Thinking

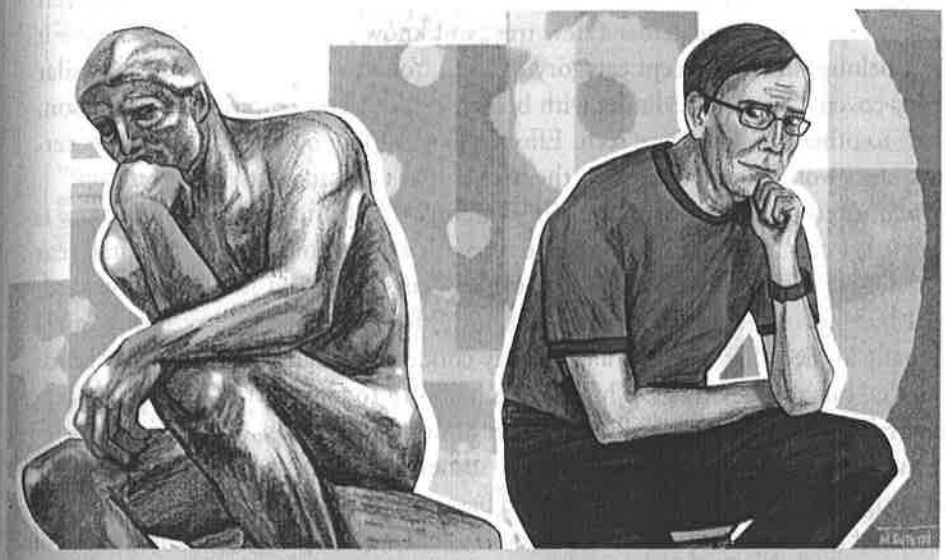
Module 25

Learning Goals

25-1 Describe how and why we form concepts.

25-2 Explain the roles of algorithms, heuristics, and insight in problem solving.

25-3 Explain how fixation, confirmation bias, the use of heuristics, overconfidence, and framing can influence the quality of our decisions.



I know there is very little resemblance between Auguste Rodin's famous sculpture titled *The Thinker* and me, but it turns out that thinking is something humans are very good at. We make our share of thinking mistakes, but our survival as a species is largely dependent on how well we conceptualize and solve problems.

What is it that makes us human? Are there characteristics that separate us from other species, characteristics uniquely human that only we can claim? How about our thinking abilities? Indeed, in **cognitive abilities**—the mental activities associated with thinking, knowing, and remembering—humans have no equals. Consider that you spend your entire waking day in thought, from deciding what clothes to put on in the morning ("Does this shirt match my pants? It's cold—maybe I need a sweatshirt."), to making the judgments necessary for safe driving, to ironing out differences of opinion with friends.

cognitive abilities All mental activities associated with thinking, knowing, and remembering.

We organize and process vast amounts of information with ease. The processing of sensory information—of depth and color, for example, and the monitoring of balance, body temperature, and other internal systems—often takes place subconsciously, without our being actively aware that it's occurring. On the conscious level, we turn our attention to solving countless problems in the course of a day. We exercise judgment regularly. We do make mistakes sometimes, but most of the time our thinking is remarkably accurate. Let's look at some components of thinking, a topic so central to psychology and being human that it has found a place in the title of this book.

Concepts

25-1 How and why do we form concepts?

Psychologists define a **concept** as a mental group based on shared similarities. This definition differs from the more general definition of *concept* as an *idea* that we hear in everyday speech. Psychologists use the more precise definition of concept when they study the conceptual categories we form when we use our brain's built-in capacity to group objects, events, and people that share some similar characteristics. Your

concept A mental grouping based on shared similarity.

Cartoon Stock

"YOU LOOK LIKE YOU HAVE A LOT ON YOUR MIND, JIM!"

kitchen is more efficient with its various items sorted—silverware in one place, measuring cups in another. Your brain also sorts information into conceptual categories. You have a concept for trees, another for bicycles, yet another for balls. These mental categories let you make instant judgments about new objects you've never seen before. When you come across a new tree, you know as quickly as you perceive it that it belongs in the concept category of tree.[1] You know this because it is similar (a bark-covered, wooden cylinder with branches and needles or, in the right season, leaves) to other trees you have seen. Effortlessly grouping objects into concepts certainly beats wondering, "Gee, what the heck is that tall thing with the green top?"

Encountering new information for which you have no matching concepts is awkward. I can remember being invited to a friend's room during my first year in college. Steve had been given a beanbag chair. They had just been invented, and I had never seen one before. He said, "How do you like my new chair?" I actually argued that it wasn't a chair. My concept of chair included many kinds of chairs, but not beanbags. This glaring inability to classify the new object was memorable because we typically categorize almost effortlessly.

prototype A typical best example incorporating the major features of a concept.

One of the ways we decide whether something belongs in a concept is by matching it with our **prototype,** a typical best example that incorporates the major features of a concept.[2] The closer the new object is to our prototype, the faster and more easily we can categorize it. We are quicker to recognize an oak tree as a tree than we are to assign a tiny Japanese bonsai tree to this category. Both qualify as trees, but the oak is much closer to our prototype—it is somehow more treelike than a bonsai (to us, at least; the Japanese bonsai grower might pause at the sight of a giant California sequoia). I struggled to identify my friend's beanbag as a chair because it was much further from my chair prototype than the desk chair and old armchair that furnished my dorm room. Some prototype biases are more serious. For example, we may not recognize an illness as quickly if the symptoms don't match our prototype for that disease.[3] This can be a fatal error for people who don't realize they are having a heart attack because their symptoms don't match their prototype for this condition.

We develop *concept hierarchies* to keep mental information organized. Consider our hierarchy for organizing food in our culture. We begin by learning basic concepts like bread and cake. From there, we identify more specific concepts that fit under each of the basic ones—bread includes white bread, French bread, and banana bread, and cake includes angel food cake, sheet cake, and cupcakes. Bread and cake, in turn, fit into the larger category of baked goods. Similarly, we can break the basic concepts of cheese and milk into more specific concepts (cheddar, skim) or lump them into a broader concept (dairy products). This organizational hierarchy, which we begin to build as we learn the basic concepts (bread, cake, cheese, and milk) as young children, helps us process information about food quickly and efficiently. Grocery stores organize their products to take advantage of our understanding of broad categories, such as frozen food and canned goods. We develop similar hierarchies to deal with concepts as diverse as tools, vehicles, and recreation (see **Figure 25.1**). Our brains have a strong tendency to keep information neat and tidy. Most of us organize our computer files in a similar fashion, with folders representing a few broad categories (school, music, pictures, and so on) each containing more folders with ever more specific topics. When you organize your computer's folders and files, you are creating a hierarchy. (I wonder why the one on my computer is less organized than the one in my head.)

When Is a Chair Not a Chair?
We are quicker to recognize the item on the left as a chair because it more closely resembles our prototype than does the beanbag chair on the right.

Purestock/Getty Images

Bambu Productions/Iconica/Getty Images

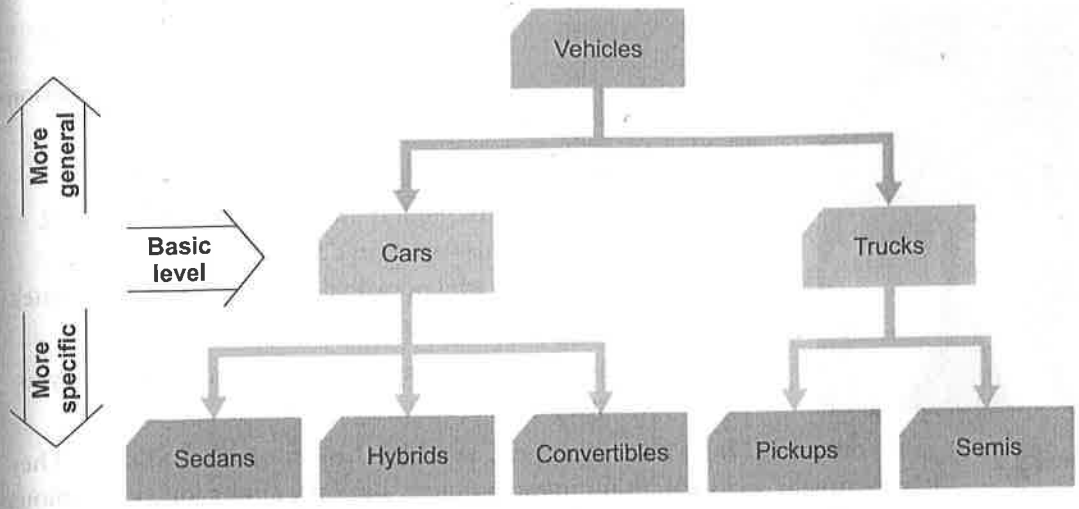


FIGURE 25.1
A Concept Hierarchy
Children use concept hierarchies to organize the world around them and learn about it. First, they master basic concepts (cars and trucks). Then, as their thinking becomes more sophisticated, they connect those basic concepts to both more general concepts (vehicles) and to more specific ones (hybrids).

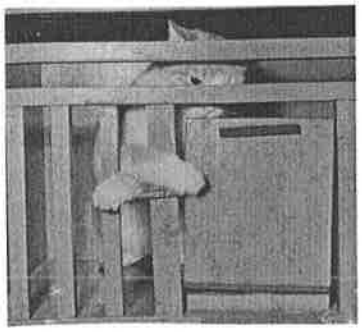
MAKE IT STICK!

1. True or False: Concepts are useful for organizing information, but using them is time consuming and slows down cognitive processes.
2. Which of the following is a prototype for the concept "bird"?
   a. ostrich
   b. emu
   c. penguin
   d. robin
3. A concept _____ organizes information into more general, basic, and specific levels.

Problem Solving

25-2 What roles do algorithms, heuristics, and insight play in the solution of problems?

Are there enough problems in your life? *Probably so.* Problems exist when something blocks you from achieving a desired outcome. If you need to get to school but are caught in traffic, that's a problem. If you want a B in your psychology class but are 30 points short, that's a problem. Problems can range from trivial (deciding which playlist to queue up) to serious (figuring out what path will allow you to achieve your career goals after graduating). We all have several strategies we apply when problems arise in our lives. Many of these strategies fall into the broad categories of algorithms and heuristics.



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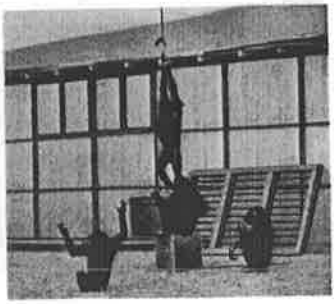

American Philosophical Society

Animals Are Problems Solvers, Too
Humans aren't the only ones who can solve problems. Many species of animals have demonstrated remarkable abilities to generate solutions when something blocks them from achieving a desired outcome. Two examples from the history of psychology are shown here. The photograph on the left shows a cat in a puzzle box designed by Edward Thorndike. Cats were able to complete a sequence of steps to open the door and gain access to food. On the right is Sultan, a chimpanzee studied by Wolfgang Köhler. Sultan, in a flash of insight, figured out he could stack the boxes and climb on them to reach a banana suspended from the top of his cage.

Krzysztof Kwiatkowski /istockphoto

Algorithms

An **algorithm** is a problem-solving strategy that guarantees a solution to a problem. Here are some examples of algorithms:

- Applying the formula length times height to determine the area of a rectangle. Many mathematical formulas are algorithms.
- Systematically trying every possible combination on someone's locker until you come across the correct one.
- Checking every shelf of every aisle in a grocery store until you find the Gatorade.

Algorithms and Heuristics
If your problem is to find a particular sports book as a gift for your younger brother, would you be better off systematically checking every book on every shelf—an algorithm—or starting in the sports section—a heuristic? If you're like me, you may even try another heuristic—asking for help.

As you can tell from these examples, algorithms are not always efficient. They may eventually yield a solution to the problem, but only after a long and tedious process. Knowing this, computer programmers may build algorithms into their software. The computers do the tedious work, and we benefit from the solutions.

Heuristics

A **heuristic** is a rule-of-thumb problem-solving strategy that makes a solution more likely but does not guarantee one. Here are some examples of heuristics:

- Using spelling rules such as *i* before *e* except after *c*.
- Checking the canned-goods section of a grocery store to find a particular brand of baked beans.

Heuristics are shortcuts. When they work, we are likely to reuse them the next time we need to save time and increase our mental efficiency in a similar situation. Unlike algorithms, however, there is no guarantee that a heuristic will produce a correct solution.

Insight

Have you ever spent time trying to figure out where you left your psychology book when—all of a sudden—it dawns on you that you left it on the counter by the refrigerator? Nice, right? These wonderfully rewarding moments are examples of **insight,** the sudden realization (Aha!) of a solution to a problem. Typically, the answer is just there, with no prior sense that it's about to appear.[4] Cartoons often express a moment of insight as a light bulb over a character's head. Insight is fun, satisfying, and one of the reasons most of us enjoy working on word jumbles and other types of mental puzzles—we experience a pleasing excitement when that answer pops into our head (see **Figure 25.2**). Researchers have discovered that the brain areas involved in insight are different from those involved in other kinds of problem solving.[5] Chimpanzees appear to share the ability to form insights with humans. In one classic study,[6] a chimp suddenly realized he could stack several boxes to form a platform from which he could reach bananas that had been suspended from the ceiling (see photo on page 383).

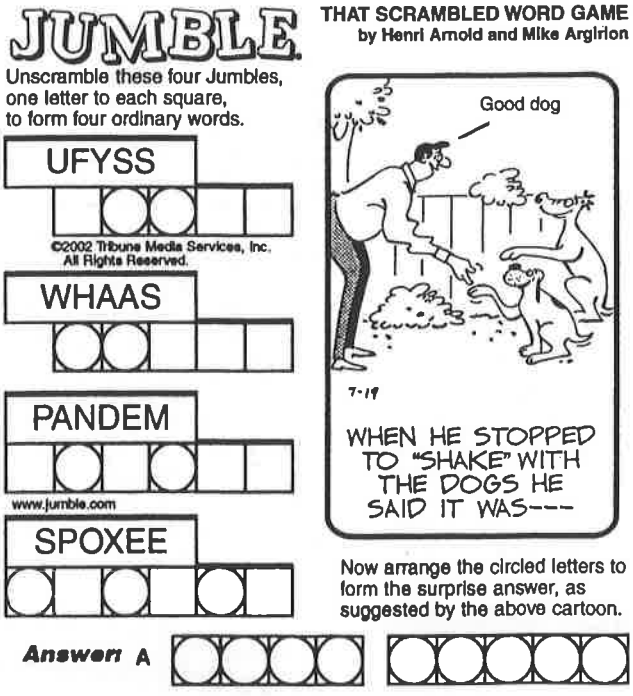

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FIGURE 25.2
Insight
Enjoy the "Aha!" as the solutions to these jumbled words pop into your head (turn the page for the answers).

MAKE IT STICK!

1. A(n) _____ for finding which key on a big key ring will start a car is to begin by eliminating all the keys that do not look like car keys.
2. A(n) _____ for finding which key on a big key ring will start a car is to systematically try each key in order until you find the one that fits.
3. Which of the following is an example of solving a problem by insight?
   a. Asking your friends to learn how they succeeded in a class with a difficult teacher.
   b. Unpacking your whole backpack to find a pen that you know for sure is in there.
   c. Trying several strategies to get your car unstuck from a snowbank.
   d. Suddenly realizing the perfect gift to get your mom for her birthday.

Problems Solving Problems

25-3 How can fixation, confirmation bias, and the use of heuristics, overconfidence, and framing influence the quality of our decisions?

algorithm A problem-solving strategy that guarantees the solution to a problem.

heuristic A rule-of-thumb problem-solving strategy that makes finding a solution more likely and efficient but does not guarantee a solution.

insight The sudden realization (Aha!) of the solution to a problem.

Have you ever had trouble estimating how long a school project will take? Have you ever struggled to find a substitute for a broken shoelace? A variety of normal tendencies can hinder our ability to solve such problems effectively. Many of them give us tunnel vision, preventing us from searching for alternatives that might offer terrific solutions. In this section, we look at five of these tendencies: fixation, confirmation bias, inappropriate use of heuristics, overconfidence, and framing. Knowing about these pitfalls will help you avoid them and become a more effective problem solver.

Fixation

mental set The tendency to approach a particular problem in a particular way.

fixation A mental set applied so rigidly that it hinders the solution of a problem.

We have a tendency, known as a **mental set,** to approach a particular problem in a particular way. Mental sets are often helpful because they are efficient and may lead to a rapid solution. Chess players, for example, may have a particular move they like to open with because they have learned it usually leads to a win. Mechanics often use a particular approach when diagnosing and repairing engine problems. Technical support team members learn mental sets to help them help customers with computer problems. They ask questions designed to focus on specific problems, usually beginning with basic, but sometimes overlooked, issues. ("Is the computer plugged in?")

Sometimes, however, a mental set can get in the way. Instead of becoming an efficient problem-solving strategy, it becomes a **fixation**—a mental set applied so rigidly that it hinders the solution to a problem. Have you heard the expression "thinking outside the box"? It implies breaking away from routine, conventional ways of thinking—away from your mental set. Even though these old ways of thinking may have worked in the past, something new and different may now be required. Henry Ford was able to see that cars could be mass-produced by having workers specialize in a single task as an assembly line brought each vehicle past them. By thinking outside the box, he was able to manufacture cars far more cheaply than he could have if a small team of individuals had built one car at a

Problem	Given jugs of these sizes A	B	C	Measure out this much water
1	21	127	3	100
2	14	46	5	22
3	18	43	10	5
4	7	42	6	23
5	20	57	4	29
6	23	49	3	20
7	15	39	3	18

FIGURE 25.3 The Luchins Water Jar Problem Can you measure out the amount of water in the right-hand column, using any of the three jars (A, B, and C) with volumes as shown in the middle column? A solution appears as Figure 25.6 on the next page. (Data from Luchins, 1946.)

functional fixedness The tendency to think of things only in terms of their usual functions.

time from the ground up. Ford revolutionized manufacturing by breaking free from old traditions. Can you break free from your own fixations? Find out by trying your hand at the puzzles in **Figures 25.3** and **25.4**. (Their solutions are in **Figures 25.6** and **25.7**.)

A special kind of fixation is known as **functional fixedness,** the tendency to think of things only in terms of their usual functions. What if you need to remove a screw, but you don't have access to a screwdriver? If you have trouble thinking of other things that can be used to perform this function, you are suffering from functional fixedness. However, if you are mentally flexible enough to realize that a coin, a butter knife, the edge of a credit card, or a paper clip (among many other items) can all be used as a substitute screwdriver, then you are good at overcoming functional fixedness. If there's no molasses for the cookies, a clever baker substitutes honey. If there's no bracket for a loose tailpipe, a clever mechanic substitutes a coat hanger. If there's no toilet paper in the supplies box, a clever camper substitutes a leaf (a solution employed long ago by a friend of mine, who, unfortunately, had never learned to identify poison ivy). Finding new uses for duct tape has produced a cult following. Ready for a functional fixedness challenge? See **Figure 25.5** (and **Figure 25.8** for the solution).

● Answers to Jumble puzzle in Figure 25.2: Fussy, awash, dampen, expose; A paws pause.

LIFE MATTERS

Charles Darwin said, "It's not the strongest of the species that survives, nor the most intelligent that survives. It is the one most adaptable to change." Those who are able to overcome functional fixedness,and other cognitive biases, are more likely to thrive personally and professionally.

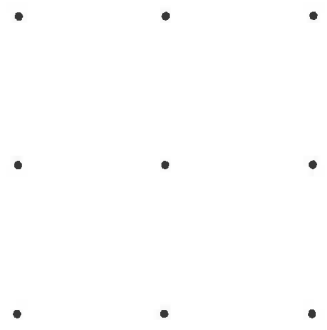


FIGURE 25.4 The Nine-Dot Problem Make a copy of this figure on a piece of scratch paper (*not* in this book, please!) and try to connect all nine dots with four straight lines without lifting your pen or pencil from the paper or retracing a line. A solution appears in Figure 25.7 on the next page.

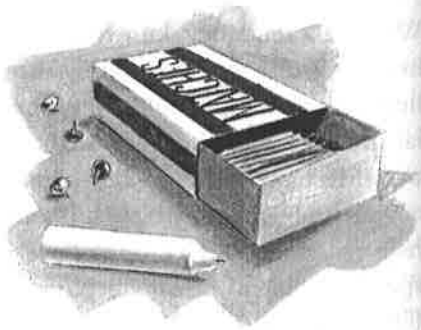
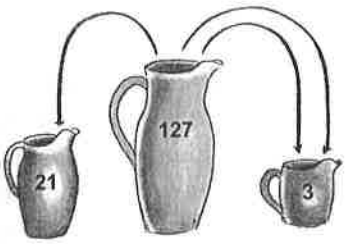
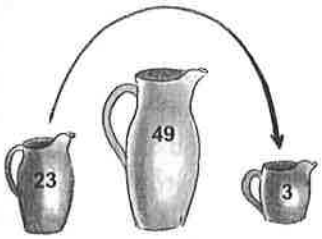


FIGURE 25.5 The Candle-Mounting Problem Can you think of a way to use these materials to mount the candle on a bulletin board? A solution appears in Figure 25.8 on the next page. (Data from Duncker, 1945.)



(Problem 1)



(Problem 6)

FIGURE 25.6
Solution to the Luchins Water Jar Problem
Problems 1 through 7 can all be solved by filling Jar B, then pouring off enough water to fill Jar A once and Jar C twice (desired volume = B – A – 2C). However, Problem 6 can be solved with a simpler formula (A – C), and so can Problem 7 (A + C). Many people miss these easy solutions because the mental set from the first several problems becomes fixated. Did your thinking stay flexible? (Data from Luchins, 1946.)

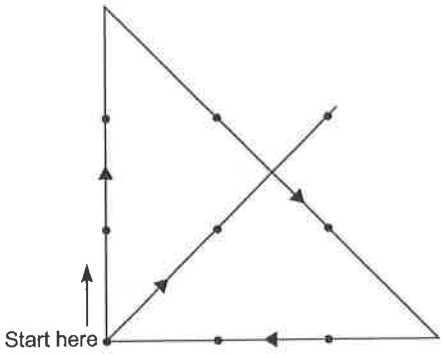


FIGURE 25.7
Solution to the Nine-Dot Problem
This problem literally requires you to "think outside the box." Only by leaving the square created by the outer dots can you solve the problem.

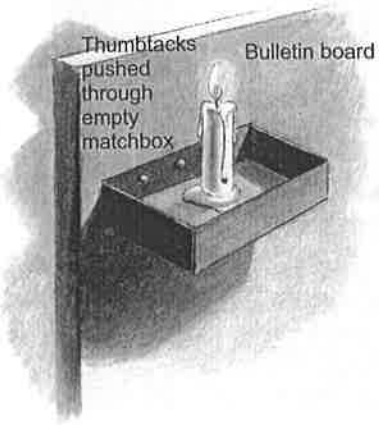


FIGURE 25.8
Solution to the Candle-Mounting Problem
If you could not imagine using the box as anything other than a container to hold matches, functional fixedness impaired your problem-solving ability. (Data from Duncker, 1945.)

confirmation bias The tendency to focus on information that supports preconceptions.

Confirmation Bias

Confirmation bias is our tendency to focus on information that supports our preconceptions. I had a student drop by one day because she was concerned about her grade in my class. She felt she must be doing better than the grade indicated. I sometimes make mistakes in calculating a student's grade, but in this case, the problem was hers. She was recalling accurately the quizzes on which she had done well, but she had forgotten several on which she had performed poorly at the beginning of the quarter. She knew she was a bright, capable student. This preconception made her more likely to notice (and remember) the quiz scores that confirmed this idea than the ones that refuted it. As a result, her own estimate of what her grade should be was inflated.

Confirmation bias can seriously affect juries in criminal trials. As testimony unfolds, each member of the jury begins to develop a hypothetical story to explain what happened. One juror may speculate, for example, that the defendant acted out of fear. From this point on, the juror will be more likely to notice testimony that supports this particular story and will be less likely to consider nonconfirming testimony. Once the testimony is complete and deliberations begin, the assembled jury is often surprised to learn that various members have generated (and confirmed) several different stories during the trial.[7,8]

moodboard/Brand X Pictures/Getty Images

Confirmation Bias
As testimony unfolds, each member of this jury will develop a personal story to explain the crime and will then focus more on the evidence that supports that personal story. When the jury meets later to deliberate, the jurors may be surprised to discover how individual their stories are and how different pieces of evidence and testimony stood out as a result.

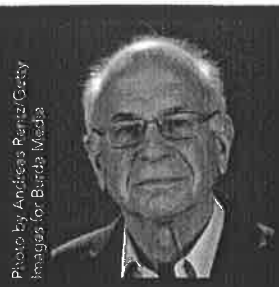


Photo by Andreas Rentz/Getty Images for Bunte Media

DANIEL KAHNEMAN (1934–) Psychologist who, along with Amos Tversky, conducted research to discover factors that influence human judgment and decision making. He won the Nobel Prize in 2002 for this work.

Counterproductive Heuristics

"Look before you leap." "A stitch in time saves nine." "Don't judge a book by its cover." No doubt you've been hearing expressions such as these since you were little. Such statements are designed to lead you to better decisions and judgment. Your elders wanted to give you guidelines that would help you survive and thrive in the world. These guidelines qualify as *heuristics,* the quick rule-of-thumb problem-solving strategies we discussed earlier.

We all regularly use heuristics to get through the countless decisions we must make each day. Sometimes, however, our brain can fall into the trap of using seemingly helpful heuristics that actually lead us to inaccurate or harmful decisions. Amos Tversky and **Daniel Kahneman** identified several counterproductive heuristics.[9] One is the **availability heuristic,** which estimates the likelihood of events based on their availability in our memory. Information that is readily available in our memory can indeed be a good indicator that an event is likely. When I hear thunder, I am quick to assume that rain will follow because I have many instances available in my memory when thunder signaled rain. Sometimes, however, the information available in memory is not such a good indicator.

availability heuristic Estimating the likelihood of events based on their availability in memory.

The lottery commission in my state of Iowa intentionally uses the availability heuristic to influence people's judgment of their likelihood of winning. The commission does this by running ads and commercials featuring the gleeful winners. Often these winners are holding huge million-dollar cardboard checks and talking about the wonderful ways in which the money will improve their lives. These images are readily available in viewers' memories when they next think about playing the lottery. ("Big winners must be common because we see them on TV all the time!") Unfortunately, the commission does not show an equal number of dramatic images of those in a much more common category—lottery losers. As a result, many people greatly overestimate their chances of winning, which encourages them to play more than they otherwise would have. In these cases, the availability heuristic has clouded people's judgment.

Susan Watts/The Daily News via AP Images

Availability Heuristic Available images can distort our thinking. Many people buy lottery tickets regularly because images such as this one lead them to believe winning big is more likely than it actually is.

Kahneman's work with Tversky on how such cognitive factors influence judgment led to a Nobel Prize in 2002. It helps us explain how media coverage of plane crashes or shark attacks can lead us to overestimate the frequency with which these events occur. In circumstances like this, our reasoning is based more on our emotions and less on statistical probability.[10]

Overconfidence

Every student is familiar with the sinking feeling of getting a test back where you haven't done as well as you thought you had. People often overestimate the likelihood that they are correct. **Overconfidence** occurs when our confidence is greater than our accuracy. One study asked participants to estimate answers to factual questions by completing such statements as "I feel 98 percent certain that the population of New Zealand is more than _____ but less than _____." Did the instruction to be 98 percent certain produce answers that were correct 98 percent of the time? Not even close. People were able to "trap" the correct answer—3.7 million people—only two-thirds of the time. The gap between certainty (98 percent) and accuracy (66 percent) was nicely concealed by overconfidence.[11] Even when participants are 100 percent certain of their answers, they are right only 85 percent of the time.[12]

overconfidence Confidence that is greater than accuracy.

It's not just experiments that produce overconfidence. Decisions tainted by overconfidence work their way into everyday life regularly. A friend of mine, the late psychologist Charles Brewer, often reminded people that "everything takes longer than it takes" to help dampen the frustration borne of overconfident planning. One study showed that students typically took twice as many days to complete a project as they originally predicted.[13] I can relate. The writing I'm doing on this module tonight is taking much longer than I anticipated.

Why do so many of us appear programmed to make false, overconfident judgments so regularly? It may be a way to protect our well-being. Overconfidence is associated with happiness and making tough decisions more easily.[14,15] The overconfidence allows us to think everything will work out, and belief in our own judgment can keep us from fretting and stewing about things.

Framing

Framing is the way we word or present an issue, and it can profoundly affect judgment. Framing the same issue in two different ways can produce two different results. Consider these two statements:

framing How an issue is worded or presented, which can influence decisions and judgments.

1. Condoms have a 95 percent success rate in preventing the spread of HIV, the virus that causes AIDS.
2. Condoms have a 5 percent failure rate in preventing the spread of HIV, the virus that causes AIDS.

The two statements are equally true, yet 90 percent of college students who read only the first statement rated condoms as effective. Only 40 percent did so after reading the second statement.[16]

Can you imagine what would happen if ground beef were marketed as 20 percent fat instead of 80 percent lean? What if a surgeon bragged about a 2 percent death rate, rather than a 98 percent success rate? Framing makes a difference.

We can all make better decisions. Part of making that happen is to be aware of how fixation, confirmation bias, the use of heuristics, overconfidence, and framing can get in the way. You can work hard to identify and minimize these factors in your own life. The next time an exasperated parent or teacher exhorts you to think! you can honestly reply that you are thinking. To be human is to think. We hope this module has provided you with some ideas not for thinking more but for thinking better.

MAKE IT STICK!

1. Some people overestimate the odds of shark attacks because when shark attacks do occur, they are widely publicized. This illustrates a counterproductive aspect of
   a. the prototype effect.
   b. framing.
   c. the availability heuristic.
   d. confirmation bias.
2. Attending a political debate and only remembering statements from the candidates you agree with is an example of
   a. confirmation bias.
   b. framing.
   c. overconfidence.
   d. the availability heuristic.
3. True or False: Overconfidence can lead you to underestimate the time you need to complete a school project.
4. If I don't realize that the edge of my school ID card can be used to scrape frost from my windshield, I am experiencing _____.