is not related to measured



The children of migrant workers (left) often spend long hours in backbreaking field work and may miss out on the educational opportunities and intellectual advantages available to middle-class children from the same culture (right).

intelligence (Scarr et al., 1977). And white and black infants do equally well on a test that measures their preference for novel stimuli, a predictor of later IQ scores (Fagan, 1992).

An intelligent reading of the research on intelligence, therefore, does not direct us to conclude that differences among cultural, ethnic, or national groups are permanent, genetically determined, or signs of any group's innate superiority (J. Aronson, 2010). On the contrary, the research suggests that we should make sure that all children grow up in the best possible soil, with room for the smartest and the slowest to find a place in the sun.

The Environment and Intelligence

By now you may be wondering what kinds of experiences hinder intellectual development and what kinds of environmental "nutrients" promote it. Here are some of the factors associated with reduced mental ability:

- *Poor prenatal care.* If a pregnant woman is malnourished, contracts infections, smokes, is exposed to secondhand smoke, or drinks alcohol regularly, her child is at risk of having learning disabilities and a lower IQ.
- *Malnutrition.* The average IQ gap between severely malnourished and well-nourished children can be as high as 20 points (Stoch & Smythe, 1963; Winick, Meyer, & Harris, 1975).
- *Exposure to toxins.* Lead, especially, can damage the brain and nervous system, even at fairly low levels, producing attention problems, lower IQ scores, and poorer school achievement (Hornung, Lanphear, & Dietrich, 2009; Needleman et al., 1996). Many children in the United States are exposed to dangerous levels of lead from dust, contaminated soil, lead paint, and old lead pipes, and the concentration of lead in black children's blood is 50 percent higher than in white children's (Lanphear et al., 2002).
- *Stressful family experiences.* Factors that predict reduced intellectual competence include, among others, having a father who does not live with the family, a mother with a history of mental illness, parents with limited work skills, and a history of stressful events, such as domestic violence, early in life (Sameroff et al., 1987). On average, each risk factor reduces a child's IQ score by 4 points. And when children live in severely disadvantaged neighborhoods, their IQs decline over time, even after they have moved to better areas; the drop is comparable to that seen when a child misses a year of school (Sampson, 2008).

Extreme poverty, exposure to toxic materials, a neglected neighborhood, and stressful family circumstances can all have a negative impact on children's cognitive development and IQ.

In contrast, a healthy and stimulating environment can raise IQ scores, as several intervention studies with at-risk children have shown. In one longitudinal study called the Abecedarian Project, inner-city children who got lots of mental enrichment at home and in child care or school, starting in infancy, showed signficant IQ gains and had much better school achievement than did children in a control group (Campbell & Ramey, 1995). In another important study, of abandoned children living in Romanian orphanages, researchers randomly assigned some children to remain in the orphanages and others to move to good foster homes. By age 4, the fostered children scored dramatically higher on IQ tests that did those left behind. Children who moved before age 2 showed the largest gains, almost 15 points on average. A comparison group of children reared in their biological homes did even better, with average test scores 10 to 20 points higher than those of the foster children (Nelson et al., 2007). (Since this study was done, Romania has stopped institutionalizing abandoned children younger than 2 years unless the infants are seriously disabled.)

Perhaps the best evidence for the importance of environmental influences on intelligence is the fact that around the world, IQ scores have been climbing steadily for at least three generations (Flynn, 1987, 1999). (See Figure 7.8.) The fastest increase in a group's average IQ scores ever reported has occurred in Kenya, where IQ scores of rural 6- to 8-year-old children jumped about 11 points

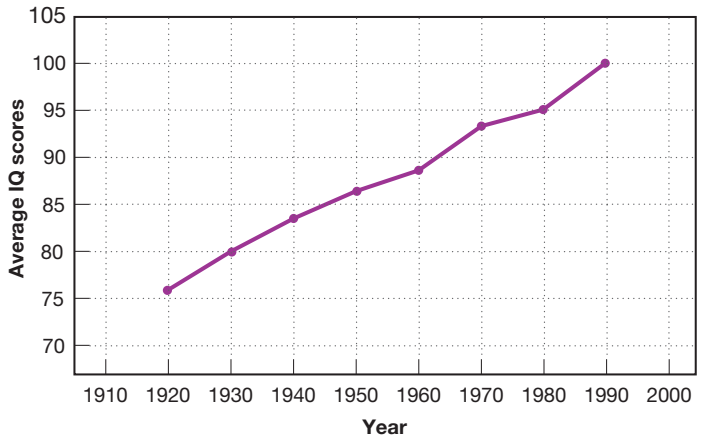


FIGURE 7.8
Climbing IQ Scores
Raw scores on IQ tests have been rising in developed countries for many decades at a rate much too steep to be accounted for by genetic changes. Because test norms are periodically readjusted to set the average score at 100, most people are unaware of the increase. On this graph, average scores are calibrated according to 1989 norms. As you can see, performance was much lower in 1918 than in 1989 (adapted from Horgan, 1995).

between 1984 and 1998 (Daley et al., 2003). Genes cannot possibly have changed enough to account for these findings, and most scientists attribute the increases to improvements in education, the growth in jobs requiring abstract thought, and better health.

We see, then, that although heredity may provide the range of a child's intellectual potential—a Homer Simpson can never become an Einstein—many other factors affect where in that range the child will fall.

Motivation, Hard Work, and Intellectual Success

Even with a high IQ, emotional intelligence, and practical know-how, you still might get nowhere at all. Talent, unlike cream, does not inevitably rise to the top; success also depends on drive and determination.

Consider a finding from one of the longest-running psychological studies ever conducted. In 1921, researchers began following more than 1,500 children with IQ scores in the top one percent of the distribution. These boys and girls were nicknamed Termites after Lewis Terman, who originally directed the research. The Termites started out bright, physically healthy, sociable, and well adjusted. As they entered adulthood, most became successful in the traditional ways of the times: men in careers and women as homemakers (Sears & Barbee, 1977; Terman & Oden, 1959). However, some gifted men failed to live up to their early promise, dropping out of school or drifting into low-level work. When the researchers compared the 100 most successful men in the Terman study with the 100 least successful, they found that the successful men were ambitious, were socially active, had many interests, and had been encouraged by their parents. The least successful drifted casually through life. There was no average difference in IQ between the two groups.

Once you are motivated to succeed intellectually, you need self-discipline to reach your goals. In a longitudinal study of ethnically diverse eighth graders attending a magnet school, researchers assigned each student a self-discipline score based on the students' self-reports, parents' reports, teachers' reports, and questionnaires. They also had a behavioral measure of "delay of gratification," the students' ability to postpone getting an immediate reward now in favor of getting a bigger reward later (Duckworth & Seligman, 2005). Self-discipline accounted for more than twice as much of the variance in the students' final grades and achievement test scores as IQ did. As you can see in Figure 7.9, correlations between self-discipline and good grades were much stronger than those between IQ and grades.

Self-discipline and the motivation to work hard depend, in turn, on your attitudes about intelligence and achievement, which are strongly influenced by cultural values. For many years, Harold Stevenson and his colleagues studied attitudes toward achievement in Asia and the United States,

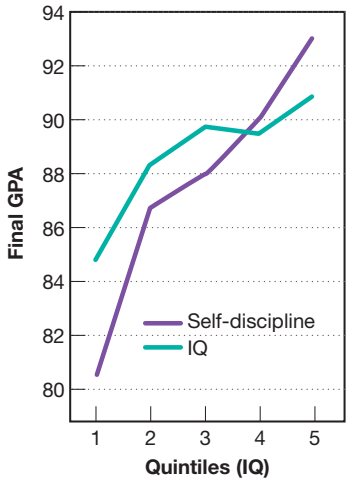


FIGURE 7.9
Grades, IQ, and Self-Discipline
When researchers divided eighth grade students into five groups (quintiles) based on their IQ scores and then followed them for a year to test their academic achievement, they found that self-discipline was a stronger predictor of success than IQ was (Duckworth & Seligman, 2005).

comparing large samples of grade school children, parents, and teachers in Minneapolis, Chicago, Sendai (Japan), Taipei (Taiwan), and Beijing (Stevenson, Chen, & Lee, 1993; Stevenson & Stigler, 1992). Their results have much to teach us about the cultivation of intellect.

In 1980, the Asian children far outperformed the American children on a broad battery of mathematical and reading tests. On computations, reading, and word problems, there was virtually no overlap between schools, with the lowest-scoring Beijing schools doing better than the highest-scoring Chicago schools. By 1990, the gulf between the Asian and American children had grown even greater. Only 4 percent of the Chinese children and 10 percent of the Japanese children had math scores as low as those of the *average* American child. These differences could not be accounted for by educational resources: The Chinese had worse facilities and larger classes than the Americans, and on average, the Chinese parents were poorer and less educated than the American parents. Nor did it have anything to do with intellectual abilities in general; the American children were just as knowledgeable and capable as the Asian children on tests of general information.

But the Asian and American children were worlds apart in their attitudes and efforts:

- *Beliefs about intelligence.* American parents, teachers, and children were far more likely than Asians to believe that mathematical ability is innate (see Figure 7.10). Americans tended to think that if you have this ability you don't have to work hard, and if you don't have it, there's no point in trying.

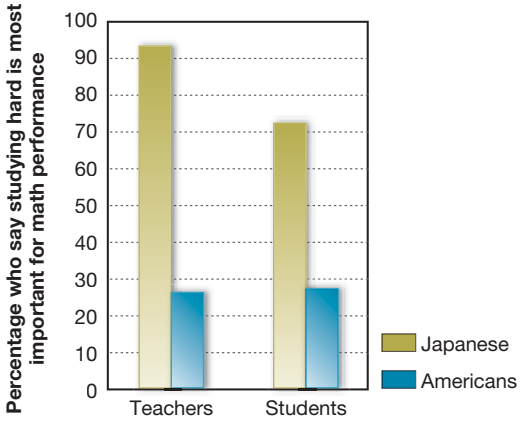


FIGURE 7.10
What's the Secret of Math Success?
Japanese schoolteachers and students are much more likely than their American counterparts to believe that the secret to doing well in math is working hard. Americans tend to think that you either have mathematical intelligence or you don't.

- *Standards.* American parents had far lower standards for their children's performance; they were satisfied with scores barely above average on a 100-point test. In contrast, Chinese and Japanese parents were happy only with very high scores.
- *Values.* American students did not value education as much as Asian students did, and they were more complacent about mediocre work. When asked what they would wish for if a wizard could give them anything they wanted, more than 60 percent of the Chinese fifth graders named something related to their education. Can you guess what the American children wanted? A majority said money or possessions.

When it comes to intellect, then, it's not just what you've got that counts, but what you do with it. Complacency, fatalism, low standards, and a desire for immediate gratification can prevent people from recognizing what they don't know and stifle their efforts to learn.

Quick Quiz

We hope you are not feeling complacent about your quiz performance.

1. On average, behavioral-genetic studies estimate the heritability of intelligence to be (a) about .90, (b) about .20, (c) low at all ages, (d) higher for adults than for children.
2. *True or false:* If a trait such as intelligence is highly heritable within a group, then differences between groups must also be due mainly to heredity.
3. The available evidence (does/does not) show that ethnic differences in average IQ scores are due to genetic differences.
4. Name four environmental factors associated with reduced mental ability.
5. According to a study of eighth graders, _____ is more strongly correlated with school performance than _____ is.

Answers:

1. d 2. false 3. does not 4. poor prenatal care, malnutrition, exposure to toxins, and stressful family circumstances 5. self-discipline; IQ

Study and Review on mypsychlab.com

cognitive ethology The study of cognitive processes in nonhuman animals.

YOU are about to learn...

- **whether animals can think.**
- **whether some animal species can master aspects of human language.**

Animal Minds

How smart is this otter?

A green heron swipes some bread from a picnicker's table and scatters the crumbs on a nearby stream. When a minnow rises to the bait, the heron strikes, swallowing its prey before you can say "dinner's ready." A sea otter, floating calmly on its back, bangs a mussel shell against a stone that is resting on its stomach. When the shell cracks apart, the otter devours the tasty morsel inside, tucks the stone under its flipper, and dives for another shell, which it *will* open in the same way. Incidents such as these and scores of others have convinced some biologists, psychologists, and ethologists that we are not the only animals with cognitive abilities—that "dumb beasts" are not so dumb after all. But how smart are they?

Animal Intelligence

In an early study of animal intelligence, Sultan, a talented chimpanzee studied by Wolfgang Köhler, was able to figure out how to reach a cluster of bananas by stacking some boxes and climbing on top of them.

In the 1920s, Wolfgang Köhler (1925) put chimpanzees in situations in which some tempting bananas were just out of reach and watched to see what the apes would do. Most did nothing, but a few turned out to be quite clever. If the bananas were outside the cage, the chimp might pull them in with a stick. If they were hanging overhead, and there were boxes in the cage, the chimp might pile up the boxes and climb on top of them to reach the fruit. Often the solution came after the chimp had been sitting quietly for a while. It appeared as though the animal had been thinking about the problem and was struck by a sudden insight.

Learning theorists felt that this seemingly impressive behavior could be accounted for perfectly well by the standard principles of operant learning, without resorting to mental explanations (see Chapter 9). Because of their influence, for years any scientist who claimed that animals could think was likely to be ignored or laughed at. Today, however, the study of animal intelligence is booming, especially in the interdisciplinary field of **cognitive ethology**. (Ethology is the study of animal behavior, especially in natural environments.) Cognitive ethologists argue that some animals can anticipate future events, make plans, and coordinate their activities with those of their comrades (Griffin, 2001).

When we think about animal cognition, we must be careful, because even complex behavior that appears to be purposeful can be genetically prewired and automatic (Wynne, 2004). The assassin bug of South America catches termites by gluing nest material on its back as camouflage, but it is hard to imagine how the bug's tiny dab of brain tissue could enable it to plan this strategy consciously. Yet explanations of animal behavior that leave out any sort of consciousness at all and that attribute animals' actions entirely to instinct do not seem to account for some of the amazing things that animals can do.

Like the otter that uses a stone to crack mussel shells, many primates use objects in the natural environment as rudimentary tools, but the truly amazing thing is that their use of tools is learned rather than innate. Chimpanzee mothers occasionally show their young how to use stones to open hard nuts (Boesch, 1991). Orangutans in one Sumatran swamp have learned to use sticks as tools, held in their mouths, to pry insects from holes in tree trunks and to get seeds out of cracks in a bulblike fruit, whereas nearby groups of orangutans use only brute force to get to the delicacies (van Schaik, 2006). Even some nonprimates may have the capacity to learn to use tools, although the evidence remains controversial among ethologists. Female bottlenose dolphins off the coast of Australia attach sea sponges to their beaks while hunting for food, which protects them from sharp coral and stinging stonefish, and they seem to have acquired this unusual skill from their mothers (Krützen et al., 2005). Is this yet another case of mothers telling their daughters what to wear?

In the laboratory, nonhuman primates have accomplished even more surprising things. For example, dozens of studies have found that chimpanzees have a rudimentary sense of number. In one study, chimpanzees compared two pairs of food wells containing chocolate chips. One pair might contain, say, five chips and three chips, the other four chips and three chips. Allowed to choose which pair they wanted, the chimps almost always chose the one with the higher combined total, showing some sort of summing ability (Rumbaugh, Savage-Rumbaugh, & Pate, 1988). Chimpanzees can even remember over a period of 20 minutes which of two containers holds more bananas (e.g., five versus eight, or six versus ten), after watching the bananas being placed one at a time into the containers. In fact, they do as well as young children on this task (Beran & Beran, 2004).

One of the most controversial questions about animal cognition is whether any animals besides human beings have a **theory of mind**: a system of beliefs about the way one's own mind and the minds of others work, and an understanding of how thoughts and feelings affect behavior. A theory of mind enables you to draw conclusions about the intentions, feelings, and beliefs of others; empathize with others ("What would I experience if I were in the other person's position?"); deceive others; recognize when someone else is lying; recognize yourself in a mirror; and know when others can or cannot see you. In human beings, a theory of mind starts to develop in the second year and is clearly present by about age 3 or 4 (see Chapter 3). Some researchers believe that the great apes (chimpanzees, gorillas, and orangutans), dolphins, and elephants have some abilities that reflect a theory of mind (de Waal, 2001a; Plotnik, de Waal, & Reiss, 2006; Suddendorf & Whiten, 2001). When looking in a mirror, these animals may try to find marks on their bodies that are not directly visible, suggesting self-recognition, or at least bodily awareness.

Dodger, a 2-year-old dolphin in Shark Bay, Australia, carries a sea sponge on her sensitive beak as protection against stinging creatures and sharp coral. Dolphin "sponge moms" apparently teach the behavior to their daughters.

In addition, chimpanzees console other chimps who are in distress, use deceptive tactics when competing for food, and point to draw attention to objects, suggesting that they are able to grasp what is going on in another chimp's mind. In the wild, when one male African chimp makes an exaggerated scratching movement on part of its body during social grooming—say, on the forehead—a comrade will then groom the indicated spot, even if he was already grooming some other spot (Pika & Mitani, 2006). Chimps and even monkeys may also be capable of some metacognition. When they are tested on a new task, they will sometimes avoid difficult trials in which they are likely to be wrong. And they will press an icon on a touch screen to request a hint from their human observers when they are unsure of the correct response, even when seeking a hint means getting a lesser reward for a correct answer (Kornell, 2009). These findings suggest that the animals know what they know and don't know!

theory of mind A system of beliefs about the way one's own mind and the minds of others work, and of how individuals are affected by their beliefs and feelings.

"It's always 'Sit,' 'Stay,' 'Heel'–never 'Think,' 'Innovate,' 'Be yourself.'"

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Animals and Language

A primary ingredient of human cognition is *language*, the ability to combine elements that are themselves meaningless into an infinite number of utterances that convey meaning, and to express and comprehend an infinite number of novel utterances. Language is often regarded as the last bastion of human uniqueness, a result of evolutionary forces that produced our species (see Chapter 3). Do animals have anything comparable?

Animals do communicate, of course, using gestures, body postures, facial expressions, vocalizations, and odors. Some of these signals have highly specific meanings. Vervet monkeys have separate calls to warn each other about leopards versus eagles versus snakes (Cheney & Seyfarth, 1985). But vervets cannot combine these sounds to produce entirely novel utterances, as in "Look out, Harry, that eagle-eyed leopard is a real snake-in-the-grass."

Perhaps, however, some animals could acquire language if they got a little help from their human friends. Because the vocal tract of an ape does not permit speech, most researchers have used innovative approaches that rely on gestures or visual symbols. In one project, chimpanzees learned to use, as words, geometric plastic shapes arranged on a magnetic board (Premack & Premack, 1983). In another, they learned to punch symbols on a keyboard connected to a computer (Rumbaugh, 1977). In yet another, they learned hundreds of signs in American Sign Language (ASL) (Fouts & Rigby, 1977; Gardner & Gardner, 1969).

Kanzi, a bonobo who answers questions and makes requests by punching symbols on a specially designed computer keyboard, also understands short English sentences. Kanzi is shown here with researcher Sue Savage-Rumbaugh.

Animals in these studies learned to follow instructions, answer questions, and make requests. They even seemed to use their newfound skills to apologize for being disobedient, scold their trainers, and talk to themselves. Koko, a lowland gorilla, reportedly used signs to say that she felt happy or sad, to refer to past and future events, to mourn for her dead pet kitten, and to lie when she did something naughty (Patterson & Linden, 1981). Most important, the animals combined individual signs or symbols into longer utterances that they had never seen before.

Unfortunately, in their desire to talk to the animals and their affection for their primate friends, some early researchers overinterpreted the animals' communications, reading all sorts of meanings and intentions into a single sign or symbol, ignoring scrambled word order ("banana eat me"), and unwittingly giving nonverbal cues that might enable the apes to respond correctly.

But over the past few decades, as researchers have improved their techniques, they have discovered that with careful training, chimps can indeed acquire some aspects of language, including the ability to use symbols to refer to objects. Some have also used signs spontaneously to converse with one another, suggesting that they are not merely imitating or trying to get a reward (Van Cantfort & Rimpau, 1982). Bonobos (a type of ape) are especially adept at language. One bonobo named Kanzi has learned to understand English words, short sentences, and keyboard symbols without formal training (Savage-Rumbaugh & Lewin, 1994; Savage-Rumbaugh, Shanker, & Taylor, 1998). Kanzi responds correctly to commands such as "Put the key in the refrigerator" and "Go get the ball that is outdoors," even when he has never heard the words combined in that particular way before. He picked up language as children do, by observing others using it and through normal social interaction. He has also learned to manipulate keyboard symbols to request favorite foods or activities (games, TV, visits to friends) and to announce his intentions.

Research on animal language and comprehension of symbols is altering our understanding of animal cognition, and not only of primates. Dolphins have learned to respond to requests made in two artificial languages, one consisting of computer-generated whistles and another of hand and arm gestures (Herman, Kuczaj, & Holder, 1993; Herman & Morrel-Samuels, 1996). To interpret a request correctly, the dolphins had to take into account both the meaning of the individual symbols in a string of whistles or gestures and the order of the symbols (syntax). They had

to understand the difference between "To left Frisbee, right surfboard take" and "To right surfboard, left Frisbee take."

And some psychologists are calling border collies "the new chimps," ever since researchers in Germany reported that a border collie named Rico had a vocabulary of more than 200 words (Kaminski, Call, & Fisher, 2004). When Rico's owner asked him to retrieve an object from another room, Rico could pick the correct object 37 times out of 40. Even more impressive, Rico, like a human child, could learn a new word in just one trial, something chimpanzees cannot do. If given the name of a new object, he could usually infer that his owner wanted him to select that object from among more familiar ones and would often remember the new label weeks later. Similar results have since been reported for another border collie named Betsy (Morell, 2008).

Most amazingly, we now know that birds are not as birdbrained as once assumed. Irene Pepperberg (2000, 2002, 2008) has been working with African gray parrots since the late 1970s. Her favorite, named Alex, could count, classify, and compare objects by vocalizing English words. When he was shown up to six items and was asked how many there were, he responded with spoken (squawked?) English phrases, such as "two cork(s)" or "four key(s)." He even responded correctly to questions about items specified on two or three dimensions, as in "How many blue key(s)?" or "What matter [material] is orange and three-cornered?" Alex also made requests ("Want pasta") and answered simple questions about objects ("What color [is this]?" "Which is bigger?"). When presented with a blue cork and a blue key and asked "What's the same?" he would correctly respond "color." He actually scored slightly better with new objects than with familiar ones, suggesting that he was not merely "parroting" a set of stock phrases. He could sum two small sets of objects, such as nuts or jelly beans, for amounts up to six (Pepperberg, 2006).

Alex was a remarkably clever bird. His abilities have raised intriguing questions about the intelligence of animals and their capacity for specific aspects of language.

Alex was also able to say remarkably appropriate things in informal interactions. He would tell Pepperberg, "I love you," "I'm sorry," and, when she was feeling stressed out, "Calm down." One day, sitting on his perch as Pepperberg's accountant was working at a desk, Alex asked her: "Wanna nut?" "No," said the accountant. "Want some water?" "No," she said. "A banana?" "No." After making several other suggestions, Alex finally said, "What *do* you want?" (quoted in Talbot, 2008). To the sorrow of thousands of his admirers all over the world, Alex died in 2007. Pepperberg is continuing her work with other African grays. Watch

Watch the Video **Birds and Language** on **mypsychlab.com**

Thinking about the Thinking of Animals

These results on animal language and cognition are impressive, but scientists are still divided over just what the animals in these studies are doing. Do they have true language? Are they thinking, in human terms? How intelligent are they? Are Kanzi, Rico, and Alex unusual, or are they typical of their species? In their efforts to correct the centuries-old underestimation of animal cognition, are modern researchers now reading too much into their data and overestimating animals' abilities?

Thinking Critically about Animal Cognition

On one side are those who worry about *anthropomorphism*, the tendency to falsely attribute human qualities to nonhuman beings (Wynne, 2004). They like to tell the story of Clever Hans, a "wonder horse" at the turn of the century who was said to possess mathematical and other abilities (Spitz, 1997). Clever Hans would answer math problems by stamping his hoof the appropriate number of times. But a little careful experimentation by psychologist Oskar Pfungst (1911/1965) revealed that when Clever Hans was prevented from seeing his questioners, his powers left him. It seems that questioners were staring at the horse's feet and

This old photo shows Clever Hans in action. His story has taught researchers to beware of anthropomorphism when they interpret findings on animal cognition.

leaning forward expectantly after stating the problem, then lifting their eyes and relaxing as soon as he completed the right number of taps. Clever Hans was indeed clever, but not at math or other human skills. He was merely responding to nonverbal signals that people were inadvertently providing. (Perhaps he had a high EQ.)

On the other side are those who warn against *anthropodenial*—the tendency to think, mistakenly, that human beings have nothing in common with other animals, who are, after all, our evolutionary cousins (de Waal, 2001a; Fouts, 1997). The need to see our own species as unique, they say, may keep us from recognizing that other species, too, have cognitive abilities, even if not as sophisticated as our own. Those who take this position point out that most modern researchers have gone to great lengths to avoid the Clever Hans problem.

The outcome of this debate is bound to affect the way we view ourselves and our place among other species. Perhaps, as cognitive ethologist Marc Hauser (2000) has suggested, we can find a way to study animal minds and emotions without assuming sentimentally that they are just like our own. There is no disputing, however, that scientific discoveries are teaching us to have greater respect for the cognitive abilities of our animal relatives.

Study and **Review** on **mypsychlab.com**

Quick Quiz

Your pet beagle may be incredibly smart, but she probably can't help you answer these questions.

1. Which of the following abilities have primates demonstrated, either in the natural environment or the laboratory? (a) the use of objects as simple tools; (b) the summing of quantities; (c) the use of symbols to make requests; (d) an understanding of short English sentences
2. Barnaby thinks his pet snake Curly is harboring angry thoughts about him because Curly has been standoffish and won't curl around his neck anymore. What error is Barnaby making?

Answers:

1. all of them 2. anthropomorphism

Psychology in the News REVISITED

Has reading this chapter given you an appreciation of what it takes, mentally speaking, to concoct the experiments that won the Ig Nobel prizes? Or, for that matter, to have the sense of humor to honor them? Some of the awards reflect great intelligence and creativity. Consider Catherine Douglas and Peter Rowlinson's research, which found that cows with names produce more milk than cows without names. That may seem to be a charming but trivial discovery, yet it shows that the quality of the human-animal relationship can affect not just an animal's behavior but even the animal's basic biology. Consider, too, the prize awarded to Donald Unger, who, as a boy, wondered whether his mother's stern warning to stop cracking his knuckles—"You'll get arthritis!"—would

turn out to be true or false, and began a lifelong experiment using his own hands. Although his negative finding would need to be verified with more people and controlled procedures, it vividly demonstrates the first, most fundamental step in critical thinking: Ask questions and be willing to wonder.

So it is for good reason that we are used to thinking of ourselves as the smartest species around. Our cognitive abilities allow us to be funny, playful, smart, and creative. A great artist like Rodin can create "The Thinker," and then countless creative imitators will make their own versions of the Thinker in sand, metal, cartoons, ice, or, who knows, ice cream. Human beings can not only think critically, but also think critically about thinking critically—and understand the reasons that we often don't or can't.

Yet, as the studies in this chapter have shown, we also get ourselves into colossal muddles; we think we are better at many skills than we actually are; we have many cognitive biases that distort reality; and we often behave mindlessly. The Irish police who won an Ig Nobel Prize are, after all, an example of how mental sets can trap us. Their mental set—"the two main words on a driver's license are the driver's name"—caused them to overlook the possibility that "Prawo Jazdy" might not be the driver's name at all. And so they mindlessly kept issuing tickets to all those speeding Polish drivers, who no doubt were delighted with the officers' mistake.

As if our mental flaws in thinking and reasoning weren't bad enough, many people worry that machines are gaining on us in the mental abilities department—a frequent theme in science fiction. Enormous strides have been made in the field of *artificial intelligence* (AI), the use of computers to simulate human thinking. Avatars already are being designed to diagnose patients long distance, provide psychotherapy, handle grumpy but rambling customers, and be "virtual personal assistants." As speech recognition and other technologies of AI improve, ethicists are concerned about the potential for their manipulation and misuse. On a social level, will corporations shield themselves behind robot voices designed to chill out angry consumers? On a personal level, will computers and robots eventually be able to make crucial decisions for us on how to improve public education, choose a life partner, or manage a baseball team?

Computers are impressive, but keep in mind—your own complicated, remarkable, fallible mind!—that real intelligence is more than the capacity to perform computations with lightning speed. As we have seen, it involves the ability to deal with informal reasoning problems, reason dialectically and reflectively, devise mental shortcuts, read emotions, and acquire tacit knowledge. Robots and computers, of course, are not the least bit troubled by their lack of cleverness, inasmuch as they lack a mind to be troubled. As computer scientist David Gelernter (1997) put it, "How can an object that wants nothing, fears nothing, enjoys nothing, needs nothing, and cares about nothing have a mind?"

Because machines are mindless, they lack the one trait that distinguishes human beings not only from computers but also from other species: We try to understand our own misunderstandings (Gazzaniga, 2008). We want to know what we don't know; we are motivated to overcome our mental shortcomings. This uniquely human capacity for self-examination is probably the best reason to remain optimistic about our cognitive abilities.

Courtesy of Andrew Toos/CartoonStock.com

Human beings worry that machines will outsmart us, but it's not likely.

Taking Psychology with You

Becoming More Creative

Throughout this book, we have been emphasizing the importance of asking questions, thinking of explanations other than just the most obvious ones, and examining assumptions and biases. All of these critical thinking guidelines involve creativity as much as they do reasoning.

Take a few moments to answer these items based on the Remote Associates Test, a test of the mental flexibility necessary for creativity. Your task is to come up with a fourth word that is associated with each item in a set of three words (Mednick, 1962). For example, an answer for the set *news–clip–wall* is *paper*. Got the idea? Now try these. (The answers are given at the end of this chapter.)

1. piggy—green—lash
2. surprise—political—favor
3. mark—shelf—telephone
4. stick—maker—tennis
5. cream—cottage—cloth

Creative thinking requires you to associate elements of a problem in new ways by finding unexpected connections among them. People who are uncreative rely on *convergent thinking*, following a particular set of steps that they think will converge on one correct solution. Then, once they have solved a problem, they tend to develop a mental set and approach future problems the same way. Creative people, in contrast, exercise *divergent thinking*; instead of stubbornly sticking to one tried-and-true path, they explore side alleys and generate several possible solutions. They come up with new hypotheses, imagine other interpretations, and look for connections that are not immediately obvious. For artists and novelists, of course, creativity is a job requirement, but it also takes creativity to invent a tool, put together a recipe from leftovers, find ways to distribute unsold food to the needy, decorate your room …

Creative people do not necessarily have high IQs. Personality characteristics seem more important, especially these three (Helson, Roberts, & Agronick, 1995; McCrae, 1987; Schank, 1988):

Nonconformity. Creative individuals are not overly concerned about what others think of them. They are willing to risk ridicule by proposing ideas that may initially appear foolish or off the mark. Geneticist Barbara McClintock's research was ignored or belittled by many for nearly 30 years. But she was sure she could show how genes move around and produce sudden changes in heredity. In 1983, when McClintock won the Nobel Prize, the judges called her work the second greatest genetic discovery of our time, after the discovery of the structure of DNA.

Curiosity. Creative people are open to new experiences; they notice when reality contradicts expectations, and they are curious about the reason. Wilhelm Roentgen, a German physicist, was studying cathode rays when he noticed a strange glow on one of his screens. Other people had seen the glow, but they ignored it because it didn't jibe with their understanding of cathode rays. Roentgen studied the glow, found it to be a new kind of radiation, and thus discovered X-rays.

Persistence. After that imaginary lightbulb goes on over your head, you still have to work hard to make the illumination last. Or, as Thomas Edison, who invented the real lightbulb, reportedly put it, "Genius is one percent inspiration and ninety-nine percent perspiration." No invention or work of art springs forth full-blown from a person's head. There are many false starts and painful revisions along the way.

If you are thinking critically (and creatively), you may wonder whether these personal qualities are enough. Do you recall the "Termites" who were the most successful? They were smart, but they also got plenty of encouragement for their efforts. Likewise, some individuals may be more creative than others, but there are also *circumstances* that foster creative accomplishment. Creativity flourishes when schools and employers encourage intrinsic motivation and not just extrinsic rewards such as gold stars and money (see Chapters 9 and 14). Intrinsic motives include a sense of accomplishment, intellectual fulfillment, the satisfaction of curiosity, and the sheer love of the activity. Creativity also increases when people have control over how to perform a task or solve a problem, are evaluated unobtrusively instead of being constantly observed and judged, and work independently (Amabile, 1983; Amabile & Khair, 2008). Organizations encourage creativity when they let people take risks, give them plenty of time to think about problems, and welcome innovation.

In sum, if you hope to become more creative, there are two things you can do. One is to cultivate qualities in yourself: your skills, curiosity, intrinsic motivation, and self-discipline. The other is to seek out the kinds of situations that will permit you to express your abilities and experiment with new ideas.

Summary

Listen to an audio file of your chapter on mypsychlab.com

Thought: Using What We Know

- Thinking is the mental manipulation of information. Our mental representations simplify and summarize information from the environment.
- A *concept* is a mental category that groups objects, relations, activities, abstractions, or qualities that share certain properties. *Basic concepts* have a moderate number of instances and are easier to acquire than concepts with few or many instances. *Prototypical* instances of a concept are more representative than others. The language we use to express concepts may influence how we perceive and think about the world.
- *Propositions* are made up of concepts and express a unitary idea. They may be linked together to form *cognitive schemas*, which serve as mental models of aspects of the world. *Mental images* also play a role in thinking.
- Not all mental processing is conscious. *Subconscious processes* lie outside of awareness but can be brought into consciousness when necessary. They allow us to perform two or more actions at once when one action is highly automatic. But multitasking is usually inefficient, introduces errors, and can even be dangerous, leading to accidents if done while driving. *Nonconscious processes* remain outside of awareness but nonetheless affect behavior; they are involved in insight and *implicit learning*. Conscious processing may be carried out in a *mindless* fashion if we overlook changes in context that call for a change in behavior.

Reasoning Rationally

- *Reasoning* is purposeful mental activity that involves drawing inferences and conclusions from observations, facts, or assumptions (premises). *Formal reasoning problems* can often be solved by applying an *algorithm* or by using logical processes, such as *deductive* and *inductive reasoning*. *Informal reasoning problems* often have no clearly correct solution. Disagreement may exist about basic premises, information may be incomplete, and many viewpoints may compete. Such problems often call for the application of *heuristics*, or may require *dialectical thinking* about opposing points of view.
- Studies of *reflective judgment* show that many people have trouble thinking dialectically. People in the *prereflective* stages do not distinguish between knowledge and belief or between belief and evidence. Those in the *quasi-reflective* stages think that because knowledge is sometimes uncertain, any judgment about the evidence is purely subjective. Those who think *reflectively* understand that although some things cannot be known with certainty, some judgments are more valid than others, depending on their coherence, fit with the evidence, and so on. Higher education moves people gradually closer to reflective judgment.

Barriers to Reasoning Rationally

- The ability to reason clearly and rationally is affected by many cognitive biases. People tend to exaggerate the likelihood of improbable events in part because of the *affect and availability heuristics*. They are swayed in their choices by the desire to *avoid loss* and by the *framing effect*, how the choice is presented. They forgo economic gain because of a *fairness bias*. They often overestimate their ability to have made accurate predictions (the *hindsight bias*), attend mostly to evidence that confirms what they want to believe (the *confirmation bias*), and are often mentally rigid, forming *mental sets* and seeing patterns where none exists.
- The theory of *cognitive dissonance* holds that people are motivated to reduce the tension that exists when two cognitions, or a cognition and a behavior, conflict. They can reduce dissonance by rejecting or changing a belief, changing their behavior, or rationalizing. Dissonance is most uncomfortable, and people are most likely to try to reduce it after a decision has been made (*postdecision dissonance*), when their actions violate their concept of themselves as honest and kind, and when they have put hard work into an activity (the *justification of effort*).

Measuring Intelligence: The Psychometric Approach

- *Intelligence* is hard to define. The *psychometric approach* focuses on how well people perform on standardized aptitude tests. Most psychometric psychologists believe that a general ability, a *g factor*, underlies this performance. Others, however, argue that a person can do well in some kinds of reasoning or problem solving but not others.
- The *intelligence quotient*, or *IQ*, represents how well a person has done on an intelligence test compared to other people. Alfred Binet designed the first widely used intelligence test to identify children who could benefit from remedial work. But in the United States, people assumed that intelligence tests revealed natural ability and used the tests to categorize people in school and in the armed services.
- IQ tests have been criticized for being biased in favor of white, middle-class people. However, efforts to

construct tests that are free of cultural influence have been disappointing. Culture affects nearly everything to do with taking a test, from attitudes to problem-solving strategies. Negative stereotypes about a person's ethnicity, gender, or age may cause the person to feel *stereotype threat*, which can lead to anxiety that interferes with test performance.

Dissecting Intelligence: The Cognitive Approach

- In contrast to the psychometric approach, *cognitive approaches* to intelligence emphasize several kinds of intelligence and the strategies people use to solve problems. Sternberg's *triarchic theory of intelligence* proposes three aspects of intelligence: *componential* (including *metacognition*), *experiential* or *creative*, and *contextual* or *practical*. Contextual intelligence allows you to acquire *tacit knowledge*, practical strategies that are important for success but are not explicitly taught.
- Another important kind of intelligence, *emotional intelligence*, is the ability to identify your own and other people's emotions accurately, express emotions clearly, and regulate emotions in yourself and others.

The Origins of Intelligence

- Heritability estimates for intelligence (as measured by IQ tests) average about .40 to .50 for children and adolescents, and .60 to .80 for adults. Identical twins are more similar in IQ test performance than fraternal twins, and adopted children's scores correlate more highly with those of their biological parents than with those of their nonbiological relatives. These results do not mean that genes determine intelligence; the remaining variance in IQ scores must be due largely to environmental influences.
- Genes might contribute to intelligence by influencing the number of nerve cells in the brain or the number of connections among them, as reflected by the total volume of gray matter. The total volume of gray matter is highly heritable and is correlated with general intelligence.
- It is a mistake to draw conclusions about *group* differences from heritability estimates based on differences *within* a group. The available evidence fails to support genetic explanations of black–white differences in performance on IQ tests.
- Environmental factors such as poor prenatal care, malnutrition, exposure to toxins, and stressful family circumstances are associated with lower performance on intelligence tests. Conversely, a healthy and stimulating environment can improve performance. IQ scores have been rising in many countries for several generations, most likely because of improved education, better health, and the increase in jobs requiring abstract thought.
- Intellectual achievement also depends on motivation, hard work, and self-discipline. Cross-cultural work shows that beliefs about the origins of mental abilities, parental standards, and attitudes toward education can also help account for differences in academic performance.

Animal Minds

- Some researchers, especially those in *cognitive ethology*, argue that nonhuman animals have greater cognitive abilities than has previously been thought. Some animals can use objects as simple tools. Chimpanzees have shown evidence of a simple understanding of number. Some researchers believe that the great apes, and possibly other animals, have aspects of a *theory of mind*, an understanding of how their own minds and the minds of others work. In some apes and monkeys, these aspects may include some metacognition.
- In projects using visual symbol systems or American Sign Language (ASL), primates have acquired linguistic skills. Some animals, even nonprimates such as dolphins and African gray parrots, seem able to use simple grammatical ordering rules to convey or comprehend meaning. However, scientists are divided about how to interpret the findings on animal cognition, with some worrying about *anthropomorphism* and others about *anthropodenial*.

Psychology in the News, Revisited

- Our cognitive abilities allow us to be funny, playful, smart, and creative, yet we also are blinded by cognitive biases that distort reality and allow us to behave mindlessly. Although enormous strides have been made in the field of *artificial intelligence*, human intelligence is more than the capacity to perform computations with lightning speed. We remain the only creatures that try to understand our own minds and misunderstandings.

Taking Psychology with You

- Creativity is part of critical thinking. Creative people rely on *divergent* rather than *convergent* thinking when solving problems. They tend to be nonconformist, curious, and persistent, but circumstances can also foster (or suppress) creative accomplishment.

Key Terms

concept **224**
basic concept **224**
prototype **224**
Benjamin Lee Whorf **225**
proposition **225**
cognitive schema **225**
mental image **225**
subconscious processes **225**
nonconscious processes **226**
implicit learning **226**
mindlessness **227**
reasoning **228**
formal reasoning **228**
algorithm **228**
deductive reasoning **228**
premise **228**
inductive reasoning **228**
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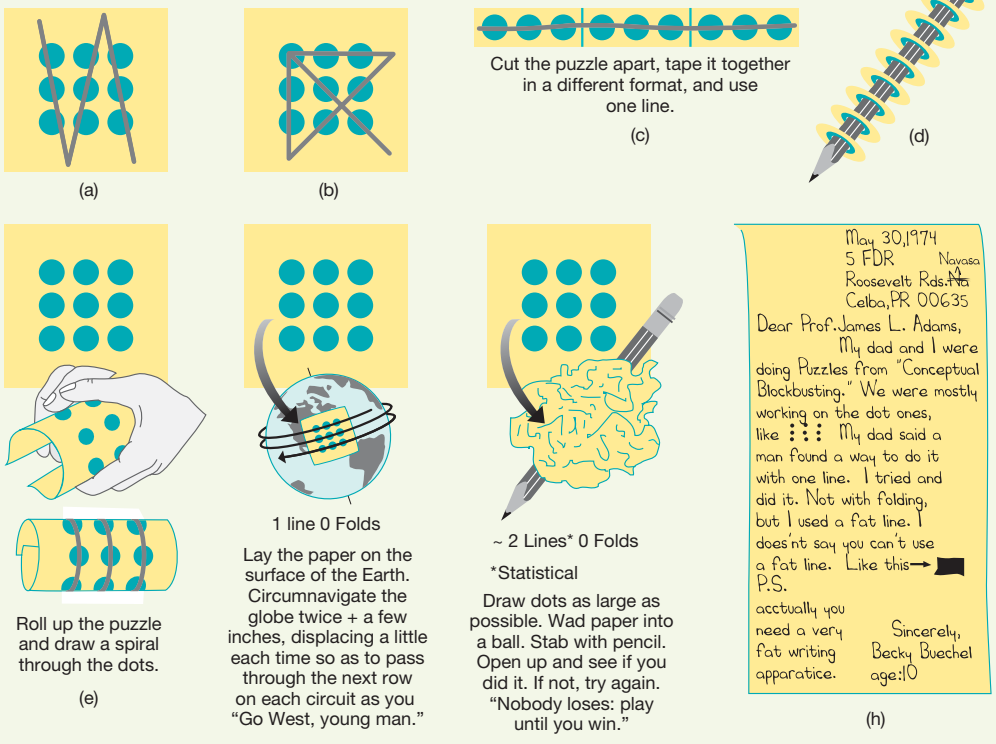
heuristic **228**
dialectical reasoning **229**
reflective judgment **229**
prereflective stages **230**
quasi-reflective stages **230**
reflective stages **230**
affect heuristic **231**
availability heuristic **232**
avoidance of loss **232**
framing effect **232**
fairness bias **233**
Ultimatum Game **233**
behavioral economics **233**
hindsight bias **233**
confirmation bias **234**
mental set **235**
cognitive dissonance **235**
postdecision dissonance **236**
justification of effort **237**
intelligence **238**
psychometric approach to intelligence **238**
factor analysis **238**
g factor **238**
mental age (MA) **239**
intelligence quotient (IQ) **239**
Stanford–Binet Intelligence Scale **239**
Wechsler Adult Intelligence Scale (WAIS) **240**
Wechsler Intelligence Scale for Children (WISC) **240**
stereotype threat **241**
cognitive approach to intelligence **242**
triarchic theory of intelligence **242**
componential intelligence **242**
metacognition **242**
experiential (creative) intelligence **243**
contextual (practical) intelligence **243**
tacit knowledge **243**
emotional intelligence **243**
heritability **245**
cognitive ethology **250**
theory of mind **251**
anthropomorphism **253**
anthropodenial **254**
artificial intelligence **255**
convergent versus divergent thinking **256**

Answers to the creativity test on page 256: back, party, book, match, cheese

Some solutions to the nine-dot problem in the Get Involved exercise on page 235 (from Adams, 1986):



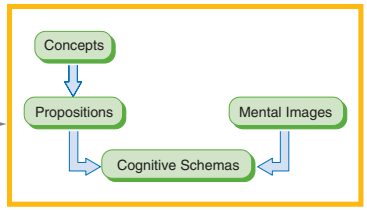
Thought

The Elements of Cognition

- *Thinking* is the mental manipulation of information.
- A **concept** is a mental category that groups objects, relations, activities, abstractions, or qualities that share certain properties.
- **Prototypical** instances of a concept are more representative than others.
  - —**Basic concepts** have a moderate number of instances and are easier to acquire than those having few or many instances.
- The words and grammatical rules used to express concepts may influence how we think about them.
- **Propositions** are made up of concepts and express a unitary idea. They may be linked together to form **cognitive schemas**, which serve as mental models of aspects of the world.
- **Mental images** also play a role in thinking.

How Conscious Is Thought?

- **Subconscious processes** lie outside of awareness but can be brought into consciousness when necessary.
- Because of the capacity for automatic processing, many people think they are good multitaskers, but in reality *multitasking* increases stress, errors, and reaction times, while impairing memory and attention.
- **Nonconscious processes** remain outside of awareness but are involved in what we call "intuition" and in **implicit learning.**
- *Mindlessness* keeps people from recognizing the need for a change in behavior.



Reasoning Rationally

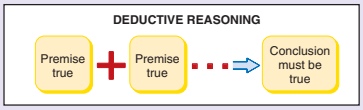
Reasoning

Reasoning is purposeful mental activity that involves drawing inferences and conclusions from observations or propositions.

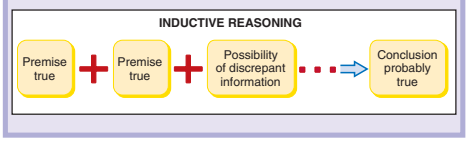
Formal Reasoning

Formal reasoning problems can often be solved by:

- Applying an **algorithm**, a set of procedures guaranteed to produce each solution
- Using logical processes
- Using **deductive reasoning**



- Using **inductive reasoning**



Informal Reasoning

Informal reasoning problems often have no clearly correct solution.

- **Heuristics** are rules of thumb that suggest a course of action without guaranteeing an optimal solution.
- **Dialectical reasoning** is a process of comparing and evaluating opposing points of view.

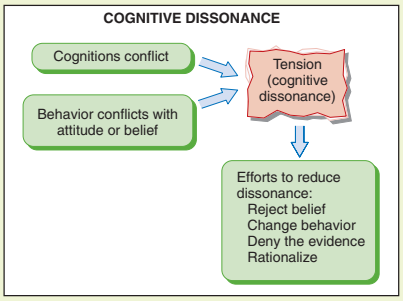
Reflective Judgment

Reflective judgment is the ability to evaluate and integrate evidence, consider alternative interpretations, and reach a defensible conclusion.

Barriers to Reasoning Rationally

Many cognitive biases are obstacles to rational thinking:

1. Exaggerating the probability of improbable events, in part because of the **affect** and **availability heuristics.**
2. Avoidance of loss, which makes people susceptible to the **framing effect**; in general, people are more cautious when a choice is framed in terms of loss rather than gain.
3. The *fairness bias*
4. The **hindsight bias**
5. The **confirmation bias**
6. Formation of **mental sets**
7. Avoidance of **cognitive dissonance**: people are motivated to reduce the tension created when two cognitions or a cognition and a behavior conflict. They reduce **postdecision dissonance** in various ways, including the **justification of effort**.



Intelligence

Intelligence is an inferred characteristic, usually defined as the ability to profit from experience, acquire knowledge, think abstractly, act purposefully, or adapt to change.

Measuring Intelligence

The **psychometric** approach to intelligence focuses on performance on standardized aptitude tests.

- The use of **factor analysis** can help identify clusters of correlated items on a test that measure some common ability, such as a **g factor** in intelligence.
- Alfred Binet came up with the idea of measuring a person's **mental age**, or level of intellectual development relative to that of others.
- The **intelligence quotient** (**IQ**) represents a person's score on a particular test, compared to others' scores.
- Efforts to create intelligence tests unaffected by culture have been disappointing.
- **Stereotype threat** can affect the test performance of women and minority groups.

Dissecting Intelligence

Cognitive approaches emphasize problem-solving strategies and several kinds of intelligence, rather than a g factor.

The **triarchic theory of intelligence** proposes three aspects of intelligence:

- Componential (includes **metacognition**)
- Experiential or creative
- Contextual or practical (which allows one to acquire **tacit knowledge**)

Other theories propose multiple domains of intelligence. A leading one emphasizes **emotional intelligence.**

The Origins of Intelligence

Behavioral-genetic studies show the **heritability** of intelligence (as measured by IQ tests) to be high.

The Question of Group Differences

- Genetic explanations of black–white differences in IQ inappropriately use heritability estimates based mainly on white samples.
- Environmental influences on intelligence include:
  - Poor prenatal care
  - Malnutrition
  - Exposure to toxins
  - Stressful family circumstances

Motivation, Hard Work, and Intellectual Success

- Intellectual performance is strongly influenced by motivation and self-discipline.
- These in turn are affected by cultural (parental) expectations, attitudes toward education, and beliefs about the origins of mental abilities.

Animal Minds

Animal Intelligence

Cognitive ethologists study animal intelligence, cognition, and behavior in natural environments:

- Some animals can use rudimentary tools.
- Chimpanzees can learn to use numerals and symbols.
- Whether or not animals possess a **theory of mind** is the subject of much debate. Some theorists argue that the great apes, and even some other animals, have some understanding of their own minds and those of others.

Animals and Language

In several studies, primates and other animals have acquired some aspects of human language.

In thinking about animal cognition, we must avoid both *anthropomorphism* and *anthropodenial.*