Think About It

Which are more accurate: first impressions or in-depth analyses?

What's the best way to make important decisions?

Do nonhuman animals have language?

Are children who learn two languages at a disadvantage?

Does speed-reading work?

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One of the most valuable lessons psychology can teach us is to appreciate mental capacities we normally take for granted. Take thinking and language. We rely on them almost every second of our waking hours but rarely notice the complexity that goes into them.

Picture this scenario:

Two friends decide to go fishing. Jason is responsible for bringing the fishing gear, and Tre is responsible for bringing snacks and drinks. After a long drive, they reach their favorite fishing hole. As they are unpacking the car, Jason says, "Oh no! I forgot to bring the sinkers. Now we won't have anything to weigh down the fishing line; it's just going to float at the top of the water." Tre thinks for a second and then snaps his fingers. "I've got some keys to my uncle's old apartment rattling around in my backpack." "Nice one!" says Jason.

What just happened? Tre generated a novel solution to a problem by thinking of something that was about the right size and weight to hold down the fishing line and that had a hole through which the fishing line could be threaded. Problem solving in action! Notice also that although Tre never actually spelled out his solution ("I know. We can use some old keys as weights instead!"), Jason (and you) figured out what he meant when he announced that he had some old keys in his bag. The simple act of following the implications of that conversation required both reasoning and language skills.

These are the kinds of abilities we'll explore in this chapter. First, we'll examine our thinking and reasoning processes in everyday life and discover how we make decisions and solve problems. Then we'll examine how we communicate and comprehend meaning using words, and the enormous challenges we face—and overcome—when doing so.

Thinking and Reasoning

8.1 Identify methods for achieving cognitive economy.

8.2 Describe what factors affect our reasoning about the world.

Nearly all of the chapters of this text thus far, and more still to come, describe aspects of thinking. Generally speaking, we can define **thinking** as any mental activity or processing of information. It includes learning, remembering, perceiving, communicating, believing, and deciding. All are fundamental aspects of what psychologists call cognition (see Chapter 1).

As we discovered in Chapter 6, behaviorists attempted to explain mental activity in terms of stimulus and response, reinforcement and punishment. Yet psychologists have long known that our minds often go beyond the available information, making leaps of insight and drawing inferences. Our minds fill in the gaps to create information that isn't present in its environmental inputs (see Chapters 2 and 4). Behaviorism's "black box psychology" (see Chapter 1) can't easily account for this phenomenon.

Cognitive Economy—Imposing Order on Our World

Given the complexity of the cognitive tasks we must perform every day, our brains have adapted by finding ways to streamline the process. That's where cognitive economy enters the picture. As we learned in Chapter 2, we're *cognitive misers*. We economize mentally in a variety of ways that reduce our mental effort, but enable us to get things right most of the time. Yet as we've also seen, cognitive economy can occasionally get us in trouble, especially when it leads us not merely to simplify, but *over*simplify.

Our minds use a variety of heuristics, or mental shortcuts, to increase our thinking efficiency (Ariely, 2008; Herbert, 2010; Kahneman, 2011). From an evolutionary perspective, heuristics may have enhanced our survival. Even though these shortcuts can backfire if we're not careful, we've developed them for a reason: They're often useful in everyday life (Gigerenzer, 2007; Gilovich, Griffin, & Kahneman, 2002).

We process an enormous amount of information every minute of every day. From the moment we wake up, we must take into account what time it is, notice if there are any obstacles on the floor (like a roommate's shoes) between us and the shower, plan

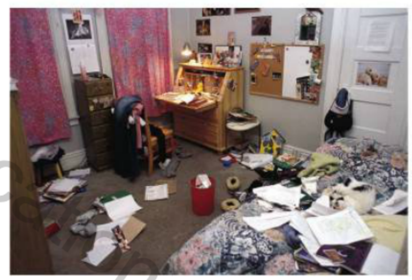
thinking
any mental activity or processing of information, including learning, remembering, perceiving, communicating, believing, and deciding

what time we need to get to class or work, and collect everything we need to take with us. Of course, that's all before we've even stepped out the door. If we were to attend to and draw conclusions about every aspect of our experience all the time, we'd be so overwhelmed that we'd be paralyzed psychologically.

We draw inferences that provide mental shortcuts many times a day, and most of the time, they steer us right. If a roommate's keys are lying on the dining table, we might infer that our roommate is home. We might conclude that the stressed-looking woman walking briskly by might not be the best person to stop and ask to contribute to our charity. Without actually tasting it (or better yet, conducting a microscopic bacterial analysis), we typically can decide that the three-week-old milk in our refrigerator has gone bad based on its smell. Each of these conclusions is unwarranted under rigorous standards of evidence-based reasoning. Yet most of these guesses (what we called "intuitive" or System 1 thinking in Chapter 2) are probably accurate enough to be safe bets.

Cognitive economy allows us to simplify what we attend to and keep the information we need for decision making to a manageable minimum. Gerd Gigerenzer and his colleagues (Gigerenzer & Goldstein, 1996; Gigerenzer, Hertwig, & Pachur, 2011) referred to this type of cognitive economy as "fast and frugal" thinking. He argued that it serves us well most of the time. In fact, in many cases, the heuristics we use are more valid than an exhaustive (and exhausting!) analysis of all potential factors (Gladwell, 2005).

One study revealed that untrained observers can make surprisingly accurate judgments about people on the basis of limited information. Samuel Gosling and his colleagues asked a group of untrained observers to make personality judgments about students by viewing their dorm rooms or bedrooms for only a few minutes. The researchers gave observers no instructions about what features of the room to focus on and covered all photos in the rooms so that observers couldn't determine the sex, race, or age of the rooms' occupants. Yet observers accurately gauged several aspects of the occupants' personalities, such as their emotional stability, openness to new experiences, and conscientiousness (Gosling, 2008; see Chapter 14). Presumably, observers were relying on mental shortcuts to draw conclusions about occupants' personalities because they had no firsthand experience with them.



Research by Samuel Gosling and his collaborators suggests that observers can often infer people's personality traits at better-than-chance levels merely by inspecting their rooms. What might you guess about the level of conscientiousness of this room's occupant?

Nalini Ambady and Robert Rosenthal (1993) provided another remarkable example of how cognitive economy serves us well. They showed participants 30-second silent clips of instructors teaching and asked them to evaluate the instructors' nonverbal behaviors. Participants' ratings on the basis of only 30 seconds of exposure were correlated significantly with the teachers' end-of-course evaluations by their students; in fact, their ratings were still predictive of course evaluations even when the clips were only six seconds long. Ambady and Rosenthal referred to our ability to extract useful information from small bits of behavior as "thin slicing." John Gottman and his colleagues also showed that after observing just 15 minutes of a couple's videotaped interaction, they could predict with more than 90 percent accuracy which couples would divorce within the next 15 years. It turns out that the emotion of contempt—perhaps surprisingly, not anger—is one of the best predictors (Carrère & Gottman, 1999; see Chapter 11).

But cognitive economy is a mixed blessing, because it can also lead us to faulty conclusions (Lehrer, 2009; Myers, 2002). Although our snap judgments are usually accurate (or at least accurate enough to get by), we can occasionally be wildly wrong (Gigerenzer, 2007; Krueger & Funder, 2005; Shepperd & Koch, 2005).

Heuristics and Biases: Double-Edged Swords

Psychologists have identified many more heuristics and **cognitive biases**, predispositions and default expectations that we use to interpret our experiences, that operate in our everyday lives. We'll examine a few of them here.

cognitive bias
systematic error in thinking

Factoid

Are there more words in the English language with the letter *k* as the first letter in the word or the third letter in the word? If you're like most people, you guessed that there are more words beginning with the letter *k* than with *k* in the third position. In fact, there are more than twice as many words with *k* in the third position as there are words beginning with the letter *k*. Most of us get this question wrong because we rely on the availability heuristic: Because of how our brains categorize words, we find it easier to think of words with *k* in the first position (like *kite* and *kill*) than words with *k* in the third position (like *bike* and *cake*).

FIGURE 8.1 A Floral Demonstration of Base Rates. This bouquet includes purple irises and yellow and purple tulips. If we were to choose a purple flower at random, would it be more likely to be an iris or a tulip? Even though all of the irises are purple and most of the tulips are yellow, the purple flower we chose is more likely to be a tulip because there are twice as many purple tulips as there are purple irises. That means that the base rate of purple tulips in this bouquet is higher than the base rate of purple irises.

representative heuristic
heuristic that involves judging the probability of an event by its superficial similarity to a prototype

base rate
how common a characteristic or behavior is in the general population

REPRESENTATIVENESS HEURISTIC. The **representativeness heuristic** involves judging the probability of an event based on how prevalent that event has been in past experience (Kahneman, Slovic, & Tversky, 1982; Tversky & Kahneman, 1974). If we meet someone who is shy, awkward, and a tournament chess player, we might guess that he is more likely to be a computer science major than a communications major. If so, we relied on a representativeness heuristic, because this person matched our stereotype of a computer science major.

As we'll learn in Chapter 13, stereotyping is a form of cognitive economy, and it's often a result of our overgeneralizing from experiences with individuals in a minority group (such as African-Americans or Muslim Americans) to all individuals in that group. So the representativeness heuristic can sometimes lead us to incorrect conclusions. Imagine we met another student who is Asian-American, is bilingual in English and Chinese, and is vice president of the college's Chinese Students Association. We might judge that she's more likely to be an Asian-American Studies major than a psychology major. However, in this case, the representativeness heuristic may have misled us. Although this student's characteristics may be consistent with those of many Asian-American Studies majors, we also must consider the fact that even within the broad group of Asian-American students, there are many more psychology majors than there are Asian-American Studies majors. So the odds would actually predict that she's more likely to be a psychology major.

The challenge to our reasoning in this example is that we are poor at taking into account *base rate* information. **Base rate** is a fancy term for how common a behavior or characteristic is in general (Finn & Kamphuis, 1995; Meehl & Rosen, 1955). When we say that alcoholism has a base rate of about 5 percent in the U.S. population (American Psychiatric Association, 2000), we mean that about 1 in 20 Americans experiences alcoholism on average. When evaluating the probability that a person belongs to a category (for example, Asian-American Studies major), we need to consider not only how similar that person is to other members of the category, but also how prevalent that category is overall, the base rate (see **FIGURE 8.1**).

AVAILABILITY HEURISTIC. We also rely heavily on the **availability heuristic** in our everyday lives. Based on this heuristic, we estimate the likelihood of an occurrence based on how easily it comes to our minds—on how "available" it is in our memories (Kahneman et al., 1982). Like representativeness, availability often works well. If we ask you whether there's a higher density of trees (a) on your college campus or (b) in the downtown area of the nearest major city, you're likely to answer (a). Odds are you'd be right (unless, of course, your college campus is *in* a downtown area). When you answered the question, it's unlikely you actually calculated the precise proportion of trees you've observed in each place. Instead, you probably called to mind mental images of your campus and of a downtown area and observed that the examples of the campus that came to mind more often had trees in them than the examples of downtown areas that came to mind.

But now consider this example, which you may want to try on your friends (Jaffe, 2004). Ask half of your friends to guess the number of murders per year in Michigan and the other half to guess the number of murders per year in Detroit, Michigan. If you average the answers for each group, based on the availability heuristic, you will probably find that your friends give higher estimates for the number of murders in Detroit, Michigan, than for the entire state of Michigan! In one study, people who were asked about the state of Michigan estimated about 100 murders per year, but those asked about Detroit estimated 200 murders per year (Kahneman, 2011).

This paradoxical result is almost certainly due to our reliance on the availability heuristic. When we imagine the state of Michigan, we conjure up images of sprawling farms and peaceful suburbs. Yet when we imagine the city of Detroit, we conjure up images of dangerous inner-city areas and run-down buildings. So thinking of Detroit makes the idea of murder more readily available to us.

from inquiry to understanding

WHY DO WE WORRY ABOUT THE WRONG THINGS?

Try answering the following four questions:

In the United States, which causes more deaths?

(1) All types of accidents combined or strokes?

(2) All motor vehicle (car, truck, bus, and motorcycle) accidents combined or digestive cancer?

(3) Diabetes or homicide?

(4) Sharks or cattle?

The answers are (1) strokes (by about twofold), (2) digestive cancer (by about threefold), (3) diabetes (by about fourfold), and (4) cattle (by about twenty-fold). If you got one or more questions wrong, you're in good company, because most people do. In fact, a large body of data demonstrates that we're poor at estimating risks. We worry a lot about things that aren't all that dangerous and don't worry enough about things that are dangerous (Daley, 2012; Ropeik, 2010). Why?

Scientific research shows that the availability heuristic is a major culprit (Hertwig, Pachur, & Kurzenhauser, 2005; Tversky & Kahneman, 1974). Because the news media provide far more coverage of dramatic accidents and homicides than they do strokes, digestive cancer, or diabetes, we overestimate the probability of accidents and homicides and underestimate the probability of many common diseases. For example, because the media feature so many emotional stories of famous women who've developed breast cancer, the availability heuristic makes us think of breast cancer as a more frequent and deadly illness than heart disease, when the truth is just the opposite (Slovic, Finucane, Peters, & MacGregor, 2012). Heart disease is probably less newsworthy precisely because it's more commonplace than cancer. These errors in judgment can be costly: If women believe heart disease isn't a health threat, they may not change their lifestyles to minimize their risk.

These errors can also shape our decision making. If you learned that four jumbo jets at full capacity crashed every day in the United States, you'd probably never get on a commercial airplane again. Yet the equivalent of that number—about 1,200 people—die each day in America from smoking-related causes (Centers for Disease Control and Prevention, 2005), and still, millions of Americans take up smoking every year. What are the odds that we'll die in a commercial plane crash? Infinitesimally small. We'd need to fly in commercial airliners for about 10,000 years straight—that is, around the clock without any breaks—before the odds of our dying in a plane crash exceed 50 percent. But because big plane crashes make big news, we overestimate their frequency, leading many people to avoid flying altogether.

Overall, we underestimate the frequency of the most common causes of death and overestimate the occurrence of the least common causes of death (Lichtenstein, Slovic, Fischhoff, et al., 1978). As John Ruscio (2000) points out, this tendency sometimes leads to a negative correlation between the actual risk of events and their perceived risk. The less likely something is, the more likely the media is to cover it and, as a result, the more common we believe it to be. So in an ironic twist, not only do we often worry about the wrong things, we often worry about the safest things.

Our mental images of Michigan (top) and Detroit, Michigan (bottom), conjure up markedly different estimates of violent crime. In this case, the availability heuristic can lead us to faulty conclusions.

Simulate in **MyPsychLab** the **Experiment:** Heuristics

HINDSIGHT BIAS. **Hindsight bias**, sometimes also known as the "I knew it all along" effect, refers to our tendency to overestimate how accurately we could have predicted something happening once we know the outcome (Fischoff, 1975; Kunda, 1999). As the old saying goes, "Hindsight is 20/20." This is also where the term "Monday Morning Quarterbacking" comes from—when commentators and spectators of a football game played Sunday evening point out after the fact that a different strategy would have worked better. Even if they are correct, it's much easier to say "It would have worked better if…" once you already know that the action taken hasn't worked.

availability heuristic
heuristic that involves estimating the likelihood of an occurrence based on the ease with which it comes to our minds

hindsight bias
our tendency to overestimate how well we could have predicted something after it has already occurred

Nostradamus was a sixteenth-century prophet whose four-line poems supposedly foretold the future. Here's a famous one:

Beasts ferocious with hunger will cross the rivers, The greater part of the battlefield will be against the Hister. Into a cage of iron will the great one be drawn, When the child of Germany observes nothing.

After reading it, can you guess what historical event it supposedly predicted? (The answer is upside down at the bottom of this page.) Odds are high you won't. Yet after discovering the answer, you're likely to find that the poem fits the event quite well. This is an example of hindsight bias. (Yafeh & Heath, 2003).

As we talked about back in Chapter 1, we're also prone to a powerful cognitive bias called *confirmation bias*, which is our tendency to seek out evidence that supports our hypotheses or beliefs and to deny, dismiss, or distort evidence that doesn't. In Chapter 2, we discovered how the scientific method helps us compensate for this bias in research but, as we'll discover later in this chapter, it can also have consequences for our real-world decision making.

Top-Down Processing

Our brains have evolved to streamline processing in other ways besides heuristics and biases. One key example is that we fill in the gaps of missing information using our experience and background knowledge. As we learned in Chapter 4, psychologists call this phenomenon *top-down processing*. We can contrast top-down processing with bottom-up processing, in which our brain processes only the information it receives, and constructs meaning from it slowly and surely by building up understanding through experience. In Chapter 4, we saw how perception differs from sensation because our perceptual experiences rely not only on raw sensory input, but also on stored knowledge that our brains access to interpret those experiences. In Chapter 7, we encountered chunking, another form of top-down processing. Chunking is a memory aid that relies on our ability to organize information into larger units, expanding the span and detail of our memories. Each of these examples highlights our brain's tendency to simplify our cognitive functioning by using preexisting knowledge to spare us from reinventing the wheel.

One common source of top-down processing that helps us to think and reason is our use of concepts and schemas. **Concepts** are our knowledge and ideas about objects, actions, and characteristics that share core properties. We have concepts of the properties that all motorcycles share of what feature unifies all purple things. As we learned in Chapter 7, schemas are concepts we've stored in memory about how certain actions, objects, and ideas relate to each other. They help us to mentally organize *events* that share core features, say, going to a restaurant, cleaning the house, or visiting the zoo. As we acquire knowledge, we create schemas that enable us to draw on our knowledge when we encounter something new.

An example of top-down processing comes from mondegreens—commonly misheard song lyrics. For example, one of your textbook's authors thought that Soulja Boy was singing "Shook my leg in the mirror" in his song "Turn My Swag On" (much to her teenage son's chagrin). The real lyric was "Took a look in the mirror."

A concept allows us to have all of our general knowledge about dogs, for example, at our disposal when dealing with a new dog, Rover. We don't need to discover from scratch that Rover barks, pants when he's hot, and has a stomach. All of these things come "for free" once we recognize Rover as a dog. Similarly, when we go to a new doctor's office, no one has to tell us to check in with the receptionist and sit in the waiting room until someone calls us to enter an examining room, because our schema for doctors' visits tells us that this is the standard script. Of course, our concepts and schemas don't apply to all real-world situations. Rover may be unable to bark because of a throat disorder. Yet most of the time, our concepts and schemas safely allow us to exert less cognitive effort over basic knowledge, freeing us to engage in more complex reasoning and emotional processing.

concept
our knowledge and ideas about a set of objects, actions, and characteristics that share core properties

Answer: Adolph Hitler's rise to power.

Assess Your Knowledge FACT or FICTION?

1. Fast and frugal processing almost always leads to false conclusions. **True / False**
2. Concepts are a form of cognitive economy because they don't rely on any specific knowledge or experience. **True / False**
3. Assuming that someone must play basketball because he or she is extremely tall is an example of the availability heuristic. **True / False**
4. Humans are typically biased to consider base rates when calculating the likelihood that something is true. **True / False**
5. Top-down processing involves drawing inferences from previous experience and applying them to current situations. **True / False**

Answers: **1.** F (p. 291); **2.** F (p. 294); **3.** T (p. 292); **4.** F (p. 292); **5.** T (p. 294)

Study and **Review** in **MyPsychLab**

Thinking at Its Hardest: Decision Making and Problem Solving

8.3 Discover what influences our decision making.

8.4 Describe some common problem-solving strategies and challenges.

8.5 Describe various models of the human mind.

Probably the most difficult and effortful thinking we do is that involved in making decisions and solving problems. Psychologists call these aspects of thinking "higher-order" cognition because they require us to take all of the more basic aspects of cognition, such as perception, knowledge, memory, language, and reasoning, and integrate them to generate a plan of action.

Decision Making: Choices, Choices, and More Choices

Decision making is the process of selecting among a set of alternatives. Should I order fries or a salad with my sandwich? Should I major in philosophy or physics? Which outfit looks better?

Each decision we make seems deceptively simple: It's an either/or choice. But many factors enter in to most decisions. Let's take the seemingly straightforward question of whether to order a salad or fries. Such a choice often depends on a variety of factors, such as whether we're watching our weight, whether we like the type of fries and salad dressings available at the restaurant, and maybe even what everyone else at our table is ordering. For many of these small decisions, we often weigh the considerations quickly and implicitly, that is, below conscious awareness. As we learned in Chapter 2, this often involves System 1 thinking, which is rapid and intuitive (Kahneman, 2011). But for some other decisions, such as where to go to college or whether to get married, the decisions have much larger consequences and require more careful deliberation. In these cases, decision making often becomes more explicit and deliberate. We mull over the options; sometimes identify and list the pros and cons of each option; and may solicit the advice and opinions of friends, family, and trusted advisers such as professors, clergy, and coaches. Here, we're relying on System 2 thinking, which is slow and analytical.

Is explicitly analyzing the situation before making a decision a good idea? It depends (Lehrer, 2009). Timothy Wilson and his colleagues gave female college students a choice among five art posters to take home. The investigators asked half of the students to just "go with their gut" and pick the poster they liked and the other half to carefully list each of the pros and cons of each poster. When the researchers recontacted the participants a few weeks later, those who went with their gut reported that they were much happier with their choice (Wilson et al., 1993). When it comes to emotional preferences, like which art we like or which people we find attractive, thinking too much may get us in trouble. Ironically, this may be especially

decision making
the process of selecting among a set of possible alternatives

true for complex emotionally laden decisions, like which car to buy, because our brains can easily become overwhelmed by excessive information (Dijksterhuis et al., 2006). In such cases, listing all of the pros and cons can sometimes confuse us, producing a "paralysis by analysis."

Yet when it comes to evaluating scientific claims in the laboratory and in real life, such careful analysis may be the better bet (Lilienfeld et al., 2010; Myers, 2002). In fact, business communities are increasingly encouraging managers to be more strategic in their decision making about personnel, resources, and organizational structure. The new field of "decision management" attempts to bring scientific evidence into the business world to help organizations prosper through sound decision making and avoid bias (Yates & Potworowski, 2012).

? The ad on the left emphasizes a percent reduction in sugar; the ad on the right highlights the total amount. Both emphasize the low amount of sugar in the product but present the information differently. **What concept do the differences between these two ads demonstrate?** (See answer upside down at bottom of page.)

Marketing researchers, advertising executives, and political pollsters have long known that an additional factor influences our decision making: **framing**, that is, how we formulate the question about what we need to decide (Tversky & Kahneman, 1986). Imagine you've been diagnosed with lung cancer and your doctor gives you a choice. She tells you, "We can treat your cancer with surgery, which has a 90 percent post-procedure survival rate and a 34 percent five-year survival rate, *or* we can treat it with radiation, which has a 100 percent post-procedure survival rate and a 22 percent five-year survival rate." Which option would you choose? Most people in this situation pick surgery. But imagine that your doctor reworded the question to emphasize a different aspect of the decision: "We can treat your cancer with surgery, which has a 10 percent post-procedure fatality rate and a 66 percent five-year fatality rate, *or* we can treat it with radiation, which has a 0 percent post-procedure fatality rate and a 78 percent five-year fatality rate." When the question is framed that way, more people choose radiation. Suddenly the fact that we might not live through surgery becomes much more noticeable. Even though both questions contain the same information, one emphasizes survival; the other, death. That's framing.

Researchers in a newly minted field called *neuroeconomics* have become interested in how the brain works while making financial decisions (Glimcher et al., 2008; Hasler, 2012). By using fMRI (see Chapter 3) to identify brain areas that become active in specific decision-making situations—such as when interacting with a person who's stingy or selfish—researchers hope to better predict and understand how emotion, reasoning, and arousal influence our decisions (Kato et al., 2009). For example, one team of investigators imaged the brains of participants asked to make risky monetary decisions. When participants received advice from a financial expert, brain regions involved in decision making—such as certain areas of their frontal lobes (see Chapter 3)—became less active than when they received no financial advice (Engelmann et al., 2009). This new field has the potential to help us understand why decision making goes wrong in some individuals. For example, clinical psychologists have recently begun exploring ways to use neuroeconomics approaches to diagnose and characterize psychological disorders (Sharp, Monterosso, & Read Montague, 2012).

framing
the way a question is formulated that can influence the decisions people make

problem solving
generating a cognitive strategy to accomplish a goal

Watch in **MyPsychLab** the **Video:** The Basics: The Mind Is What the Brain Does

Problem Solving: Accomplishing Our Goals

Many times a day, we're faced with problems to solve. Some are as simple as figuring out where we left our favorite pair of shoes, but others involve attempting to recover a corrupted computer file or figuring out how to get to a restaurant in an unfamiliar part of town. **Problem solving** is generating a cognitive strategy to accomplish a goal.

Answer: Framing. Seeing the different ads might lead to different decision-making processes because different pieces of information are in the foreground of our thinking.

APPROACHES TO SOLVING PROBLEMS. We've encountered a variety of heuristics, like availability and representativeness, that we use to draw conclusions and solve problems in a fast and frugal way. Although these heuristics are often effective, we can draw on a variety of more deliberate solutions, too. In particular, we can solve many problems following step-by-step learned procedures known as **algorithms**. Algorithms come in handy for problems that depend on the same basic steps for arriving at a solution every time the solution is required, such as replacing the starter on a car, performing a tonsillectomy, or making a peanut-butter-and-jelly sandwich. Algorithms ensure that we address all steps when we solve a problem, but they're pretty inflexible. Imagine you had an algorithm for cooking a mushroom omelet that includes melting some butter but you ran out of butter. You'd be stuck. As a result, you could either give up—or, instead, "use your head" to engage in a more flexible solution.

Another more flexible approach is to break down a problem into subproblems that are easier to solve. If we're trying to construct a doghouse, we might break down the problem into identifying the size and dimensions of the doghouse, purchasing the materials, constructing the floor, and so on. By breaking down the problem into bite-sized chunks, we can often solve it more quickly and easily. Another effective approach involves reasoning from related examples, such as realizing that because oil is often substituted for butter in baking recipes, it might work for an omelet, too (Gentner et al., 2009). Many breakthroughs in scientific problems in the laboratory and real world have come from drawing *analogies* between two distinct topics. These analogies solve problems with similar structures. For example, after observing how burrs stuck to his dog's fur by using a series of tiny hooks that attached to individual strands of fur, George de Mestral invented Velcro in 1948 .

Watch in **MyPsychLab** the **Video:** IT Video: Water Lilly

OBSTACLES TO PROBLEM SOLVING. Although we use a variety of effective strategies to solve problems, we also face a variety of hurdles—cognitive tendencies that can interfere with the use of effective problem-solving strategies. We'll consider three obstacles to solving problems correctly: salience of surface similarities, mental sets, and functional fixedness.

Simulate in **MyPsychLab** the **Experiment:** Obstacles to Problem Solving

Salience of Surface Similarities. Salience refers to how attention-grabbing something is. We tend to focus our attention on the surface-level (superficial) properties of a problem, such as the topic of an algebra word problem, and try to solve problems the same way we solved problems that exhibited similar surface characteristics. When one algebra word problem calls for subtraction and another calls for division, the fact that both deal with trains isn't going to help us. Ignoring the surface features of a problem and focusing on the underlying reasoning needed to solve it can be challenging.

Imagine learning about two problems. In one problem, a general wants to capture a fortress but realizes that taking all his forces down a single path makes them vulnerable to attack, so he divides the forces up into many smaller units who each attack along a different path. By surrounding the fortress along many paths, the fortress is taken without significant loss of troops. In the second problem, a doctor is attempting to treat a stomach tumor by use of a laser but realizes that sending the full-intensity beam required to destroy the tumor will damage the healthy tissue in its path. Can you think of a solution that destroys the tumor but protects the healthy tissue? Hint: the second problem involves the same reasoning process as the first. Did you realize that the same solution—sending lots of low-intensity beams in from lots of directions—would work for the tumor problem? In one study, only 20 percent of students who saw the fortress problem figured out the tumor problem (Gick & Holyoak, 1983). But when researchers told students that the fortress problem could help them solve the tumor problem, their success shot up to 92 percent. The students hadn't noticed that the fortress solution was relevant.

Explore in **MyPsychLab** the **Concept:** Intuition and Discovery in Problem Solving

Mental Sets. Once we find a workable solution that's dependable, we often get stuck in that solution mode; we have trouble generating alternatives or "thinking outside the box." Psychologists term this phenomenon a **mental set**. When attempting to pick a topic for a term paper, we may have trouble thinking of topics the professor hasn't already covered in class. Ironically, a friend who hasn't taken the class may be able to come up with more creative ideas because our thinking has become "boxed in" by our experiences.

algorithm
step-by-step learned procedure used to solve a problem

mental set
phenomenon of becoming stuck in a specific problem-solving strategy, inhibiting our ability to generate alternatives

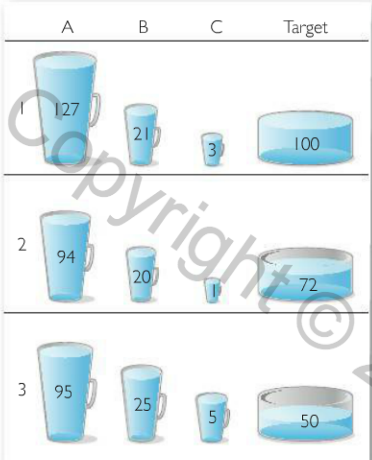


FIGURE 8.2 Mental Set Problems. Solve these problems by figuring out how to add and remove precise amounts of water using the jars provided. The first two problems use the same formula: Add the amount in the first jug (A), subtract the amount from the second jug (B), and then subtract the amount from the third jug (C) twice (A – B – C – C = Target amount). The third problem requires a different solution. Can you figure it out? If you're stuck, you may be experiencing a "mental set."

In a classic study of mental sets, participants solved a series of problems that required measuring out a precise amount of water by adding and subtracting water given only three odd measuring jars (such as filling a jug with precisely 100 quarts using only a 21-quart jar, a 127-quart jar, and a 3-quart jar; see **FIGURE 8.2**). Half the participants solved eight problems that used the same formula (A – B – C – C = Target amount) before working on a problem that used a different formula, and the other half solved only the ninth problem without working on the first eight. Only 36 percent of participants who solved the first eight problems the same way generated the correct solution on the ninth one. In contrast, participants who solved the ninth problem first generated a correct solution 95 percent of the time (Luchins, 1946). Solving the first eight problems actually made solving the ninth more difficult, because the eight problems created a mental set from which subjects had a hard time breaking free.

More recent research has explored some of the ways to break out of mental sets. One study showed that giving people actual jars to manipulate made participants less likely to get stuck in a mental set. This approach worked especially well for participants with strong visual-spatial skills (Vallée-Tourangeau, Euden, & Hearn, 2011). Studies using fMRI suggest that being able to break free of a mental set depends on activation of the frontal and parietal lobes, probably because these regions help us to inhibit previous responses and allow us to generate new strategies (Witt & Stevens, 2012).

Functional Fixedness. **Functional fixedness** occurs when we experience difficulty conceptualizing that an object typically used for one purpose can be used for another (German & Defeyter, 2000). That is, we become "fixated" on one conventional use for an object. Have you ever needed a hammer, tape, or scissors but didn't have any of these items around? Were you able to come up with an alternative solution? Functional fixedness can prevent us from realizing that we could use a shoe as a hammer or a mailing label as tape. Remember our buddy Tre who realized that a key could weigh down a fishing line? His clever idea is a clear example of overcoming functional fixedness.

One famous technique for measuring functional fixedness asked participants to figure out a way to mount a candle on a wall given only a candle, a book of matches, and a box of tacks, as shown in **FIGURE 8.3** (Duncker, 1945). Can you figure out how to do it? Most of us find this problem difficult because it forces us to use conventional objects in unconventional ways. Nevertheless, one study challenged the idea of functional fixedness as an explanation for this finding. The researchers showed that individuals from a rural area of Ecuador who live in a traditional nontechnological society and consequently have few expectations about the functional roles of these objects still had difficulty solving the problem (German & Barrett, 2005). So functional fixedness may occur even when we've had little or no experience with the objects in question.

RULING OUT RIVAL HYPOTHESES
Have important alternative explanations for the findings been excluded?

FIGURE 8.3 Functional Fixedness. A classic demonstration of functional fixedness requires participants to figure out how to mount a candle on a wall given only a candle, a book of matches, and a box of tacks (Duncker, 1945). For the solution, see the upside-down figure on the next page.

Models of the Mind

Given everything we've learned about our fast and frugal processing, our heuristics and biases, and our abilities and limitations as problem solvers, what's the best model—or unifying explanation—for how the mind works? In the 1980s, many psychologists adopted a computer analogy to explain the mind's tendency to process information, fill in gaps, and draw inferences. Perhaps thinking is akin to running data through a computer program. From this perspective, the brain's algorithms are like preprogrammed abilities; the brain runs data through its "software program" and spits out an answer.

Although some modern psychologists still rely on the computer model, most believe that a computer analogy doesn't do a good job of explaining how we think (Searle, 1990). In fact, some of the tasks that humans find simplest are among the most difficult for computers. Although we can perceive and recognize speech without difficulty, anyone who's attempted to use voice commands on an automated phone menu knows that computers are notoriously poor at this task. One reason humans beat out computers on such tasks is that we can take context into account and draw subtle inferences that computers can't.

functional fixedness
difficulty conceptualizing that an object typically used for one purpose can be used for another

For example, we might hear someone say something that sounds a lot like "I frog," but that occurs in the context of him apologizing for not bringing you something he promised. So we could guess correctly that he meant to say "I forgot." In contrast, a computer won't be able to use top-down knowledge to resolve this ambiguity.

Another important way that human thinking differs from computers is that computers don't have a chance to explore and interact with the world. From infancy, we act on the world and observe the consequences of our actions. We learn that sitting on a surface that isn't designed to hold our weight can cause us to fall or that telling someone "You're a jerk" usually produces a different emotional reaction than telling her "I'm upset about what you said."

Recent models of the mind have attempted to reflect the physically interactive nature of our knowledge and experience by developing *embodied* accounts of thinking. According to embodiment models, our knowledge is organized and accessed in a manner that enables us to simulate our actual experiences (Lakoff, 2012). For example, people who hear the sentence "The man saw the eagle in the sky" and then see a picture of an eagle are quicker to label the eagle if its wings are spread (consistent with how it would look in the scenario described in the sentence) than if its wings are folded close to its body (Fischer & Zwaan, 2008). Neuroimaging studies of brain activation are consistent with an embodied approach to thinking (Barsalou, 2008). These studies show that the brain's sensory areas (for example, visual, auditory, and motor cortex; see Chapter 3) become activated when people think about objects, actions, and events.

Human cognitive processing is remarkably flexible and creative, taking advantage of past experience, context, imagination, and mental shortcuts to provide us with rapid and efficient solutions to problems. Our fast and frugal thinking serves us remarkably well much of the time. Nevertheless, one of our major goals in this textbook is to raise awareness about how our cognitive systems can lead us astray—and just as important, how we can guard against it. Such awareness can help us recognize situations in which we're vulnerable to faulty reasoning and to think twice about our intuitions. When we hear on the news that one presidential candidate is leading in the polls or that bilingual schooling is bad for children, we should pause to think about the information on which the media based these conclusions. When deciding whether that incredible deal on laptops ("Laptops for only $200, and they're five times faster than your home computer!") or the financing on the car you're thinking of buying is too good to be true, you should consider whether the information is sufficient to warrant the remarkable claims. When deciding whether a diet plan we're considering is effective, we should think about what scientific research says instead of relying on a handful of anecdotes from friends. Cognitive economy has a lot going for it, but being aware of its pitfalls will make us more informed consumers of information in our everyday lives.

EXTRAORDINARY CLAIMS
Is the evidence as strong as the claim?

Assess Your Knowledge — FACT or FICTION?

1. Decision making is always an implicit process subtly influenced by how we frame the problem. **True / False**
2. Performing careful analysis of pros and cons is typically most useful when making decisions about emotional preferences. **True / False**
3. Neuroeconomics has the potential to use brain imaging to identify personality differences and psychiatric disorders. **True / False**
4. Comparing problems that require similar reasoning processes but different surface characteristics can help us overcome deceptive surface similarities. **True / False**
5. Functional fixedness is a product of Western technology-dependent society. **True / False**

Answers: **1.** F (p. 295); **2.** F (pp. 295–296); **3.** T (p. 296); **4.** T (p. 297); **5.** F (p. 298)

Study and **Review** in **MyPsychLab**

Answer to Figure 8.3.