Module 35

Solving Problems and Making Decisions

Mike Cohea/Brown University

Module Learning Objectives

35-1 Describe the cognitive strategies that assist our problem solving, and identify the obstacles that hinder it.

35-2 Explain what is meant by intuition, and describe how the representativeness and availability heuristics, overconfidence, belief perseverance, and framing influence our decisions and judgments.

35-3 Describe how smart thinkers use intuition.

Problem Solving: Strategies and Obstacles

35-1 What cognitive strategies assist our problem solving, and what obstacles hinder it?

One tribute to our rationality is our problem-solving skill. What's the best route around this traffic jam? How should we handle a friend's criticism? How can we get in the house without our keys?

Some problems we solve through *trial and error.* Thomas Edison tried thousands of light bulb filaments before stumbling upon one that worked. For other problems, we use **algorithms,** step-by-step procedures that guarantee a solution. But step-by-step algorithms can be laborious and exasperating. To find a word using the 10 letters in *SPLOYOCHYG,* for example, you could try each letter in each of the 10 positions—907,200 permutations in all. Rather than give you a computing brain the size of a beach ball, nature resorts to **heuristics,** simpler thinking strategies. Thus, you might reduce the number of options in the *SPLOYOCHYG* example by grouping letters that often appear together (*CH* and *GY*) and excluding rare letter combinations (such as two Y's together). By using heuristics and then applying trial and error, you may hit on the answer. Have you guessed it?[1]

Sometimes, no problem-solving strategy seems to be at work at all, and we arrive at a solution to a problem with **insight**. Teams of researchers have identified brain activity associated with sudden flashes of insight (Kounios & Beeman, 2009; Sandkühler & Bhattacharya, 2008). They gave people a problem: Think of a word that will form a compound word or phrase with each of three other words in a set (such as *pine, crab,* and *sauce*), and press a button to sound a bell when you know the answer. (If you need a hint: The word is a fruit.[2]) EEGs or fMRIs (functional MRIs) revealed the problem solver's brain activity.

[1] Answer to SPLOYOCHYG anagram: PSYCHOLOGY.
[2] The word is apple: pineapple, crabapple, applesauce.

AP® Exam Tip

There are several sample problems for you to enjoy in this section. It can be very interesting to ask several of your friends to try to solve them, too. Have them talk through the problem out loud and you will gain some understanding of the processes they are using.

algorithm a methodical, logical rule or procedure that guarantees solving a particular problem. Contrasts with the usually speedier—but also more error-prone—use of *heuristics.*

heuristic a simple thinking strategy that often allows us to make judgments and solve problems efficiently; usually speedier but also more error-prone than *algorithms.*

insight a sudden realization of a problem's solution; contrasts with strategy-based solutions.

Heuristic searching To search for hot cocoa mix, you could search every supermarket aisle (an algorithm), or check the breakfast, beverage, and baking supplies sections (heuristics). The heuristics approach is often speedier, but an algorithmic search guarantees you will find it eventually.

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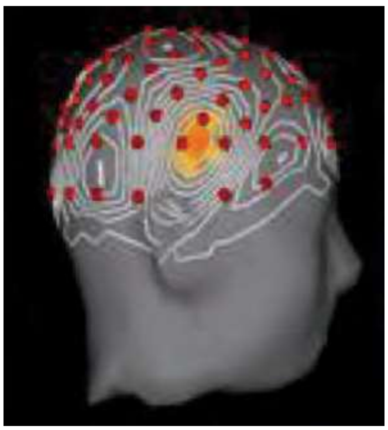


From Mark Jung-Beeman, Northwestern University and John Kounios, Drexel University

Figure 35.1

The Aha! moment A burst of right temporal lobe activity accompanied insight solutions to word problems (Jung-Beeman et al., 2004). The red dots designate EEG electrodes. The light gray lines show the distribution of high-frequency activity accompanying insight. The insight-related activity is centered in the right temporal lobe (yellow area).

In the first experiment, about half the solutions were by a sudden Aha! insight. Before the Aha! moment, the problem solvers' frontal lobes (which are involved in focusing attention) were active, and there was a burst of activity in the right temporal lobe, just above the ear (**FIGURE 35.1**).

We are also not the only creatures to display insight, as psychologist Wolfgang Köhler (1925) demonstrated in an experiment with Sultan, a chimpanzee. Köhler placed a piece of fruit and a long stick outside Sultan's cage. Inside the cage, he placed a short stick, which Sultan grabbed, using it to try to reach the fruit. After several failed attempts, he dropped the stick and seemed to survey the situation. Then suddenly, as if thinking "Aha!" Sultan jumped up and seized the short stick again. This time, he used it to pull in the longer stick—which he then used to reach the fruit. What is more, apes will even exhibit foresight, by storing a tool they can use to retrieve food the next day (Mulcahy & Call, 2006).

Insight strikes suddenly, with no prior sense of "getting warmer" or feeling close to a solution (Knoblich & Oellinger, 2006; Metcalfe, 1986). When the answer pops into mind *(apple!)*, we feel a happy sense of satisfaction. The joy of a joke may similarly lie in our sudden comprehension of an unexpected ending or a double meaning: "You don't need a parachute to skydive. You only need a parachute to skydive twice."

Inventive as we are, other cognitive tendencies may lead us astray. For example, we more eagerly seek out and favor evidence verifying our ideas than evidence refuting them (Klayman & Ha, 1987; Skov & Sherman, 1986). Peter Wason (1960) demonstrated this tendency, known as **confirmation bias,** by giving British university students the three-number sequence 2-4-6 and asking them to guess the rule he had used to devise the series. (The rule was simple: any three ascending numbers.) Before submitting answers, students generated their own three-number sets and Wason told them whether their sets conformed to his rule. Once *certain* they had the rule, they could announce it. The result? Seldom right but never in doubt. Most students formed a wrong idea *("Maybe it's counting by twos")* and then searched only for confirming evidence (by testing 6-8-10, 100-102-104, and so forth).

confirmation bias a tendency to search for information that supports our preconceptions and to ignore or distort contradictory evidence.

"Ordinary people," said Wason (1981), "evade facts, become inconsistent, or systematically defend themselves against the threat of new information relevant to the issue." Thus, once people form a belief—that vaccines cause autism spectrum disorder, that President Barack Obama is a Kenyan-born Muslim, that gun control does (or does not) save lives—they prefer belief-confirming information. The results can be momentous. The U.S. war against Iraq was launched on the belief that Saddam Hussein possessed weapons of mass destruction (WMD) that posed an immediate threat. When that assumption turned out to be false, the bipartisan U.S. Senate Select Committee on Intelligence (2004) identified confirmation bias as partly to blame: Administration analysts "had a tendency to accept information which supported [their presumptions] . . . more readily than information which contradicted" them. Sources denying such weapons were deemed "either lying or

"The human understanding, when any proposition has been once laid down . . . forces everything else to add fresh support and confirmation." -Francis Bacon, *Novum Organum*, 1620 not knowledgeable about Iraq's problems," while those sources who reported ongoing WMD activities were seen as "having provided valuable information."

Once we incorrectly represent a problem, it's hard to restructure how we approach it. If the solution to the matchstick problem in **FIGURE 35.2** eludes you, you may be experiencing *fixation*—an inability to see a problem from a fresh perspective. (For the solution, turn the page to see **FIGURE 35.3**.)

A prime example of fixation is **mental set,** our tendency to approach a problem with the mind-set of what has worked for us previously. Indeed, solutions that worked in the past often do work on new problems. Consider:

Given the sequence *O-T-T-F-?-?-?,* what are the final three letters?

Most people have difficulty recognizing that the three final letters are *F*(ive), *S*(ix), and *S*(even). But solving this problem may make the next one easier:

Given the sequence *J-F-M-A-?-?-?,* what are the final three letters? (If you don't get this one, ask yourself what month it is.)

As a perceptual set predisposes what we perceive, a mental set predisposes how we think; sometimes this can be an obstacle to problem solving, as when our mental set from our past experiences with matchsticks predisposes us to arrange them in two dimensions.

Figure 35.2
The matchstick problem How would you arrange six matches to form four equilateral triangles?

B. Veley

"The problem is I can't tell the difference between a deeply wise, intuitive nudge from the Universe and one of my own bone-headed ideas!"

Forming Good and Bad Decisions and Judgments

35-2 What is intuition, and how can the representativeness and availability heuristics, overconfidence, belief perseverance, and framing influence our decisions and judgments?

When making each day's hundreds of judgments and decisions *(Is it worth the bother to take a jacket? Can I trust this person? Should I shoot the basketball or pass to the player who's hot?),* we seldom take the time and effort to reason systematically. We just follow our **intuition,** our fast, automatic, unreasoned feelings and thoughts. After interviewing policy makers in government, business, and education, social psychologist Irving Janis (1986) concluded that they "often do not use a reflective problem-solving approach. How do they usually arrive at their decisions? If you ask, they are likely to tell you . . . they do it mostly by *the seat of their pants.*"

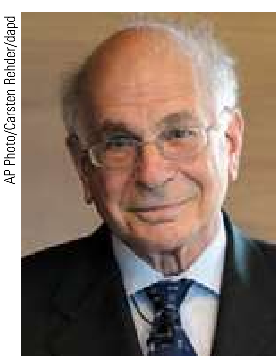
When we need to act quickly, the mental shortcuts we call *heuristics* enable snap judgments. Thanks to our mind's automatic information processing, intuitive judgments are instantaneous and usually effective. However, research by cognitive psychologists Amos Tversky and Daniel Kahneman (1974) on the *representativeness* and *availability heuristics* showed how these generally helpful shortcuts can lead even the smartest people into dumb decisions.[3]

"Kahneman and his colleagues and students have changed the way we think about the way people think." -American Psychological Association President, Sharon Brehm, 2007

[3] Tversky and Kahneman's joint work on decision making received a 2002 Nobel Prize; sadly, only Kahneman was alive to receive the honor.

"In creating these problems, we didn't set out to fool people. All our problems fooled us, too." Amos Tversky (1985)

AP Photo/Carsten Rehder/dapd



"Intuitive thinking [is] fine most of the time. . . . But sometimes that habit of mind gets us in trouble." Daniel Kahneman (2005)

mental set a tendency to approach a problem in one particular way, often a way that has been successful in the past.

intuition an effortless, immediate, automatic feeling or thought, as contrasted with explicit, conscious reasoning.

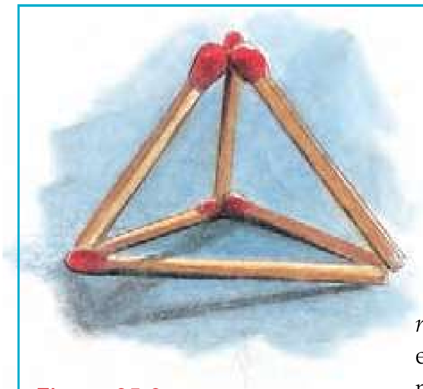


Figure 35.3

Solution to the matchstick problem To solve this problem, you must view it from a new perspective, breaking the fixation of limiting solutions to two dimensions.

The Representativeness Heuristic

To judge the likelihood of things in terms of how well they represent particular prototypes is to use the **representativeness heuristic.** To illustrate, consider:

> A stranger tells you about a person who is short, slim, and likes to read poetry, and then asks you to guess whether this person is more likely to be a professor of classics at an Ivy League university or a truck driver (adapted from Nisbett & Ross, 1980). Which would be the better guess?

Did you answer "professor"? Many people do, because the description seems more *representative* of Ivy League scholars than of truck drivers. The representativeness heuristic enabled you to make a snap judgment. But it also led you to ignore other relevant information. When I help people think through this question, the conversation goes something like this:

Question: First, let's figure out how many professors fit the description. How many Ivy League universities do you suppose there are?

Answer: Oh, about 10, I suppose.

Question: How many classics professors would you guess there are at each?

Answer: Maybe 4.

Question: Okay, that's 40 Ivy League classics professors. What fraction of these are short and slim?

Answer: Let's say half.

Question: And, of these 20, how many like to read poetry?

Answer: I'd say half—10 professors.

Question: Okay, now let's figure how many truck drivers fit the description. How many truck drivers do you suppose there are?

Answer: Maybe 400,000.

Question: What fraction are short and slim?

Answer: Not many—perhaps 1 in 8.

Question: Of these 50,000, what percentage like to read poetry?

Answer: Truck drivers who like poetry? Maybe 1 in 100—oh, oh, I get it— that leaves 500 short, slim, poetry-reading truck drivers.

Comment: Yup. So, even if we accept your stereotype that the description is more representative of classics professors than of truck drivers, the odds are 50 to 1 that this person is a truck driver.

The representativeness heuristic influences many of our daily decisions. To judge the likelihood of something, we intuitively compare it with our mental representation of that category—of, say, what truck drivers are like. If the two match, that fact usually overrides other considerations of statistics or logic.

representativeness heuristic judging the likelihood of things in terms of how well they seem to represent, or match, particular prototypes; may lead us to ignore other relevant information.

availability heuristic estimating the likelihood of events based on their availability in memory; if instances come readily to mind (perhaps because of their vividness), we presume such events are common.

The Availability Heuristic

The **availability heuristic** operates when we estimate the likelihood of events based on how mentally available they are. Casinos entice us to gamble by signaling even small wins with bells and lights—making them vividly memorable—while keeping big losses soundlessly invisible.

The availability heuristic can lead us astray in our judgments of other people, too. Anything that makes information "pop" into mind—its vividness, recency, or distinctiveness—can make it seem commonplace. If someone from a particular ethnic or religious group commits a terrorist act, as happened on September 11, 2001, when Islamic extremists killed nearly 3000 people in the United States in coordinated terrorist attacks, our readily available memory of the dramatic event may shape our impression of the whole group.

Even during that horrific year, terrorist acts claimed comparatively few lives. Yet when the statistical reality of greater dangers (see **FIGURE 35.4**) was pitted against a single vivid case, the memorable case won, as emotion-laden images of terror exacerbated our fears (Sunstein, 2007).

We often fear the wrong things. We fear flying because we play in our heads some air disaster. We fear letting our children walk to school because we play in our heads tapes of abducted and brutalized children. We fear swimming in ocean waters because we replay *Jaws* in our heads. Even just passing by a person who sneezes and coughs heightens our perceptions of various health risks (Lee et al., 2010). And so, thanks to these readily available images, we come to fear extremely rare events. (Turn the page to see Thinking Critically About: The Fear Factor—Why We Fear the Wrong Things.)

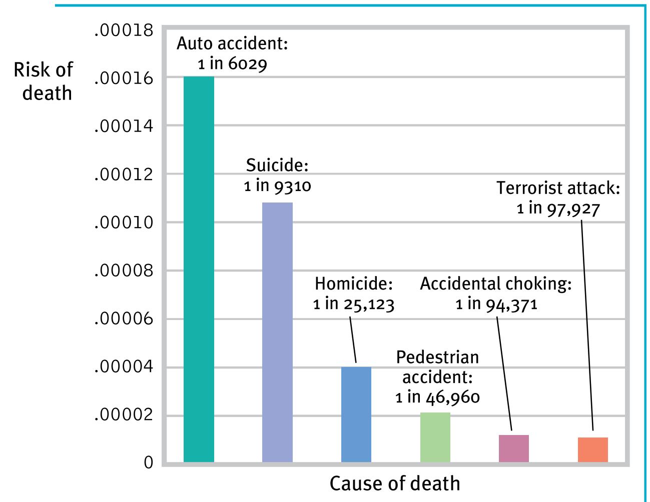


Figure 35.4
Risk of death from various causes in the United States, 2001 (Data assembled from various government sources by Randall Marshall et al., 2007.)

Meanwhile, the lack of comparably available images of global climate change—which some scientists regard as a future "Armageddon in slow motion"—has left most people little concerned (Pew, 2007). The vividness of a recent local cold day reduces their concern about long-term global warming and overwhelms less memorable scientific data (Li et al., 2011). Dramatic outcomes make us gasp; probabilities we hardly grasp. As of 2013, some 60 nations—including Canada, many in Europe, and the United States—have, however, sought to harness the positive power of vivid, memorable images by putting eye-catching warnings and graphic photos on cigarette packages (Riordan, 2013). This campaign may work, where others have failed. As psychologist Paul Slovic (2007) points out, we reason emotionally and neglect probabilities. We overfeel and underthink. In one experiment, donations to a starving 7-year-old child were greater when her image was *not* accompanied by statistical information about the millions of needy African children like her (Small et al., 2007). "If I look at the mass, I will never act," Mother Teresa reportedly said. "If I look at the one, I will." "The more who die, the less we care," noted Slovic (2010).

Overconfidence

Sometimes our judgments and decisions go awry simply because we are more confident than correct. Across various tasks, people overestimate their performance (Metcalfe, 1998). If 60 percent of people correctly answer a factual question, such as "Is absinthe a liqueur or a precious stone?," they will typically average 75 percent confidence (Fischhoff et al., 1977). (It's a licorice-flavored liqueur.) This tendency to overestimate the accuracy of our knowledge and judgments is **overconfidence.**

overconfidence the tendency to be more confident than correct—to overestimate the accuracy of our beliefs and judgments.

It was an overconfident BP that, before its exploded drilling platform spewed oil into the Gulf of Mexico, downplayed safety concerns, and then downplayed the spill's magnitude (Mohr et al., 2010; Urbina, 2010). It is overconfidence that drives stockbrokers and investment managers to market their ability to outperform stock market averages, despite overwhelming evidence to the contrary (Malkiel, 2004). A purchase of stock X, recommended by a broker who judges this to be the time to buy, is usually balanced by a sale made by someone who judges this to be the time to sell. Despite their confidence, buyer and seller cannot both be right.

History is full of leaders who were more confident than correct. And classrooms are full of overconfident students who expect to finish assignments and write papers ahead of schedule (Buehler et al., 1994). In fact, the projects generally take about twice the number of days predicted.

"Don't believe everything you think." -Bumper sticker

Thinking Critically About

The Fear Factor—Why We Fear the Wrong Things

After the 9/11 attacks, many people feared flying more than driving. In a 2006 Gallup survey, only 40 percent of Americans reported being "not afraid at all" to fly. Yet from 2005 to 2007 Americans were—mile for mile—170 times more likely to die in an automobile or pickup truck crash than on a scheduled flight (National Safety Council, 2010). In 2009 alone, 33,808 Americans were killed in motor vehicle accidents—that's 650 dead people each week. Meanwhile, in 2009 (as in 2007 and 2008) zero died from airline accidents on scheduled flights.

In a late 2001 essay, I calculated that if—because of 9/11—we flew 20 percent less and instead drove half those unflown miles, about 800 more people would die in the year after 9/11 (Myers, 2001). German psychologist Gerd Gigerenzer (2004, 2006) later checked this estimate against actual accident data. (Why didn't I think of that?) U.S. traffic deaths did indeed increase significantly in the last three months of 2001 (**FIGURE 35.5**). By the end of 2002, Gigerenzer estimated, 1600 Americans had "lost their lives on the road by trying to avoid the risk of flying." Despite our greater fear of flying, flying's greatest danger is, for most people, the drive to the airport.

Why do we fear the wrong things? Why do we judge terrorism to be a greater risk than accidents? Psychologists have identified four influences that feed fear and cause us to ignore higher risks.

1. *We fear what our ancestral history has prepared us to fear.* Human emotions were road tested in the Stone Age. Our old brain prepares us to fear yesterday's risks: snakes, lizards, and spiders (which combined now kill a tiny fraction of the number killed by modern-day threats, such as cars and cigarettes). Yesterday's risks also prepare us to fear confinement and heights, and therefore flying.
2. *We fear what we cannot control.* Driving we control; flying we do not.
3. *We fear what is immediate.* The dangers of flying are mostly telescoped into the moments of takeoff and landing. The dangers of driving are diffused across many moments to come, each trivially dangerous.
4. *Thanks to the availability heuristic, we fear what is most readily available in memory.* Powerful, vivid images, like that of United Flight 175 slicing into the World Trade Center, feed our judgments of risk. Thousands of safe car trips have extinguished our anxieties about driving. Similarly, we remember (and fear) widespread disasters (hurricanes, tornadoes, earthquakes) that kill people dramatically, in bunches. But we fear too little the less dramatic threats that claim lives quietly, one by one, continuing into the distant future. Bill Gates has noted that each year a half-million children worldwide die from rotavirus. This is the equivalent of four 747s full of children *every day,* and we hear nothing of it (Glass, 2004).

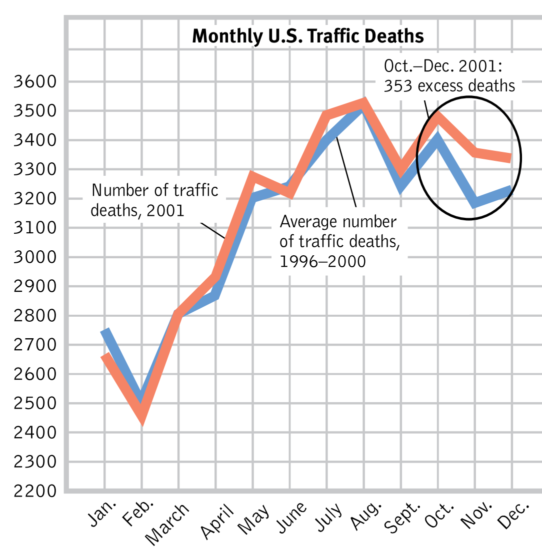


Figure 35.5
Scared onto deadly highways Images of 9/11 etched a sharper image in American minds than did the millions of fatality-free flights on U.S. airlines during 2002 and after. Dramatic events are readily available to memory, and they shape our perceptions of risk. In the three months after 9/11, those faulty perceptions led more Americans to travel, and some to die, by car. (Adapted from Gigerenzer, 2004.)

Thinking Critically About *(continued)*

Ian Berry/Magnum Photos

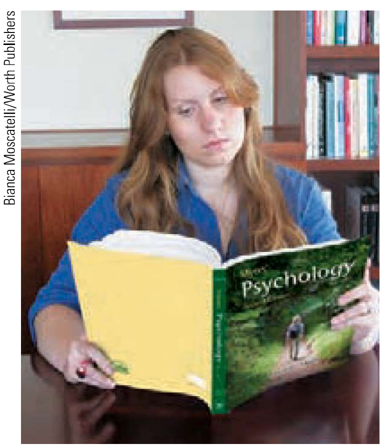
Dramatic deaths in bunches breed concern and fear The memorable Haitian earthquake that killed some 250,000 people stirred an outpouring of justified concern. Meanwhile, according to the World Health Organization, a silent earthquake of poverty-related malaria was killing about that many people, mostly in Africa, every four months.

The news, and our own memorable experiences, can make us disproportionately fearful of infinitesimal risks. As one risk analyst explained, "If it's in the news, don't worry about it. The very definition of *news* is 'something that hardly ever happens'" (Schneier, 2007). Despite people's fear of dying in a terrorist attack on an airplane, the last decade produced one terrorist attempt for every 10.4 million flights—less than one-twentieth the chance of any one of us being struck by lightning (Silver, 2009).

> "Fearful people are more dependent, more easily manipulated and controlled, more susceptible to deceptively simple, strong, tough measures and hard-line postures." -Media researcher George Gerbner to U.S. Congressional Subcommittee on Communications, 1981

The point to remember: It is perfectly normal to fear purposeful violence from those who wish us harm. When terrorists strike again, we will all recoil in horror. But smart thinkers will check their fears against the facts and resist those who aim to create a culture of fear. By so doing, we take away the terrorists' most omnipresent weapon: exaggerated fear.

Anticipating how much we will accomplish, we also overestimate our future leisure time (Zauberman & Lynch, 2005). Believing we will have more time next month than we do today, we happily accept invitations and assignments, only to discover we're just as busy when the day rolls around. Failing to appreciate our potential for error and believing we will have more money next year, we take out loans or buy on credit. Despite our painful underestimates, we remain overly confident of our next prediction.



Bianca Moscatelli/Worth Publishers

Predict your own behavior When will you finish reading this module?

Overconfidence can have adaptive value. People who err on the side of overconfidence live more happily. They make tough decisions more easily, and they seem more credible than others (Baumeister, 1989; Taylor, 1989). Moreover, given prompt and clear feedback, as weather forecasters receive after each day's predictions, people can learn to be more realistic about the accuracy of their judgments (Fischhoff, 1982). The wisdom to know when we know a thing and when we do not is born of experience.

belief perseverance clinging to one's initial conceptions after the basis on which they were formed has been discredited.

Belief Perseverance

Our overconfidence in our judgments is startling; equally startling is our tendency to cling to our beliefs in the face of contrary evidence. **Belief perseverance** often fuels social conflict, as it did in a classic study of people with opposing views of capital punishment (Lord et al., 1979). Each side studied two supposedly new research findings, one supporting and the other refuting the claim that the death penalty deters crime. Each side was more impressed by the study supporting its own beliefs, and each readily disputed the other study. Thus, showing the pro- and anti-capital-punishment groups the *same* mixed evidence actually *increased* their disagreement.

> "When you know a thing, to hold that you know it; and when you do not know a thing, to allow that you do not know it; this is knowledge." -Confucius (551–479 B.C.E.), *Analects*

If you want to rein in the belief perseverance phenomenon, a simple remedy exists: *Consider the opposite.* When the same researchers repeated the capital-punishment study, they asked some participants to be "as *objective* and *unbiased* as possible" (Lord et al., 1984). The plea did nothing to reduce biased evaluations of evidence. They asked another group to consider "whether you would have made the same high or low evaluations had exactly the same study produced results on the *other* side of the issue." Having imagined and pondered *opposite* findings, these people became much less biased in their evaluations of the evidence.

The more we come to appreciate why our beliefs might be true, the more tightly we cling to them. Once we have explained to ourselves why we believe a child is "gifted" or has a "specific learning disorder," or why candidate X or Y will be a better commander-in-chief, or why company Z makes a product worth owning, we tend to ignore evidence undermining our belief. Prejudice persists. As we will see in Unit XIV, once beliefs form and are justified, it takes more compelling evidence to change them than it did to create them.

"I'm happy to say that my final judgment of a case is almost always consistent with my prejudgment of the case."

The Effects of Framing

Framing, the way we present an issue, sways our decisions and judgments. Imagine two surgeons explaining a surgery risk. One tells patients that 10 percent of people die during this surgery. The other tells patients that 90 percent will survive. The information is the same. The effect is not. In surveys, both patients and physicians said the risk seems greater when they hear that 10 percent will *die* (Marteau, 1989; McNeil et al., 1988; Rothman & Salovey, 1997). Similarly, 9 in 10 college students rated a condom as effective if told it had a supposed "95 percent success rate" in stopping the HIV virus. Only 4 in 10 judged it effective when told it had a "5 percent failure rate" (Linville et al., 1992). To scare people, frame risks as numbers, not percentages. People told that a chemical exposure is projected to kill 10 of every 10 million people (imagine 10 dead people!) feel more frightened than if told the fatality risk is an infinitesimal .000001 (Kraus et al., 1992).

framing the way an issue is posed; how an issue is framed can significantly affect decisions and judgments.

Framing can be a powerful persuasion tool. Carefully posed options can nudge people toward decisions that could benefit them or society as a whole (Thaler & Sunstein, 2008).

- *Why choosing to be an organ donor depends on where you live.* In many European countries as well as the United States, people can decide whether they want to be organ donors when renewing their driver's license. In some countries, the default option is *Yes,* but people can opt out. Nearly 100 percent of the people in opt-out countries agree to be donors. In the United States, Britain, and Germany, the default option is *No,* but people can "opt in." There, only about 25 percent agree to be donors (Johnson & Goldstein, 2003).
- *How to help employees decide to save for their retirement.* A 2006 U.S. pension law recognized the framing effect. Before that law, employees who wanted to contribute to a 401(k) retirement plan typically had to choose a lower take-home pay, which few people will do. Companies can now automatically enroll their employees in the plan but allow them to opt out (which would raise the employees' take-home pay). In both plans, the decision to contribute is the employee's. But under the new "opt-out" arrangement, enrollments in one analysis of 3.4 million workers soared from 59 to 86 percent (Rosenberg, 2010).
- *How to help save the planet.* Some psychologists are asking: With the climate warming, but concerns lessening among the British and Americans, are there better ways to frame these issues (Krosnick, 2010; Rosenthal, 2010)? For example, although a "carbon tax" may be the most effective way to curb greenhouse gases, many people oppose new taxes. But they are more supportive of funding energy development or carbon capture with a "carbon offset" fee (Hardisty et al., 2010).

The point to remember: Those who understand the power of framing can use it to influence our decisions.

The Perils and Powers of Intuition

35-3 How do smart thinkers use intuition?

We have seen how our irrational thinking can plague our efforts to see problems clearly, make wise decisions, form valid judgments, and reason logically. Moreover, these perils of intuition feed gut fears and prejudices. And they persist even when people are offered extra pay for thinking smart, even when they are asked to justify their answers, and even when they are expert physicians or clinicians (Shafir & LeBoeuf, 2002). So, are our heads indeed filled with straw?

Good news: Cognitive scientists are also revealing intuition's powers. Here is a summary of some of the high points:

- *Intuition is huge.* Recall from Module 16 that through *selective attention,* we can focus our conscious awareness on a particular aspect of all we experience. Our mind's unconscious track, however, makes good use intuitively of what we are not consciously processing. Today's cognitive science offers many examples of unconscious influences on our judgments (Custers & Aarts, 2010). Consider: Most people guess that the more complex the choice, the smarter it is to make decisions rationally rather than intuitively (Inbar et al., 2010). Actually, Dutch psychologists have shown that in making complex decisions, we benefit by letting our brain work on a problem without thinking about it (Strick et al., 2010). In one series of experiments, they showed three groups of people complex information (about apartments or roommates or art posters or soccer football matches). They invited one group to state their preference immediately after reading information about each of four options. A second group, given several minutes to analyze the information, made slightly smarter decisions. But wisest of all, in study after study, was the third group, whose attention was distracted for a time, enabling their minds to process the complex information unconsciously. Critics of this research remind us that deliberate, conscious thought also is part of smart thinking (Gonzáles-Vallejo et al., 2008; Lassiter et al., 2009; Newell et al., 2008; Payne et al., 2008). Nevertheless, letting a problem "incubate" while we attend to other things can pay dividends (Sio & Ormerod, 2009). Facing a difficult decision involving lots of facts, we're wise to gather all the information we can, and then say, "Give me some time *not* to think about this." By taking time to sleep on it, we let our unconscious mental machinery work on, and await, the intuitive result of our unconscious processing.
- *Intuition is usually adaptive.* Our instant, intuitive reactions enable us to react quickly. Our fast and frugal heuristics, for example, enable us to intuitively assume that fuzzy looking objects are far away—which they usually are, except on foggy mornings. Our learned associations surface as gut feelings, the intuitions of our two-track mind. If a stranger looks like someone who previously harmed or threatened us, we may—without consciously recalling the earlier experience—react warily. People's automatic, unconscious associations with a political position can even predict their future decisions *before* they consciously make up their minds (Galdi et al., 2008).
- *Intuition is recognition born of experience.* It is implicit knowledge—what we've learned but can't fully explain, such as how to ride a bike. We see this tacit expertise in chess masters playing "blitz chess," where every move is made after barely more than a glance. They can look at a board and intuitively know the right move (Burns, 2004). We see it in experienced nurses, firefighters, art critics, car mechanics, and hockey players. And in you, too, for anything in which you have developed a special skill. In each case, what feels like instant intuition is an acquired ability to size up a situation in an eyeblink. As Nobel laureate psychologist Herbert Simon (2001) observed, intuition is analysis "frozen into habit."

Hmm . . . male or female? When acquired expertise becomes an automatic habit, as it is for experienced chicken sexers, it feels like intuition. At a glance, they just know the sex of the chick, yet cannot easily tell you how they know.


Jean-Philippe Ksiazek/AFP

The bottom line: Intuition can be perilous, especially when we overfeel and underthink, as we do when judging risks. Today's psychological science reminds us to check our intuitions against reality, but also enhances our appreciation for intuition. Our two-track mind makes sweet harmony as smart, critical thinking listens to the creative whispers of our vast unseen mind, and then evaluates evidence, tests conclusions, and plans for the future.

Try This

What time is it now? When I asked you (in the section on overconfidence) to estimate how quickly you would finish this module, did you underestimate or overestimate?

Before You Move On

▶ **ASK YOURSELF**

People's perceptions of risk, often biased by vivid images from movies or the news, are surprisingly unrelated to actual risks. (People may hide in the basement during thunderstorms but fail to buckle their seat belts in the car.) What are the things you fear? Are some of those fears out of proportion to statistical risk? Are you failing, in other areas of your life, to take reasonable precautions?

▶ **TEST YOURSELF**

The availability heuristic is a quick-and-easy but sometimes misleading guide to judging reality. What is the availability heuristic?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 35 Review

35-1 What cognitive strategies assist our problem solving, and what obstacles hinder it?

- An *algorithm* is a methodical, logical rule or procedure (such as a step-by-step description for evacuating a building during a fire) that guarantees a solution to a problem.
- A *heuristic* is a simpler strategy (such as running for an exit if you smell smoke) that is usually speedier than an algorithm but is also more error-prone.
- *Insight* is not a strategy-based solution, but rather a sudden flash of inspiration that solves a problem.
- Obstacles to problem solving include *confirmation bias,* which predisposes us to verify rather than challenge our hypotheses, and fixation, such as *mental set,* which may prevent us from taking the fresh perspective that would lead to a solution.

35-2 What is intuition, and how can the representativeness and availability heuristics, overconfidence, belief perseverance, and framing influence our decisions and judgments?

- *Intuition* is the effortless, immediate, automatic feeling or thoughts we often use instead of systematic reasoning.
- Heuristics enable snap judgments. *The representativeness heuristic* leads us to judge the likelihood of things in terms of how they represent our prototype for a group of items. Using the *availability heuristic,* we judge the likelihood of things based on how readily they come to mind, which often leads us to fear the wrong things.
- *Overconfidence* can lead us to overestimate the accuracy of our beliefs.

- When a belief we have formed and explained has been discredited, belief perseverance may cause us to cling to that belief. A remedy for *belief perseverance* is to consider how we might have explained an opposite result.
- *Framing* is the way a question or statement is worded. Subtle wording differences can dramatically alter our responses.

35-3 How do smart thinkers use intuition?

- Smart thinkers welcome their intuitions (which are usually adaptive), but when making complex decisions they gather as much information as possible and then take time to let their two-track mind process all available information.
- As people gain expertise, they grow adept at making quick, shrewd judgments.

Multiple-Choice Questions

1. What is another term for a methodical, logical rule that guarantees solving a particular problem?

a. Heuristic
b. Algorithm
c. Insight
d. Mental set
e. Confirmation bias

2. Which of the following is the tendency to search for supportive information of preconceptions while ignoring contradictory evidence?

a. Confirmation bias
b. Intuition
c. Mental set
d. Availability heuristic
e. Overconfidence

3. What is another word for the way an issue is presented to you?

a. Intuition
b. Insight
c. Framing
d. Overconfidence
e. Perseverance

4. When instances come readily to mind, we often presume such events are common. What of the following is the term for this phenomenon?

a. Intuition insight
b. Confirmation bias
c. Belief perseverance
d. Mental set
e. Availability heuristic

Practice FRQs

1. Name and define two problem-solving strategies. Next, explain an advantage each has over the other.

Answer

1 point: An algorithm is a step-by-step procedure that guarantees a solution.

1 point: A heuristic is a simple thinking strategy that often allows us to make quick judgments.

1 point: Algorithm advantage: More likely to produce a correct solution.

1 point: Heuristic advantage: Often faster than using an algorithm.

2. Explain how each of the following can lead to inaccurate judgments: overconfidence, mental set, and confirmation bias.

(3 points)

Module 36

Thinking and Language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Module Learning Objectives

36-1 Describe the structural components of a language.

36-2 Identify the milestones in language development.

36-3 Describe how we acquire language.

36-4 Identify the brain areas involved in language processing and speech.

36-5 Describe the relationship between language and thinking, and discuss the value of thinking in images.

Imagine an alien species that could pass thoughts from one head to another merely by pulsating air molecules in the space between them. Perhaps these weird creatures could inhabit a future science fiction movie?

Actually, we are those creatures. When we speak, our brain and voice apparatus conjure up air pressure waves that we send banging against another's eardrum—enabling us to transfer thoughts from our brain into theirs. As cognitive scientist Steven Pinker (1998) has noted, we sometimes sit for hours "listening to other people make noise as they exhale, because those hisses and squeaks contain *information.*" And thanks to all those funny sounds created in our heads from the air pressure waves we send out, we get people's attention, we get them to do things, and we maintain relationships (Guerin, 2003). Depending on how you vibrate the air after opening your mouth, you may get slapped or kissed.

language our spoken, written, or signed words and the ways we combine them to communicate meaning.

But **language** is more than vibrating air. As I create this paragraph, my fingers on a keyboard generate electronic binary numbers that are translated into squiggles of dried carbon pressed onto the page in front of you. When transmitted by reflected light rays into your retina, the printed squiggles trigger formless nerve impulses that project to several areas of your brain, which integrate the information, compare it with stored information, and decode meaning. Thanks to language, information is moving from my mind to yours. Monkeys mostly know what they see. Thanks to language (spoken, written, or signed) we comprehend much that we've never seen and that our distant ancestors never knew.


AP Photo/M. Spencer Green

Language transmits knowledge Whether spoken, written, or signed, language—the original wireless communication—enables mind-to-mind information transfer, and with it the transmission of civilization's accumulated knowledge across generations.

Today, notes Daniel Gilbert (2006), "The average newspaper boy in Pittsburgh knows more about the universe than did Galileo, Aristotle, Leonardo, or any of those other guys who were so smart they only needed one name."

To Pinker (1990), language is "the jewel in the crown of cognition." If you were able to retain one cognitive ability, make it language, suggests researcher Lera Boroditsky (2009). Without sight or hearing, you could still have friends, family, and a job. But without language, could you have these things? "Language is so fundamental to our experience, so deeply a part of being human, that it's hard to imagine life without it."

phoneme in a language, the smallest distinctive sound unit.

morpheme in a language, the smallest unit that carries meaning; may be a word or a part of a word (such as a prefix).

grammar in a language, a system of rules that enables us to communicate with and understand others. In a given language, *semantics* is the set of rules for deriving meaning from sounds, and *syntax* is the set of rules for combining words into grammatically sensible sentences.

Language Structure

36-1 What are the structural components of a language?

Consider how we might go about inventing a language. For a spoken language, we would need three building blocks:

- **Phonemes** are the smallest distinctive sound units in a language. To say *bat,* English speakers utter the phonemes *b, a,* and *t.* (Phonemes aren't the same as letters. *Chat* also has three phonemes—*ch, a,* and *t.*) Linguists surveying nearly 500 languages have identified 869 different phonemes in human speech, but no language uses all of them (Holt, 2002; Maddieson, 1984). English uses about 40; other languages use anywhere from half to more than twice that many. As a general rule, consonant phonemes carry more information than do vowel phonemes. *The treth ef thes stetement shed be evedent frem thes bref demenstretien.*
- **Morphemes** are the smallest units that carry meaning in a given language. In English, a few morphemes are also phonemes—the personal pronoun *I* and the *s* that indicates plural, for instance. But most morphemes combine two or more phonemes. Some, like *bat* or *gentle,* are words. Others—like the prefix *pre-* in *preview* or the suffix *-ed* in *adapted*—are parts of words.
- **Grammar** is the system of rules that enables us to communicate with one another. Grammatical rules guide us in deriving meaning from sounds *(semantics)* and in ordering words into sentences *(syntax).*

AP® Exam Tip

It is sometimes challenging to keep these building blocks straight. Phonemes are sounds. It may help to remember that phones carry sounds. Morphemes have meaning, and both words begin with the letter *m.*

Language becomes increasingly complex as we move from one level to the next. In English, for example, 40 or so phonemes can be combined to form more than 100,000 morphemes, which alone or in combination produce the 616,500 word forms in the *Oxford English Dictionary.* Using those words, we can then create an infinite number of sentences, most of which (like this one) are original. Like life constructed from the genetic code's simple alphabet, language is complexity built of simplicity. I know that you can know why I worry that you think this sentence is starting to get too complex, but that complexity—and our capacity to communicate and comprehend it—is what distinguishes human language capacity (Hauser et al., 2002; Premack, 2007).

From The Wall Street Journal—permission Cartoon Features Syndicate.

"Let me get this straight now. Is what you want to build a jean factory or a gene factory?"

Language Development

Make a quick guess: How many words will you have learned during the years between your first birthday and your high school graduation? Although you use only 150 words for about half of what you say, you will have learned about 60,000 words in your native language during those years (Bloom, 2000; McMurray, 2007). That averages (after age 2) to nearly 3500 words each year, or nearly 10 each day! How you do it—how those 3500 words so far outnumber the roughly 200 words your schoolteachers are consciously teaching you each year—is one of the great human wonders.


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Could you even state all your language's rules of syntax (the correct way to string words together to form sentences)? Most of us cannot. Yet, before you were able to add 2 + 2, you were creating your own original and grammatically appropriate sentences. As a preschooler, you comprehended and spoke with a facility that puts to shame college students struggling to learn a foreign language.

We humans have an astonishing facility for language. With remarkable efficiency, we sample tens of thousands of words in our memory, effortlessly assemble them with near-perfect syntax, and spew them out, three words a second (Vigliocco & Hartsuiker, 2002). Seldom do we form sentences in our minds before speaking them. Rather we organize them on the fly as we speak. And while doing all this, we also adapt our utterances to our social and cultural context, following rules for speaking *(How far apart should we stand?)* and listening *(Is it OK to interrupt?)*. Given how many ways there are to mess up, it's amazing that we can master this social dance. So when and how does it happen?

When Do We Learn Language?

36-2 What are the milestones in language development?

RECEPTIVE LANGUAGE

Children's language development moves from simplicity to complexity. Infants start without language (*in fantis* means "not speaking"). Yet by 4 months of age, babies can recognize differences in speech sounds (Stager & Werker, 1997). They can also read lips: They prefer to look at a face that matches a sound, so we know they can recognize that *ah* comes from wide open lips and *ee* from a mouth with corners pulled back (Kuhl & Meltzoff, 1982). This marks the beginning of the development of babies' *receptive language,* their ability to understand what is said to and about them. At 7 months and beyond, babies grow in their power to do what you and I find difficult when listening to an unfamiliar language: to segment spoken sounds into individual words. Moreover, their adeptness at this task, as judged by their listening patterns, predicts their language abilities at ages 2 and 5 (Newman et al., 2006).

PRODUCTIVE LANGUAGE

Babies' *productive language,* their ability to produce words, matures after their receptive language. They recognize noun-verb differences—as shown by their responses to a misplaced noun or verb—earlier than they utter sentences with nouns and verbs (Bernal et al., 2010).

babbling stage beginning at about 4 months, the stage of speech development in which the infant spontaneously utters various sounds at first unrelated to the household language.

Before nurture molds babies' speech, nature enables a wide range of possible sounds in the **babbling stage,** beginning around 4 months of age. Many of these spontaneously uttered sounds are consonant-vowel pairs formed by simply bunching the tongue in the front of the mouth *(da-da, na-na, ta-ta)* or by opening and closing the lips *(ma-ma),* both of which babies do naturally for feeding (MacNeilage & Davis, 2000). Babbling is not an imitation of adult speech—it includes sounds from various languages, including those not spoken in the household. From this early babbling, a listener could not identify an infant as being, say, French, Korean, or Ethiopian. Deaf infants who observe their deaf parents signing begin to babble more with their hands (Petitto & Marentette, 1991).

By the time infants are about 10 months old, their babbling has changed so that a trained ear can identify the household language (de Boysson-Bardies et al., 1989). Without exposure to other languages, babies lose their ability to hear and produce sounds and tones found outside their native language (Meltzoff et al., 2009; Pallier et al., 2001). Thus, by adulthood, those who speak only English cannot discriminate certain sounds in Japanese speech.

Nor can Japanese adults with no training in English hear the difference between the English *r* and *l*. For a Japanese-speaking adult, *la-la-ra-ra* may sound like the same syllable repeated. (Does this astonish you as it does me?) A Japanese-speaking person told that the train station is "just after the next light" may wonder, "The next what? After the street veering right, or farther down, after the light?"

Around their first birthday, most children enter the **one-word stage.** They have already learned that sounds carry meanings, and if repeatedly trained to associate, say, *fish* with a picture of a fish, 1-year-olds will look at a fish when a researcher says, "Fish, fish! Look at the fish!" (Schafer, 2005). They now begin to use sounds—usually only one barely recognizable syllable, such as *ma* or *da*—to communicate meaning. But family members quickly learn to understand, and gradually the infant's language conforms more to the family's language. Across the world, baby's first words are often nouns that label objects or people (Tardif et al., 2008). At this one-word stage, a single inflected word ("Doggy!") may equal a sentence. ("Look at the dog out there!")

At about 18 months, children's word learning explodes from about a word per week to a word per day. By their second birthday, most have entered the **two-word stage** (**TABLE 36.1**). They start uttering two-word sentences in **telegraphic speech.** Like today's text messages or yesterday's telegrams that charged by the word (TERMS ACCEPTED. SEND MONEY), a 2-year-old's speech contains mostly nouns and verbs *(Want juice)*. Also like telegrams, it follows rules of syntax: The words are in a sensible order. English-speaking children typically place adjectives before nouns—*white house* rather than *house white.* Spanish reverses this order, as in *casa blanca*.

"Got idea. Talk better. Combine words. Make sentences."

one-word stage the stage in speech development, from about age 1 to 2, during which a child speaks mostly in single words.

two-word stage beginning about age 2, the stage in speech development during which a child speaks mostly in two-word statements.

telegraphic speech early speech stage in which a child speaks like a telegram—"go car"—using mostly nouns and verbs.

Table 36.1 Summary of Language Development

Month (approximate)	Stage
4	Infant babbles many speech sounds ("Ah-goo").
10	Babbling resembles household language ("Ma-ma").
12	Child enters one-word stage ("Kitty!").
24	Child engages in two-word, telegraphic speech ("Get ball.").
24+	Language develops rapidly into complete sentences.

Moving out of the two-word stage, children quickly begin uttering longer phrases (Fromkin & Rodman, 1983). If they get a late start on learning a particular language, such as after receiving a cochlear implant or being adopted by a family in another country, their language development still proceeds through the same sequence, although usually at a faster pace (Ertmer et al., 2007; Snedeker et al., 2007). By early elementary school, children understand complex sentences and begin to enjoy the humor conveyed by double meanings: "You never starve in the desert because of all the sand-which-is there."

Explaining Language Development

36-3 How do we acquire language?

The world's 7000 or so languages are structurally very diverse (Evans & Levinson, 2009). Linguist Noam Chomsky has nonetheless argued that all languages do share some basic elements, which he calls *universal grammar.* All human languages, for example, have nouns, verbs, and adjectives as grammatical building blocks. Moreover, said Chomsky, we humans are born with a built-in predisposition to learn grammar rules, which helps explain why preschoolers pick up language so readily and use grammar so well. It happens so naturally—as naturally as birds learn to fly—that training hardly helps.

Creating a language Brought together as if on a desert island (actually a school), Nicaragua's young deaf children over time drew upon sign gestures from home to create their own Nicaraguan Sign Language, complete with words and intricate grammar. Our biological predisposition for language does not create language in a vacuum. But activated by a social context, nature and nurture work creatively together (Osborne, 1999; Sandler et al., 2005; Senghas & Coppola, 2001).

Susan Meiselas/Magnum Photos

We are not, however, born with a built-in *specific* language. Europeans and Native Australia–New Zealand populations, though geographically separated for 50,000 years, can readily learn each others' languages (Chater et al., 2009). And whatever language we experience as children, whether spoken or signed, we all readily learn its specific grammar and vocabulary (Bavelier et al., 2003). But no matter what language we learn, we start speaking it mostly in nouns *(kitty, da-da)* rather than in verbs and adjectives (Bornstein et al., 2004). Biology and experience work together.

STATISTICAL LEARNING

When adults listen to an unfamiliar language, the syllables all run together. A young Sudanese couple new to North America and unfamiliar with English might, for example, hear *United Nations* as "Uneye Tednay Shuns." Their 7-month-old daughter would not have this problem. Human infants display a remarkable ability to learn statistical aspects of human speech. Their brains not only discern word breaks, they statistically analyze which syllables, as in "hap-py-ba-by," most often go together. After just two minutes of exposure to a computer voice speaking an unbroken, monotone string of nonsense syllables *(bidakupadotigolabubidaku . . .),* 8-month-old infants were able to recognize (as indicated by their attention) three-syllable sequences that appeared repeatedly (Saffran et al., 1996, 2009).

In further testimony to infants' surprising knack for soaking up language, research shows that 7-month-olds can learn simple sentence structures. After repeatedly hearing syllable sequences that follow one rule (an ABA pattern, such as *ga-ti-ga* and *li-na-li*), infants listened longer to syllables in a different sequence (an ABB pattern, such as *wo-fe-fe,* rather than *wo-fe-wo*). Their detecting the difference between the two patterns supports the idea that babies come with a built-in readiness to learn grammatical rules (Marcus et al., 1999).

CRITICAL PERIODS

Could we train adults to perform this same feat of statistical analysis later in the human life span? Many researchers believe not. Childhood seems to represent a *critical* (or "sensitive") *period* for mastering certain aspects of language before the language-learning window closes (Hernandez & Li, 2007). People who learn a second language as adults usually speak it with the accent of their native language, and they also have difficulty mastering the new grammar. In one experiment, Korean and Chinese immigrants considered 276 English sentences *("Yesterday the hunter shoots a deer")* and decided whether they were grammatically correct or incorrect (Johnson & Newport, 1991). All had been in the United States for approximately 10 years: Some had arrived in early childhood, others as adults. As **FIGURE 36.1** reveals, those who learned their second language early learned it best. The older one is when moving to a new country, the harder it will be to learn its language and to absorb its culture (Cheung et al., 2011; Hakuta et al., 2003).

A natural talent We humans come with a remarkable capacity to soak up language. But the particular language we learn reflects our unique interactions with others.

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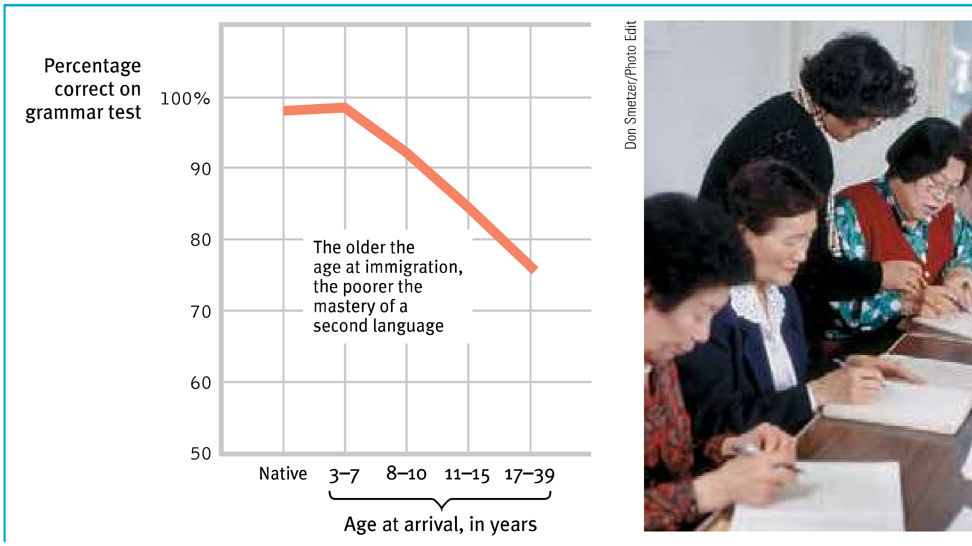
The window on language learning closes gradually in early childhood. Later-than-usual exposure to language (at age 2 or 3) unleashes the idle language capacity of a child's brain, producing a rush of language. But



Don Smetzer/Photo Edit

Figure 36.1

Our ability to learn a new language diminishes with age Ten years after coming to the United States, Asian immigrants took an English grammar test. Although there is no sharply defined critical period for second language learning, those who arrived before age 8 understood American English grammar as well as native speakers did. Those who arrived later did not. (From Johnson & Newport, 1991.)

by about age 7, those who have not been exposed to either a spoken or a signed language gradually lose their ability to master *any* language.

The impact of early experiences is evident in language learning in the 90+ percent of prelingually deaf children born to hearing-nonsigning parents. These children typically do not experience language during their early years. Natively deaf children who learn sign language after age 9 never learn it as well as those who lose their hearing at age 9 after learning English. They also never learn English as well as other natively deaf children who learned sign in infancy (Mayberry et al., 2002). Those who learn to sign as teens or adults are like immigrants who learn English after childhood: They can master basic words and learn to order them, but they never become as fluent as native signers in producing and comprehending subtle grammatical differences (Newport, 1990). As a flower's growth will be stunted without nourishment, so, too, children will typically become linguistically stunted if isolated from language during the critical period for its acquisition.

George Ancona

***No* means *No*—no matter how you say it!** Deaf children of deaf-signing parents and hearing children of hearing parents have much in common. They develop language skills at about the same rate, and they are equally effective at opposing parental wishes and demanding their way.

The Brain and Language

36-4 What brain areas are involved in language processing and speech?

We think of speaking and reading, or writing and reading, or singing and speaking as merely different examples of the same general ability—language. But consider this curious finding: **Aphasia,** an impairment of language, can result from damage to any of several cortical areas. Even more curious, some people with aphasia can speak fluently but cannot read (despite good vision), while others can comprehend what they read but cannot speak. Still others can write but not read, read but not write, read numbers but not letters, or sing but not speak. These cases suggest that language is complex, and that different brain areas must serve different language functions.

Indeed, in 1865, French physician Paul Broca reported that after damage to an area of the left frontal lobe (later called **Broca's area**) a person would struggle to *speak* words while still being able to sing familiar songs and comprehend speech.

In 1874, German investigator Carl Wernicke discovered that after damage to an area of the left temporal lobe (**Wernicke's area**) people could speak only meaningless words. Asked to describe a picture that showed two boys stealing cookies behind a woman's back, one patient responded: "Mother is away her working her work to get her better, but when

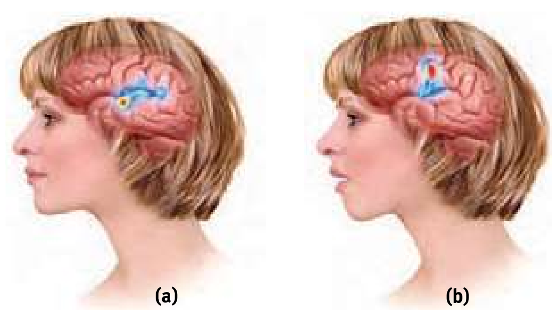
aphasia impairment of language, usually caused by left-hemisphere damage either to Broca's area (impairing speaking) or to Wernicke's area (impairing understanding).

Broca's area controls language expression—an area of the frontal lobe, usually in the left hemisphere, that directs the muscle movements involved in speech.

Wernicke's area controls language reception—a brain area involved in language comprehension and expression; usually in the left temporal lobe.

she's looking the two boys looking the other part. She's working another time" (Geschwind, 1979). Damage to Wernicke's area also disrupts understanding.

Today's neuroscience has confirmed brain activity in Broca's and Wernicke's areas during language processing (**FIGURE 36.2**). But neuroscience is refining our understanding of how our brain processes language. Language functions are distributed across other brain areas as well. Functional MRI scans show that different neural networks are activated by nouns and verbs, or objects and actions; by different vowels; and by reading stories of visual versus motor experiences (Shapiro et al., 2006; Speer et al., 2009). Different neural networks also enable one's native language and a second language learned later in life (Perani & Abutalebi, 2005).



(a)
Hearing words (auditory cortex and Wernicke's area)

(b)
Speaking words (Broca's area and the motor cortex)

Figure 36.2
Brain activity when hearing and speaking words

And here's another funny fMRI finding. Jokes that play on meaning *("Why don't sharks bite lawyers? . . . Professional courtesy")* are processed in a different brain area than jokes that play on words *("What kind of lights did Noah use on the ark? . . . Flood lights")* (Goel & Dolan, 2001).

"It is the way systems interact and have a dynamic interdependence that is—unless one has lost all sense of wonder—quite awe-inspiring." -Simon Conway Morris, "The Boyle Lecture," 2005

The big point to remember is this: In processing language, as in other forms of information processing, *the brain operates by dividing its mental functions—speaking, perceiving, thinking, remembering—into subfunctions.* Your conscious experience of reading this page *seems* indivisible, but your brain is computing each word's form, sound, and meaning using different neural networks (Posner & Carr, 1992). We saw this also in Module 18's discussion of vision, for which the brain engages specialized subtasks, such as discerning depth, movement, form, and color. And in vision as in language, a localized trauma that destroys one of these neural work teams may cause people to lose just one aspect of processing. In visual processing, a stroke may destroy the ability to perceive movement but not color. In language processing, a stroke may impair the ability to speak distinctly without harming the ability to read.

AP® Exam Tip

You'll notice that even though the brain was one of the major topics in Unit III, it keeps coming up. Each time it does provides you with an opportunity to go back and review what you learned previously about the brain. Rehearse frequently, and you will not have much to relearn before the AP® exam.

Think about it: What you experience as a continuous, indivisible stream of experience is actually but the visible tip of a subdivided information-processing iceberg.

* * *

Returning to our debate about how deserving we humans are of our name *Homo sapiens,* let's pause to issue an interim report card. On decision making and risk assessment, our error-prone species might rate a C+. On problem solving, where humans are inventive yet vulnerable to fixation, we would probably receive a better mark, perhaps a B. On cognitive efficiency, our fallible but quick heuristics earn us an A. And when it comes to our creativity, and our learning and using language, the awestruck experts would surely award the human species an A+.

Before You Move On

▶ ASK YOURSELF

There has been controversy at some universities about allowing fluency in sign language to fulfill a second-language requirement for an undergraduate degree. As you start planning for your own college years, what is your opinion?

▶ TEST YOURSELF

If children are not yet speaking, is there any reason to think they would benefit from parents and other caregivers reading to them?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Language and Thought

36-5 What is the relationship between language and thinking, and what is the value of thinking in images?

Thinking and language intricately intertwine. Asking which comes first is one of psychology's chicken-and-egg questions. Do our ideas come first and we wait for words to name them? Or are our thoughts conceived in words and therefore unthinkable without them?

Try This

To find out what we have learned about thinking and language in other animals, see Module 85.

Language Influences Thinking

Linguist Benjamin Lee Whorf (1956) contended that language determines the way we think: "Language itself shapes a [person's] basic ideas." The Hopi, who have no past tense for their verbs, could not readily *think* about the past, said Whorf.

Whorf's **linguistic determinism** hypothesis is too extreme. We all think about things for which we have no words. (Can you think of a shade of blue you cannot name?) And we routinely have *unsymbolized* (wordless, imageless) thoughts, as when someone, while watching two men carry a load of bricks, wondered whether the men would drop them (Heavey & Hurlburt, 2008; Hurlburt & Akhter, 2008).

Nevertheless, to those who speak two dissimilar languages, such as English and Japanese, it seems obvious that a person may think differently in different languages (Brown, 1986). Unlike English, which has a rich vocabulary for self-focused emotions such as anger, Japanese has more words for interpersonal emotions such as sympathy (Markus & Kitayama, 1991). Many bilingual individuals report that they have different senses of self, depending on which language they are using (Matsumoto, 1994). In one series of studies with bilingual Israeli Arabs (who speak both Arabic and Hebrew), participants thought differently about their social world, with differing automatic associations with Arabs and Jews, depending on which language the testing session used (Danziger & Ward, 2010).

Bilingual individuals may even reveal different personality profiles when taking the same test in their two languages (Dinges & Hull, 1992). This happened when China-born, bilingual students at the University of Waterloo in Ontario were asked to describe themselves in English or Chinese (Ross et al., 2002). The English-language self-descriptions fit typical Canadian profiles: Students expressed mostly positive self-statements and moods. Responding in Chinese, the same students gave typically Chinese self-descriptions: They reported more agreement with Chinese values and roughly equal positive and negative self-statements and moods. "Learn a new language and get a new soul," says a Czech proverb. Similar personality changes have been shown when bicultural, bilingual Americans and Mexicans shifted between the cultural frames associated with English and Spanish (Ramírez-Esparza et al., 2006).

So our words may not *determine* what we think, but they do *influence* our thinking (Boroditsky, 2011). We use our language in forming categories. In Brazil, the isolated Piraha tribespeople have words for the numbers 1 and 2, but numbers above that are simply "many." Thus, if shown 7 nuts in a row, they find it very difficult to lay out the same number from their own pile (Gordon, 2004).

Words also influence our thinking about colors. Whether we live in New Mexico, New South Wales, or New Guinea, we *see* colors much the same, but we use our native language to *classify* and *remember* colors (Davidoff, 2004; Roberson et al., 2004, 2005). If your language is English, you might view three colors and call two of them "yellow" and one of them "blue." Later you would likely see and recall the yellows as being more similar. But if you are a member of Papua New Guinea's Berinmo tribe, which has words for two different shades of yellow, you would more speedily perceive and better recall the distinctions between the two yellows. And if your language is Russian, which has distinct names for different shades of blue, such as *goluboy* and *sinly*, you might remember the blue better. Words matter.

Try This

Before reading on, use a pen or pencil to sketch this idea: "The girl pushes the boy." Now see the inverted comment below.

How did you illustrate "the girl pushes the boy"? Anne Maass and Aurore Russo (2003) report that people whose language reads from left to right mostly position the pushing girl on the left. Those who read and write Arabic, a right-to-left language, mostly place her on the right. This spatial bias appears only in those old enough to have learned their culture's writing system (Dobel et al., 2007).

linguistic determinism Whorf's hypothesis that language determines the way we think.

Prisma Bildagentur AG/Alamy

Culture and color In Papua New Guinea, Berinmo children have words for different shades of "yellow," so they might more quickly spot and recall yellow variations. Here and everywhere, "the languages we speak profoundly shape the way we think, the way we see the world, the way we live our lives," notes psychologist Lera Boroditsky (2009).

Perceived differences grow when we assign different names to colors. On the color spectrum, blue blends into green—until we draw a dividing line between the portions we call "blue" and "green." Although equally different on the color spectrum, two different items that share the same color name (as the two "blues" do in **FIGURE 36.3**, contrast B) are harder to distinguish than two items with different names ("blue" and "green," as in Figure 36.3, contrast A) (Özgen, 2004).

Given words' subtle influence on thinking, we do well to choose our words carefully. Does it make any difference whether I write, "A child learns language as *he* interacts with *his* caregivers" or "Children learn language as *they* interact with *their* caregivers"? Many studies have found that it does. When hearing the generic *he* (as in "the artist and his work"), people are more likely to picture a male (Henley, 1989; Ng, 1990). If *he* and *his* were truly gender free, we shouldn't skip a beat when hearing that "man, like other mammals, nurses his young."

To expand language is to expand the ability to think. As Unit IX points out, young children's thinking develops hand in hand with their language (Gopnik & Meltzoff, 1986). Indeed, it is very difficult to think about or conceptualize certain abstract ideas (commitment, freedom, or rhyming) without language! And what is true for preschoolers is true for everyone: *It pays to increase your word power.* That's why most textbooks, including this one, introduce new words—to teach new ideas and new ways of thinking. And that's also why psychologist Steven Pinker (2007) titled his book on language *The Stuff of Thought.*

"All words are pegs to hang ideas on." -Henry Ward Beecher, *Proverbs From Plymouth Pulpit*, 1887

Increased word power helps explain what McGill University researcher Wallace Lambert (1992; Lambert et al., 1993) calls the *bilingual advantage.* Although their vocabulary in each language is somewhat smaller than that of people speaking a single language, bilingual people are skilled at inhibiting one language while using the other. And thanks to their well-practiced "executive control" over language, they also are better at inhibiting their attention to irrelevant information (Bialystock & Craik, 2010). This superior attentional control is evident from 7 months of age into adulthood (Emmorey et al., 2008; Kovacs & Mehler, 2009).

FYI

Perceived distances between cities also grow when two cities are in different countries or states rather than in the same (Burris & Branscombe, 2005; Mishra & Mishra, 2010).

Lambert helped devise a Canadian program that immerses English-speaking children in French. (The number of non-Quebec children enrolled rose from 65,000 in 1981 to 300,000 in 2007 [Statistics Canada, 2010].) For most of their first three years in school, the English-speaking children are taught entirely in French, and thereafter gradually shift to classes mostly in English. Not surprisingly, the children attain a natural French fluency unrivaled by other methods of language teaching. Moreover, compared with similarly capable children in control groups, they do so without detriment to their English fluency, and with increased aptitude scores, creativity, and appreciation for French-Canadian culture (Genesee & Gándara, 1999; Lazaruk, 2007).

Whether we are in the linguistic minority or majority, language links us to one another. Language also connects us to the past and the future. "To destroy a people, destroy their language," observed poet Joy Harjo.

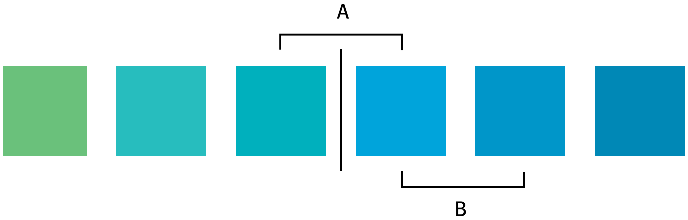


Figure 36.3

Language and perception When people view blocks of equally different colors, they perceive those with different names as more different. Thus the "green" and "blue" in contrast A may appear to differ more than the two similarly different blues in contrast B (Özgen, 2004).

Thinking in Images

When you are alone, do you talk to yourself? Is "thinking" simply conversing with yourself? Without a doubt, words convey ideas. But aren't there times when ideas precede words? To turn on the cold water in your bathroom, in which direction do you turn the handle? To answer, you probably thought not in words but with *implicit* (nondeclarative, procedural) memory—a mental picture of how you do it (see Module 31).

Indeed, we often think in images. Artists think in images. So do composers, poets, mathematicians, athletes, and scientists. Albert Einstein reported that he achieved some of his greatest insights through visual images and later put them into words. Pianist Liu Chi Kung showed the value of thinking in images. One year after placing second in the 1958 Tschaikovsky piano competition, Liu was imprisoned during China's cultural revolution. Soon after his release, after seven years without touching a piano, he was back on tour, the critics judging his musicianship better than ever. How did he continue to develop without practice? "I did practice," said Liu, "every day. I rehearsed every piece I had ever played, note by note, in my mind" (Garfield, 1986).

For someone who has learned a skill, such as ballet dancing, even *watching* the activity will activate the brain's internal simulation of it, reported one British research team after collecting fMRIs as people watched videos (Calvo-Merino et al., 2004). So, too, will imagining a physical experience, which activates some of the same neural networks that are active during the actual experience (Grèzes & Decety, 2001). Small wonder, then, that mental practice has become a standard part of training for Olympic athletes (Suinn, 1997).

One experiment on mental practice and basketball foul shooting tracked the University of Tennessee women's team over 35 games (Savoy & Beitel, 1996). During that time, the team's free-throw shooting increased from approximately 52 percent in games following standard physical practice to some 65 percent after mental practice. Players had repeatedly imagined making foul shots under various conditions, including being "trash-talked" by their opposition. In a dramatic conclusion, Tennessee won the national championship game in overtime, thanks in part to their foul shooting.

Mental rehearsal can also help you achieve an academic goal, as researchers demonstrated with two groups of introductory psychology students facing a midterm exam 1 week later (Taylor et al., 1998). (Scores of other students formed a control group, not engaging in any mental simulation.) The first group spent 5 minutes each day visualizing themselves scanning the posted grade list, seeing their A, beaming with joy, and feeling proud. This *outcome simulation* had little effect, adding only 2 points to their exam-scores average. Another group spent 5 minutes each day visualizing themselves effectively studying—reading the textbook, going over notes, eliminating distractions, declining an offer to go out. This *process simulation* paid off: This second group began studying sooner, spent more time at it, and beat the others' average by 8 points. *The point to remember:* It's better to spend your fantasy time planning how to get somewhere than to dwell on the imagined destination.

* * *

What, then, should we say about the relationship between thinking and language? As we have seen, language influences our thinking. But if thinking did not also affect language, there would never be any new words. And new words and new combinations of old words express new ideas. The basketball term *slam dunk* was coined after the act itself had become fairly common. So, let us say that *thinking affects our language, which then affects our thought* (**FIGURE 36.4**).

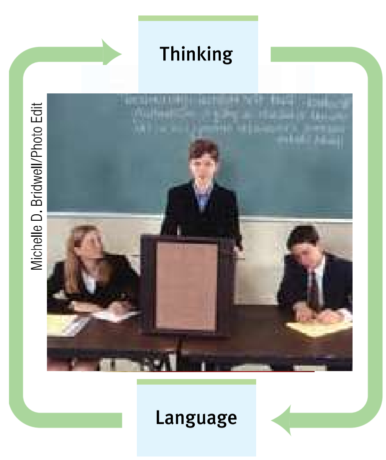


Figure 36.4
The interplay of thought and language The traffic runs both ways between thinking and language. Thinking affects our language, which affects our thought.

Psychological research on thinking and language mirrors the mixed views of our species by those in fields such as literature and religion. The human mind is simultaneously capable of striking intellectual failures and of striking intellectual power. Misjudgments are common and can have disastrous consequences. So we do well to appreciate our capacity for error. Yet our efficient heuristics often serve us well. Moreover, our ingenuity at problem solving and our extraordinary power of language mark humankind as almost "infinite in faculties."

Before You Move On

▶ ASK YOURSELF

Do you use certain words or gestures that only your family or closest circle of friends would understand? Can you envision using these words or gestures to construct a language, as the Nicaraguan children did in building their version of sign language?

▶ TEST YOURSELF

To say that "words are the mother of ideas" assumes the truth of what concept?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 36 Review

36-1 What are the structural components of a language?

- *Phonemes* are a *language's* basic units of sound.
- *Morphemes* are the elementary units of meaning.
- *Grammar*—the system of rules that enables us to communicate—includes semantics (rules for deriving meaning) and syntax (rules for ordering words into sentences).

36-2 What are the milestones in language development?

- Language development's timing varies, but all children follow the same sequence.
- Receptive language (the ability to understand what is said to or about you) develops before productive language (the ability to produce words).
- At about 4 months of age, infants *babble,* making sounds found in languages from all over the world.
- By about 10 months, their babbling contains only the sounds found in their household language.
- Around 12 months of age, children begin to speak in single words. This *one-word stage* evolves into *two-word (telegraphic)* utterances before their second birthday, after which they begin speaking in full sentences.

36-3 How do we acquire language?

- Linguist Noam Chomsky has proposed that all human languages share a universal grammar—the basic building blocks of language—and that humans are born with a predisposition to learn language.
- We acquire specific language through learning as our biology and experience interact.
- Childhood is a critical period for learning to speak or sign fluently.

36-4 What brain areas are involved in language processing and speech?

- Two important language- and speech-processing areas are *Broca's area,* a region of the frontal lobe that controls language expression, and *Wernicke's area,* a region in the left temporal lobe that controls language reception (and also assists with expression).
- Language processing is spread across other brain areas as well, where different neural networks handle specific linguistic subtasks.

36-5 What is the relationship between language and thinking, and what is the value of thinking in images?

- Although Benjamin Lee Whorf's *linguistic determinism* hypothesis suggested that language determines thought, it is more accurate to say that language influences thought.
- Different languages embody different ways of thinking, and immersion in bilingual education can enhance thinking.
- We often think in images when we use nondeclarative (procedural) memory (our automatic memory system for motor and cognitive skills and classically conditioned associations).
- Thinking in images can increase our skills when we mentally practice upcoming events.

Multiple-Choice Questions

1. What do we call the smallest distinctive sound units in language?

a. Structure
b. Morphemes
c. Grammar
d. Phonemes
e. Thoughts

2. Which of the following best identifies the early speech stage in which a child speaks using mostly nouns and verbs?

a. Two-word stage
b. Babbling stage
c. One-word stage
d. Telegraphic speech
e. Grammar

3. The prefix "pre" in "preview" or the suffix "ed" in "adapted" are examples of

a. phonemes.
b. morphemes.
c. babbling.
d. grammar.
e. intuition.

4. Evidence of words' subtle influence on thinking best supports the notion of

a. Wernicke's area.
b. Broca's area.
c. linguistic determinism.
d. babbling.
e. aphasia.

Practice FRQs

1. Name and define the three building blocks of spoken language.

Answer

1 point: Phoneme: the smallest distinctive sound unit.

1 point: Morpheme: the smallest unit carrying meaning in language.

1 point: Grammar: the system of rules that enable communication.

2. What is aphasia, and how does it relate to Broca's and Wernicke's areas?

(3 points)

Unit VII Review

Key Terms and Concepts to Remember

memory, p. 318
encoding, p. 319
storage, p. 319
retrieval, p. 319
parallel processing, p. 319
sensory memory, p. 319
short-term memory, p. 319
long-term memory, p. 319
working memory, 320
explicit memory, p. 320
effortful processing, p. 320
automatic processing, p. 320
implicit memory, p. 320
iconic memory, p. 322
echoic memory, p. 322
chunking, p. 323
mnemonics [nih-MON-iks], p. 323
spacing effect, p. 324
testing effect, p. 324
shallow processing, p. 324
deep processing, p. 325
hippocampus, p. 330
flashbulb memory, p. 332
long-term potentiation (LTP), p. 333
recall, p. 334
recognition, p. 334
relearning, p. 334
priming, p. 336
mood-congruent memory, p. 337
serial position effect, p. 337
anterograde amnesia, p. 342
retrograde amnesia, p. 342
proactive interference, p. 345
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phoneme, p. 373
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Key Contributors to Remember

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Paul Broca, p. 377
Carl Wernicke, p. 377
Benjamin Lee Whorf, p. 379