8 Language and Thought

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"Mr. Watson—Mr. Sherlock Holmes," said Stamford, introducing us.

"How are you?" he said, cordially, gripping my hand with a strength for which I should hardly have given him credit. "You have been in Afghanistan, I perceive."

"How on earth did you know that?" I asked, in astonishment.

(From A Study in Scarlet *by Arthur Conan Doyle)*

If you've ever read any Sherlock Holmes stories, you know that the great detective constantly astonished his stalwart companion, Dr. Watson, with his extraordinary deductions. Obviously, Holmes could not arrive at his conclusions without a chain of reasoning. Yet to him even an elaborate reasoning process was a simple, everyday act. Consider his feat of knowing at once, on first meeting Watson, that the doctor had been in Afghanistan. When asked, Holmes explained his reasoning as follows:

"I knew you came from Afghanistan. From long habit the train of thought ran so swiftly through my mind that I arrived at the conclusion without being conscious of the intermediate steps. There were such steps, however. The train of reasoning ran: 'Here is a gentleman of a medical type, but with the air of a military man. Clearly an army doctor, then. He has just come from the tropics, for his face is dark, and that is not the natural tint of his skin, for his wrists are fair. He has undergone hardship and sickness, as his haggard face says clearly. His left arm has been injured. He holds it in a stiff and unnatural manner. Where in the tropics could an English army doctor have seen much hardship and got his arm wounded? Clearly in Afghanistan.' The whole train of thought did not occupy a second."

Admittedly, Sherlock Holmes's deductive feats are fictional. But even to read about them appreciatively—let alone imagine them, as Sir Arthur Conan Doyle did—is a remarkably complex mental act. Our everyday thought processes seem ordinary to us only because we take them for granted, just as Holmes saw nothing extraordinary in what to him was a simple deduction.

In reality, everyone is a Sherlock Holmes, continually performing magical feats of thought. Even

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Herbet Simon

"You couldn't use a word like mind *in a psychology journal—you'd get your mouth washed out with soap."*

elementary perception—for instance, watching a football game or a ballet—involves elaborate cognitive processes. People must sort through distorted, constantly shifting perceptual inputs and deduce what they see out there in the real world. Imagine, then, the complexity of thought required to read a book, fix an automobile, or balance a checkbook. Of course, all this is not to say that human thought processes are flawless or unequaled. You probably own a $10 calculator that can run circles around you when it comes to computing square roots. As we'll see, some of the most interesting research in this chapter focuses on ways in which people's thinking can be limited, simplistic, or illogical.

In any event, as we have noted before, in psychology, ***cognition* refers broadly to mental processes or thinking.** When psychology first emerged as an independent science in the 19th century, it focused on the mind. Mental processes were explored through *introspection*—analysis of one's own conscious experience (see Chapter 1). Unfortunately, early psychologists' study of mental processes ran aground, as the method of introspection yielded unreliable results. Psychology's empirical approach depends on observation, and private mental events proved difficult to observe. Furthermore, during the first half of the 20th century, the study of cognition was actively discouraged by the theoretical dominance of behaviorism. Herbert Simon, a pioneer of cognitive psychology, recalls that "you couldn't use a word like *mind* in a psychology journal—you'd get your mouth washed out with soap" (Holden, 1986).

Although it wasn't fully recognized until much later, the 1950s brought a "cognitive revolution" in psychology (Baars, 1986). Renegade theorists, such as Herbert Simon, began to argue that behaviorists' exclusive focus on overt responses was doomed to yield an incomplete understanding of human functioning. More important, creative new approaches to research on cognitive processes led to exciting progress. For example, in his book on the cognitive revolution, Howard Gardner (1985) notes that three major advances were reported at a watershed 1956 conference—in just one day! First, Herbert Simon and Allen Newell described the first computer program to successfully simulate human problem solving. Second, Noam Chomsky outlined a new model that changed the way psychologists studied language. Third, George Miller delivered the legendary paper that we discussed in Chapter 7, arguing that the capacity of short-term memory is seven (plus or minus two) items. Since then, cognitive science has grown into a robust, interdisciplinary enterprise (Simon, 1992). Besides memory (which we covered in Chapter 7), cognitive psychologists investigate the complexities of language, problem solving, decision making, and reasoning. We'll look at all these topics in this chapter, beginning with language.

Key Learning Goals

8.1 Outline the key properties of language, and describe its structure.

8.2 Trace the development of human language during childhood.

8.3 Summarize the effects of bilingualism on language and cognitive development.

8.4 Evaluate the controversy regarding language acquisition in animals.

8.5 Discuss the possible evolutionary bases of language.

8.6 Compare the behaviorist, nativist, and interactionist perspectives on language acquisition.

8.7 Discuss culture and language and the status of the linguistic relativity hypothesis.

Language: Turning Thoughts into Words

Language obviously plays a fundamental role in human behavior. Indeed, if you were to ask people, "What characteristic most distinguishes humans from other living creatures?" a great many would reply, "Language." In this section, we'll discuss the nature, structure, and development of language and related topics, such as bilingualism and whether animals can learn language.

What Is Language?

A *language* consists of symbols that convey meaning, plus rules for combining those symbols, that can be used to generate an infinite variety of messages. Language systems include a number of critical properties.

First, language is symbolic. People use spoken sounds and written words to represent objects, actions, events, and ideas. The word *lamp,* for instance, refers to a class of objects that have certain properties. The symbolic nature of language greatly expands what people can communicate about. Symbols allow one to refer to objects that may be in another place and to events that happened at another time (for example, a lamp broken at work yesterday). The symbols used in a language are *arbitrary* in that no built-in relationship exists between the look or sound of words and the objects they stand for. *Lamps* could have been called *books,* for instance, and vice versa.

Second, language is generative. A limited number of symbols can be combined in an infinite variety of ways to *generate* an endless array of novel messages. Everyone has some "stock sayings," but every day

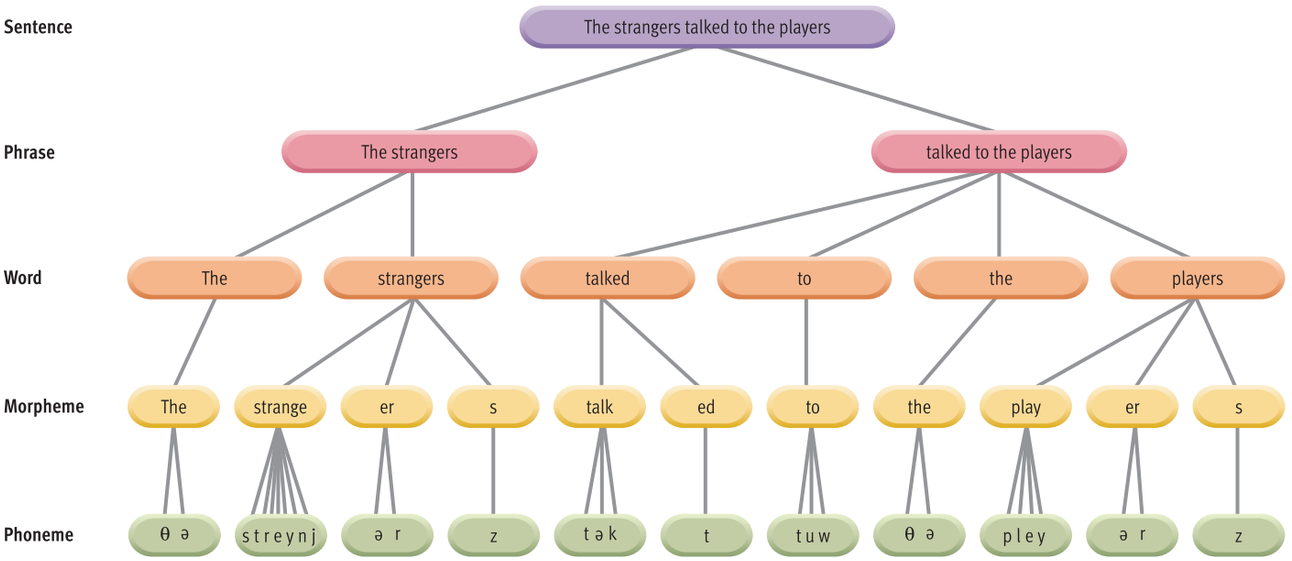


Figure 8.1

An analysis of a simple English sentence. As this example shows, verbal language has a hierarchical structure. At the base of the hierarchy are the *phonemes,* which are units of vocal sound that do not, in themselves, have meaning. The smallest units of meaning in a language are *morphemes,* which include not only root words but such meaning-carrying units as the past-tense suffix *ed* and the plural *s*. Complex rules of syntax govern how the words constructed from morphemes may be combined into phrases, and phrases into meaningful statements, or sentences.

SOURCE: Clarke-Stewart, A., Friedman, S., & Koch, J. (1985). *Child development: A topical approach* (p. 417). New York: Wiley. Reprinted by permission of John Wiley & Sons, Inc.

you create sentences that you have never spoken before. You also comprehend many sentences that you have never encountered before (like this one).

Third, language is structured. Although people can generate an infinite variety of sentences, these sentences must be structured in a limited number of ways. Rules govern the arrangement of words into phrases and sentences; some arrangements are acceptable and some are not. For example, you might say, "The swimmer jumped into the pool," but you would never recombine the same words to say, "Pool the into the jumped swimmer." The structure of language allows people to be inventive with words and still understand each other. Let's take a closer look at the structural properties of language.

The Structure of Language

Human languages have a hierarchical structure (Ratner, Gleason, & Narasimhan, 1998). As Figure 8.1 shows, basic sounds are combined into units with meaning, which are combined into words. Words are combined into phrases, which are combined into sentences.

Phonemes

At the base of the language hierarchy are ***phonemes,* the smallest speech units in a language that can be distinguished perceptually.** Considering that an unabridged English dictionary contains more than 450,000 words, you might imagine that there must be a huge number of phonemes. In fact, linguists estimate that humans are capable of recognizing only about 100 such basic sounds. Moreover, no one language uses all of these phonemes. Different languages use different groups of about 20 to 80 phonemes.

For all its rich vocabulary, the English language is composed of about 40 phonemes, corresponding roughly to the 26 letters of the alphabet plus several variations (see Table 8.1). A letter in the alphabet can represent more than one phoneme if it has more than one pronunciation. For example, the letter *a* is pronounced differently in the words *father, had, call,*

Table 8.1 Phonemic Symbols for the Sounds of American English

Consonants						Vowels			
/p/	pill	/t/	toe	/g/	gill	/i/	beet	/ɪ/	bit
/b/	bill	/d/	doe	/ŋ/	ring	/e/	bait	/ɛ/	bet
/m/	mill	/n/	no	/h/	hot	/u/	boot	/ʊ/	foot
/f/	fine	/s/	sink	/ʔ/	uh-oh	/o/	boat	/ɔ/	caught
/v/	vine	/z/	zinc	/l/	low	/æ/	bat	/a/	pot
/θ/	thigh	/č/	choke	/r/	row	/^/	but	/ə/	sofa
/ð/	thy	/j/	joke	/y/	you	/aɪ/	bite	/au/	out
/š/	shoe	/k/	kill	/w/	win	/ɔɪ/	boy		
/ž/	treasure								

Source: Hoff, E. (2001). *Language development.* Belmont, CA: Wadsworth. Reprinted by permission.

web link 8.1

John Lawler's Homepage (Linguistics & Language)

University of Michigan linguistics professor John Lawler has constructed a seemingly endless guide to web resources for the study of linguistics and language, a field allied with psychology. His homepage is a goldmine of references and guides.

and *take*. Each of these pronunciations corresponds to a different phoneme. In addition, some phonemes are represented by combinations of letters, such as *ch* and *th*. Working with this handful of basic sounds, people can understand and generate all the words in the English language—and invent new ones besides.

Morphemes and Semantics

***Morphemes* are the smallest units of meaning in a language.** There are approximately 50,000 English morphemes, which include root words as well as prefixes and suffixes. Many words, such as *fire, guard,* and *friend,* consist of a single morpheme. Many others represent combinations of morphemes. For example, the word *unfriendly* consists of three morphemes: the root word *friend,* the prefix *un,* and the suffix *ly*. Each of the morphemes contributes to the meaning of the entire word. ***Semantics* is the area of language concerned with understanding the meaning of words and word combinations.** Learning about semantics entails learning about the infinite variety of objects and actions that words refer to. A word's meaning may consist of both its *denotation,* which is its dictionary definition, and its *connotation,* which includes its emotional overtones and secondary implications.

Table 8.2 Overview of Typical Language Development

Age	General Characteristics
Months	
1–5	*Reflexive communication:* Vocalizes randomly, coos, laughs, cries, engages in vocal play, discriminates language from nonlanguage sounds
6–18	*Babbling:* Verbalizes in response to speech of others; responses increasingly approximate human speech patterns
10–13	*First words:* Uses words; typically to refer to objects
12–18	*One-word sentence stage:* Vocabulary grows slowly; uses nouns primarily; over-extensions begin
18–24	*Vocabulary spurt:* Fast-mapping facilitates rapid acquisition of new words
Years	
2	*Two-word sentence stage:* Uses telegraphic speech; uses more pronouns and verbs
2.5	*Three-word sentence stage:* Modifies speech to take listener into account; over-regularizations begin
3	Uses complete simple active sentence structure; uses sentences to tell stories that are understood by others; uses plurals
3.5	*Expanded grammatical forms:* Expresses concepts with words; uses four-word sentences
4	Uses imaginary speech; uses five-word sentences
5	*Well-developed and complex syntax:* Uses more complex syntax; uses more complex forms to tell stories
6	Displays metalinguistic awareness

Note: Children often show individual differences in the exact ages at which they display the various developmental achievements outlined here.

Syntax

Of course, most utterances consist of more than a single word. As we've already noted, people don't combine words randomly. ***Syntax* is a system of rules that specify how words can be arranged into sentences.** A simple rule of syntax is that a sentence must have both a *noun phrase* and a *verb phrase*. Thus, "The sound of cars is annoying" is a sentence. However, "The sound of cars" is not a sentence, because it lacks a verb phrase.

Rules of syntax underlie all language use, even though you may not be aware of them. Thus, although they may not be able to verbalize the rule, virtually all English speakers know that an *article* (such as *the*) comes before the word it modifies. For example, you would never say *swimmer the* instead of *the swimmer.* How children learn the complicated rules of syntax is one of the major puzzles investigated by psychologists interested in language. Like other aspects of language development, children's acquisition of syntax seems to progress at an amazingly rapid pace. Let's look at how this remarkable development unfolds.

Milestones in Language Development

Learning to use language requires learning a number of skills that become important at various points in a child's development (Siegler & Alibali, 2005). We'll examine this developmental sequence by looking first at how children learn to pronounce words, then at their use of single words, and finally at their ability to combine words to form sentences (see Table 8.2).

Moving Toward Producing Words

Three-month-old infants display a surprising language-related talent: They can distinguish phonemes from all the world's languages, including phonemes that they do not hear in their environment. In contrast, adults cannot readily discriminate phonemes that are not used in their native language. Actually, neither can 1-year-old children, as this curious ability disappears by the time children reach 12 months of age (Bates, Devescovi, & Wulfeck, 2001; Werker & Tees, 1999). The exact mechanisms responsible for this transition are not understood, but it is clear that long before infants utter their first words, they are making remarkable progress in learning the sound structure of their native language. Progress toward understanding words also occurs during the first year. By 7.5 months, infants begin to recognize common word forms (Houston, Santelmann, & Jusczyk, 2004), and by 8 months many show the

primitive first signs of understanding the meanings of familiar words (Bates et al., 2001).

During the first six months of life, a baby's vocalizations are dominated by crying, cooing, and laughter, which have limited value as a means of communication. Soon, infants are *babbling,* producing a wide variety of sounds that correspond to phonemes and, eventually, many repetitive consonant-vowel combinations, such as "lalalalalala." Babbling gradually becomes more complex and increasingly resembles the language spoken by parents and others in the child's environment (Hoff, 2005). Babbling lasts until around 18 months, continuing even after children utter their first words.

At around 10 to 13 months of age, most children begin to utter sounds that correspond to words. Most infants' first words are similar in phonetic form and meaning—even in different languages (Waxman, 2002). The initial words resemble the syllables that infants most often babble spontaneously. For example, words such as *dada, mama,* and *papa* are names for parents in many languages because they consist of sounds that are easy to produce.

Using Words

After children utter their first words, their vocabulary grows slowly for the next few months (Dapretto & Bjork, 2000). Toddlers typically can say between 3 and 50 words by 18 months. However, their *receptive vocabulary* is larger than their *productive vocabulary.* That is, they can comprehend more words spoken by others than they can actually produce to express themselves (Dan & Gleason, 2001). Thus, toddlers can *understand* 50 words months before they can *say* 50 words. Toddlers' early words tend to refer most often to *objects* and secondarily to *social actions,* such as *hello* and *goodbye* (Camaioni, 2001). Children probably acquire nouns before verbs, because the meanings of nouns, which often refer to distinct, concrete objects, tend to be easier to encode than the meanings of verbs, which often refer to more abstract relationships (Poulin-Dubois & Graham, 2007). However, this generalization may not apply to all languages (Bates et al., 2001).

Youngsters' vocabularies soon begin to grow at a dizzying pace, as a *vocabulary spurt* or *naming explosion* begins at around 18 months when toddlers realize that everything has a name (Camaioni, 2001) (see Figure 8.2). By the first grade, the average child has a vocabulary of approximately 10,000 words, which builds to an astonishing 40,000 words by the fifth grade (Anglin, 1993) (see Figure 8.3). In building these impressive vocabularies, some 2-year-olds learn as many as 20 new words every week. *Fast mapping* appears to be one factor underlying this rapid growth of vocabulary (Gershkoff-Stowe & Hahn, 2007; Markman, Wasow, & Hansen, 2003). ***Fast mapping* is the process by which children map a word onto an underlying concept after only one exposure.** Thus, children often add words like *tank, board,* and *tape* to their vocabularies after their first encounter with objects that illustrate these concepts. The vocabulary spurt may be attributable to children's improved articulation skills, improved understanding of syntax, underlying cognitive development, or some combination of these factors (MacWhinney, 1998).

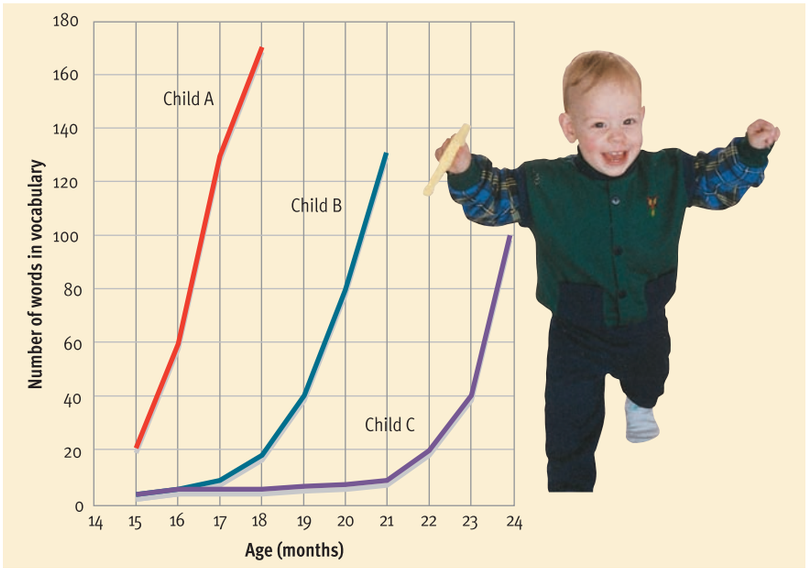


Figure 8.2
The vocabulary spurt. Children typically acquire their first 10–15 words very slowly, but they soon go through a *vocabulary spurt*—a period during which they rapidly acquire many new words. The vocabulary spurt usually begins at around 18 months, but children vary, as these graphs of three toddlers' vocabulary growth show.

SOURCE: Adapted from Goldfield, B. A., & Resnick, J. S. (1990). Early lexical acquisition: Rate, content, and the vocabulary spurt. *Journal of Child Language, 17,* 171–183. Copyright © 1990 by Cambridge University Press. Photo: Courtesy of Wayne Weiten

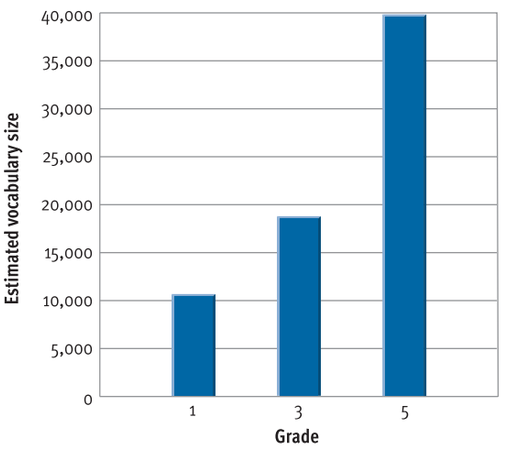


Figure 8.3
The growth of school children's vocabulary. Vocabulary growth is rapid during the early years of grade school. Youngsters' estimated vocabulary doubles about every two years between first grade and fifth grade.

SOURCE: Anglin, J. M. (1993). Vocabulary development: A morphological analysis. *Child Development, 58,* Serial 238. Copyright © 1993 The Society for Research in Child Development. Reprinted by permission.

Of course, these efforts to learn new words are not flawless. Toddlers often make errors, such as overextensions and underextensions (Harley, 2008). **An *overextension* occurs when a child incorrectly uses a word to describe a wider set of objects or actions than it is meant to.** For example, a child might use the word *ball* for anything round—oranges, apples, even the moon. Overextensions usually appear in children's speech between ages 1 and $2\frac{1}{2}$. Specific overextensions typically last up to several months. Toddlers also tend to be guilty of ***underextensions,* which occur when a child incorrectly uses a word to describe a narrower set of objects or actions than it is meant to.** For example, a child might use the word *doll* to refer only to a single, favorite doll. Overextensions and underextensions show that toddlers are actively trying to learn the rules of language—albeit with mixed success.

Combining Words

Children typically begin to combine words into sentences near the end of their second year. Early sentences are characterized as "telegraphic" because they resemble old-fashioned telegrams, which omitted nonessential words because senders were charged by the word (Bochner & Jones, 2003). ***Telegraphic speech* consists mainly of content words; articles, prepositions, and other less critical words are omitted.** Thus, a child might say, "Give doll" rather than "Please give me the doll." Although not unique to the English language, telegraphic speech is not cross-culturally universal, as once thought (de Villiers & de Villiers, 1999).

Researchers sometimes track language development by keeping tabs on subjects' ***mean length of utterance (MLU)*—the average length of youngsters' spoken statements (measured in morphemes).** As children grow and begin to combine words, their vocal expressions gradually become longer (Hoff, 2005).

By the end of their third year, most children can express complex ideas such as plurals or past tense. However, their efforts to learn the rules of language continue to result in revealing mistakes. ***Overregularizations* occur when grammatical rules are incorrectly generalized to irregular cases where they do not apply.** For example, children will say things like "The girl goed home" or "I hitted the ball." Cross-cultural research suggests that these overregularizations occur in all languages (Slobin, 1985). Most theorists believe that overregularizations demonstrate that children are working actively to master the *rules* of language (Marcus, 1996). These efforts pay off gradually, however, as specific overregularizations often linger in a child's speech even though the child has heard the correct constructions many times (Maslen et al., 2004). Children don't learn the fine points of grammar and usage in a single leap but gradually acquire them in small steps.

Refining Language Skills

Youngsters make their largest strides in language development in their first 4 to 5 years. However, they continue to refine their language skills during their school-age years. They generate longer and more complicated sentences as they receive formal training in written language.

As their language skills develop, school-age children begin to appreciate ambiguities in language. They can, for instance, recognize two possible meanings in sentences such as "Visiting relatives can be bothersome." This interest in ambiguities indicates that they're developing ***metalinguistic awareness*—the ability to reflect on the use of language.** As metalinguistic awareness grows, children begin to recognize that statements may have a *literal meaning* and an *implied meaning*. They begin to make more frequent and sophisticated use of metaphors, such as "We were packed in the room like sardines" (Gentner, 1988).

Between the ages of 6 and 8 most children begin to appreciate irony and sarcasm (Creusere, 1999). *Irony* involves conveying an implied meaning that is the opposite of a statement's literal meaning (on learning that he got a D on an exam, a student says, "Oh, that's just great"). *Sarcasm* is a variation on irony in which there is a caustic element directed at a particular person (commenting on a blunder by her husband a woman says, "My husband, the genius"). Understanding sarcasm requires appreciating the subtleties of an utterance's social and

concept check 8.1

Tracking Language Development

Check your understanding of how language skills progress in youngsters. Number the utterances below to indicate the developmental sequence in which they would probably occur. The answers can be found in Appendix A in the back of the book.

_____ 1. "Doggie," while pointing to a cow.

_____ 2. "The dogs runned away."

_____ 3. "Doggie run."

_____ 4. "The dogs ran away."

_____ 5. "Doggie," while pointing to a dog.

_____ 6. "Tommy thinks like his head is full of mashed potatoes."

cultural context (Katz, Blasko, & Kazmerski, 2004). Interestingly, although language processing is generally handled by the left hemisphere of the brain (see Chapter 3), the right hemisphere appears to play a key role in the understanding of sarcasm (Shamay-Tsoory, Tomer, & Aharon-Peretz, 2005).

Learning More Than One Language: Bilingualism

Given the complexities involved in acquiring one language, you may be wondering about the ramifications of being asked to learn *two* languages. ***Bilingualism* is the acquisition of two languages that use different speech sounds, vocabulary, and grammatical rules.** Although not the norm in the United States, bilingualism is quite common in Europe and many other regions, and nearly half of the world's population grows up bilingual (Hakuta, 1986; Snow, 1998). Moreover, bilingualism is far from rare even in the English-dominated United States, where roughly 6–7 million children speak a language other than English at home. Bilingualism has sparked considerable controversy in the United States, as a number of new laws and court rulings have reduced the availability of bilingual educational programs in many school systems (Wiese & Garcia, 2007). These laws are based on the implicit assumption that bilingualism hampers language development and has a negative impact on youngsters' educational progress. But does the empirical evidence support this assumption? Let's take a look at the research on bilingualism.

Does Learning Two Languages in Childhood Slow Down Language Development?

If youngsters are learning two languages simultaneously, does one language interfere with the other so that the acquisition of both is impeded? Given the far-reaching sociopolitical implications of this question, you might guess that many relevant studies have been conducted, but in reality there is only a modest body of research. Some studies *have* found that bilingual children have smaller vocabularies in each of their languages than monolingual children have in their one language (Umbel et al., 1992). But when their two overlapping vocabularies are added, their total vocabulary is similar or slightly superior to that of children learning a single language (Oller & Pearson, 2002). Taken as a whole, the available evidence suggests that bilingual and monolingual children are largely similar in the course and rate of their language development (de Houwer, 1995; Nicoladis & Genesee, 1997). Learning two languages simultaneously may not be as easy as learning just one, but there is little empirical support for the belief that bilingualism has serious negative effects on language development (Hoff, 2005).

Does Bilingualism Affect Cognitive Processes and Skills?

Does learning two languages slow down cognitive development or have a negative impact on intellectual skills? Some early studies of this question suggested that the answer is "yes," but the studies suffered from fundamental flaws (Hakuta, 1986). Typically, immigrant bilingual children and native English-speaking children were given IQ tests *in English,* with the results favoring the English speakers. But these results were misleading, because the bilingual students tended to come from more impoverished backgrounds and because they were handicapped by having to take the IQ test in their second language (Hakuta, 2000). Imagine if you had to take an IQ test in French after a couple years of French instruction. When studies use proper controls, the evidence is mixed, depending on the variables measured—and sometimes the results *favor* the bilinguals. For example, when middle-class bilingual subjects who are fluent in both languages are studied, they tend to score somewhat *higher* than monolingual subjects on measures of cognitive flexibility, analytical

© AP Images/Charlie Riedel

The utility of bilingual education programs has been a hotly debated local issue across the United States and Canada. Critics argue that bilingualism has a negative effect on children's language and cognitive development, but there is relatively little empirical support for this assertion.

web link 8.2

Chimpanzee and Human Communication Institute

Maintained at Central Washington University, this site focuses on efforts to train Washoe and other chimps in American Sign Language. It houses a great deal of information on this line of research and other issues related to animal welfare.

reasoning, selective attention, and metalinguistic awareness (Bialystok, 2001, 2005, 2007; Campbell & Sais, 1995). However, on some types of tasks, bilinguals may have a slight disadvantage in terms of raw language-processing *speed* (Taylor & Taylor, 1990). Nonetheless, when researchers control for the effects of social class, they do not find significant cognitive deficits in bilingual youngsters.

Can Animals Develop Language?

Can other species besides humans develop language? Although this issue does not have the practical, sociopolitical repercussions of the debate about bilingualism, it has intrigued researchers for many decades and has led to some fascinating research. Scientists have taught some language-like skills to a number of species, including dolphins (Herman, Kuczaj, & Holder, 1993), sea lions (Schusterman & Gisiner, 1988), and an African gray parrot (Pepperberg, 1993, 2002), but their greatest success has come with the chimpanzee, an intelligent primate widely regarded as humans' closest cousin.

In early studies, researchers tried training chimps to use a nonoral human language: American Sign Language (ASL). ASL is a complex language of hand gestures and facial expressions used by thousands of deaf people in the United States. With extensive training, a chimp named Washoe acquired a sign vocabulary of roughly 160 words and learned to combine these words into simple sentences, such as "Gimme flower" (Gardner & Gardner, 1969). Although these accomplishments were impressive, critics expressed doubts about whether Washoe and other chimps that learned ASL had really acquired *rules* of language. According to Terrace (1986), the chimps' sentences were the products of imitation and operant conditioning, rather than *generative* creations based on linguistic rules.

In more recent years, Sue Savage-Rumbaugh and her colleagues have reported some striking advances with *bonobo pygmy chimpanzees* that have fueled additional debate (Savage-Rumbaugh, 1991; Savage-Rumbaugh, Shanker, & Taylor, 1998; Savage-Rumbaugh, Rumbaugh, & Fields, 2006). In this line of research, the bonobos have been trained to communicate with their caretakers by touching geometric symbols representing words on a computer-monitored keyboard. Savage-Rumbaugh's star pupil has been a chimp named Kanzi, although many of his feats have been duplicated by his younger sister, Panbanisha. Kanzi has acquired hundreds of words and has used them in thousands of combinations. Many of these combinations have been spontaneous and seem to follow rules of language. For example, to specify whether he wanted to chase or be chased, Kanzi had to differentiate between symbol combinations in a way that appeared to involve the use of grammatical rules. As the years went by, Kanzi's trainers noticed that he often seemed to understand the normal utterances that they exchanged with each other. Subseqently, they began to systematically evaluate his comprehension of spoken English and found that he could understand hundreds of sentences that directed him to execute simple actions, such as "Put the collar in the water."

How have the linguistics experts reacted to Kanzi's surprising progress in language development? Many remain skeptical. Wynne (2004) has raised questions about the scoring system used to determine whether Kanzi "understood" oral requests, arguing that it was extremely "generous." Wynne and other critics (Budiansky, 2004; Kako, 1999; Wallman, 1992) have also questioned whether Kanzi's communications demonstrate all the basic properties of a language.

The newest evidence in the debate about whether language is unique to humans is a recent study of chimpanzees using brain-imaging technology. As you may recall from Chapter 3, in humans *Broca's area* is a small region in the left hemisphere of the brain that is crucial to language production (consult **Figure 3.21**). Taglialatela and colleagues (2008) set out to determine whether chimps have a comparable brain area in roughly the same location. Using PET scans to map brain activity while chimps engaged in communication, they determined that chimps do have an analogous area in the left hemisphere. The investigators conclude that the neurological substrates underlying language may also be present in chimpanzees.

Sue Savage-Rumbaugh

"What Kanzi tells us is that humans are not the only species that can acquire language if exposed to it at an early age."

Kanzi, a pygmy chimpanzee, has learned to communicate with his caretakers in surprisingly sophisticated ways via computer-controlled symbol boards, thus raising some doubt about whether language is unique to humans.

FRANK & ERNEST

So, what can we conclude? Overall, it seems reasonable to assert that the ability to use language—in a basic, primitive way—may not be entirely unique to humans, as has been widely assumed.

However, make no mistake, there is no comparison between human linguistic abilities and those of apes or other animals. As remarkable as the language studies with apes are, they should make us marvel even more at the fluency, flexibility, and complexity of human language. A normal human toddler quickly surpasses even the most successfully trained chimps. In mastering language, children outstrip chimps the way jet airplanes outrace horse-drawn buggies. Why are humans so well suited for learning language? According to some theorists, this talent for language is a product of evolution. Let's look at their thinking.

Language in Evolutionary Context

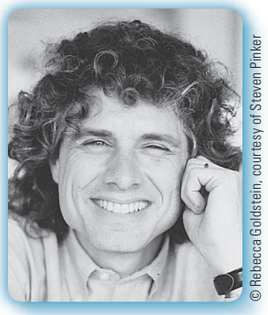
All human societies depend on complex language systems. Even primitive cultures use languages that are just as complicated as those used in modern societies. The universal nature of language suggests that it is an innate human characteristic. Consistent with this view, Steven Pinker argues that humans' special talent for language is a species-specific trait that is the product of natural selection (Pinker, 1994, 2004; Pinker & Jackendoff, 2005). According to Pinker, language is a valuable means of communication that has enormous adaptive value. As Pinker and Bloom (1992) point out, "There is an obvious advantage in being able to acquire information about the world secondhand . . . one can avoid having to duplicate the possibly time-consuming and dangerous trial-and-error process that won that knowledge" (p. 460). Dunbar (1996) argues that language evolved as a device to build and maintain social coalitions in increasingly larger groups. Although the impetus for the evolution of language remains a matter of speculation and debate (Kirby, 2007), it does not take much imagination to envision how more-effective communication among our ancient ancestors could have aided hunting, gathering, fighting, and mating and the avoidance of poisons, predators, and other dangers.

Although the adaptive value of language seems obvious, some scholars take issue with the assertion that human language is the product of evolution. For example, David Premack (1985) has expressed skepticism that small differences in language skill would influence reproductive fitness in primitive societies where all one had to communicate about was the location of the closest mastadon herd. In an effort to refute this argument, Pinker and Bloom (1992) point out that very small adaptive disparities are sufficient to fuel evolutionary change. For example, they cite an estimate that a 1% difference in mortality rates among overlapping Neanderthal and human populations could have led to the extinction of Neanderthals in just 30 generations. They also note that a trait variation that produces on average just 1% more offspring than its alternative genetic expression would increase in prevalence from 0.1% to 99.9% of the population in 4000 generations. That many generations may seem like an eternity, but in the context of evolution, it is a modest amount of time.

Whether or not evolution gets the credit, language acquisition in humans seems remarkably rapid. As you will see in the next section, this fact looms large in theories of language acquisition.

Theories of Language Acquisition

Since the 1950s, a great debate has raged about the key processes involved in language acquisition. As with arguments we have seen in other areas of psychology, this one centers on the *nature versus nurture* issue. The debate was stimulated by the influential behaviorist B. F. Skinner (1957), who argued that environmental factors govern language development. His provocative analysis brought a rejoinder from Noam Chomsky (1959), who emphasized biological determinism. Let's examine their views and subsequent theories that stake out a middle ground.



Steven Pinker

"If human language is unique in the modern animal kingdom, as it appears to be, the implications for a Darwinian account of its evolution would be as follows: none. A language instinct unique to modern humans poses no more of a paradox than a trunk unique to modern elephants."

Behaviorist Theories

The behaviorist approach to language was first outlined by Skinner in his book *Verbal Behavior* (1957). He argued that children learn language the same way they learn everything else: through imitation, reinforcement, and other established principles of conditioning. According to Skinner, vocalizations that are not reinforced gradually decline in frequency. The remaining vocalizations are shaped with reinforcers until they are correct. Behaviorists assert that by controlling reinforcement, parents encourage their children to learn the correct meaning and pronunciation of words (Staats & Staats, 1963). For example, as children grow older, parents may insist on closer and closer approximations of the word *water* before supplying the requested drink.

Behavioral theorists also use the principles of imitation and reinforcement to explain how children learn syntax. According to the behaviorists' view, children learn how to construct sentences by imitating the sentences of adults and older children. If children's imitative statements are understood, parents are able to answer their questions or respond to their requests, thus reinforcing their verbal behavior.

Nativist Theories

Skinner's explanation of language acquisition soon inspired a critique and rival explanation from Noam Chomsky (1959, 1965). Chomsky pointed out that there are an infinite number of sentences in a language. It's therefore unreasonable to expect that children learn language by imitation. For example, in English, we add *ed* to the end of a verb to construct past tense. Children routinely overregularize this rule, producing incorrect verbs such as *goed, eated,* and *thinked*. Mistakes such as these are inconsistent with Skinner's emphasis on imitation, because most adult speakers don't use ungrammatical words like *goed*. Children can't imitate things they don't hear. According to Chomsky, children learn *the rules of language,* not specific verbal responses, as Skinner proposed.

An alternative theory favored by Chomsky (1975, 1986, 2006) is that humans have an inborn or "native" propensity to develop language. (Here *native* is a variation on the word *nature* as it's used in the nature versus nurture debate.) *Nativist theory* proposes that humans are equipped with a ***language acquisition device (LAD)*—an innate mechanism or process that facilitates the learning of language.** According to this view, humans learn language for the same reason that birds learn to fly—because they're biologically equipped for it. The exact nature of the LAD has not been spelled out in nativist theories. It presumably consists of brain structures and neural wiring that leave humans well prepared to discriminate among phonemes, to fast-map morphemes, to acquire rules of syntax, and so on.

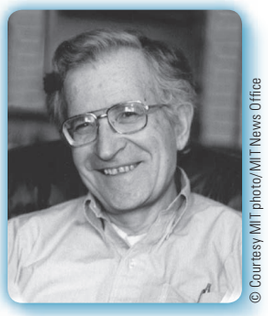
Why does Chomsky believe that children have an innate capacity for learning language? One reason is that children seem to acquire language quickly and effortlessly. How could they develop so complex a skill in such a short time unless they have a built-in capacity for it? Another reason is that language development tends to unfold at roughly the same pace for most children, even though children obviously are reared in diverse home environments. This finding suggests that language development is determined by biological maturation more than personal experience. The nativists also cite evidence that the early course of language development is similar across very different cultures (Gleitman & Newport, 1996; Slobin, 1992). They interpret this to mean that children all over the world are guided by the same innate capabilities.

Interactionist Theories

Like Skinner, Chomsky has his critics (Bohannon & Bonvillian, 2001). They ask: What exactly is a language acquisition device? How does the LAD work? What are the neural mechanisms involved? They argue that the LAD concept is awfully vague. Other critics question whether the rapidity of early language development is as exceptional as nativists assume. They assert that it isn't fair to compare the rapid progress of toddlers, who are immersed in their native language, against the struggles of older students, who may devote only a few hours per week to their foreign language course.

The problems apparent in Skinner's and Chomsky's explanations of language development have led some researchers to outline *interactionist theories* of language acquisition. These theories assert that biology and experience *both* make important contributions to the development of language. For example, *emergentist theories* argue that the neural circuits supporting language are not prewired but *emerge* gradually in response to language learning experiences (Bates, 1999; MacWhinney, 2001, 2004). These theories tend to assume that incremental changes in connectionist networks (see Chapter 7) underlie children's gradual acquisition of various language skills (Elman, 1999).

Like the nativists, interactionists believe that the human organism is biologically well equipped for learning language. They also agree that much of this learning involves the acquisition of rules. However, like the behaviorists, they believe that social exchanges with parents and others play a critical role in molding language skills. Thus, interaction-



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Noam Chomsky

"Even at low levels of intelligence, at pathological levels, we find a command of language that is totally unattainable by an ape."

ist theories maintain that a biological predisposition *and* a supportive environment both contribute to language development (see Figure 8.4).

Culture, Language, and Thought

Another long-running controversy in the study of language concerns the relations between culture, language, and thought. Obviously, people from different cultures generally speak different languages. But does your training in English lead you to think about certain things differently than someone who was raised to speak Chinese or French? In other words, does a cultural group's language determine their thought? Or does thought determine language?

Benjamin Lee Whorf (1956) has been the most prominent advocate of ***linguistic relativity,*** **the hypothesis that one's language determines the nature of one's thought.** Whorf speculated that different languages lead people to view the world differently. His classic example compared English and Eskimo views of snow. He asserted that the English language has just one word for snow, whereas the Eskimo language has many words that distinguish among falling snow, wet snow, and so on. Because of this language gap, Whorf argued that Eskimos perceive snow differently than English-speaking people do. However, Whorf's conclusion about these perceptual differences was based on casual observation rather than systematic cross-cultural comparisons of perceptual processes. Moreover, critics subsequently noted that advocates of the linguistic relativity hypothesis had carelessly overestimated the number of Eskimo words for snow, while conveniently ignoring the variety of English words that refer to snow, such as slush and blizzard (Martin, 1986; Pullum, 1991).

In any event, Whorf's hypothesis has been the subject of considerable research and continues to generate spirited debate (Chiu, Leung, & Kwan, 2007; Gleitman & Papafragou, 2005). Many studies have focused on cross-cultural comparisons of how people perceive colors, because substantial variations exist among cultures in how colors are categorized with names. For example, some languages have a single color name that includes both blue and green, whereas other languages view light blue and dark blue as fundamentally different colors (Davies, 1998). If a language doesn't distinguish between blue and green, do people who speak that language think about colors differently than people in other cultures do?

Early efforts to answer this question suggested that the color categories in a language have relatively little influence on how people perceive and think about colors (Berlin & Kay, 1969; Rosch, 1973). However, a flurry of recent studies have provided new evidence favoring the linguistic relativity hypothesis (Davidoff, 2001, 2004; Roberson et al., 2005). For example, studies of subjects who speak African languages that do not have a boundary between blue and green have found that language affects their color perception, as they have more trouble making quick discriminations between blue and green colors than English-speaking subjects do (Ozgen, 2004). Additional studies using a variety of methods have found that a culture's color categories shape subjects' similarity judgments and groupings of colors (Pilling & Davies, 2004; Roberson, Davies, & Davidoff, 2000). These findings have led Ozgen (2004) to conclude that "it is just possible that what you see when you look at the rainbow depends on the language you speak" (p. 98). Moreover, the new support for linguistic relativity is not limited to the study of color perception. Other studies have found that language also has some impact on how people

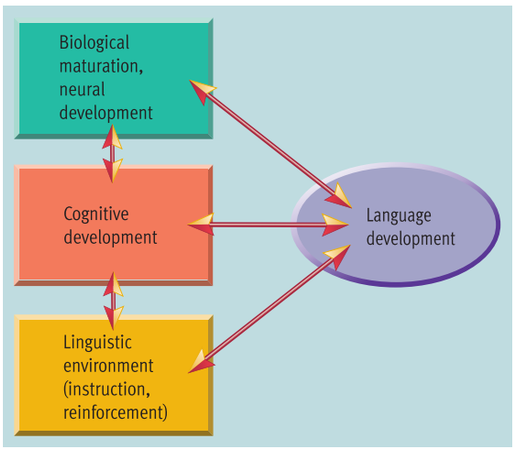


Figure 8.4
Interactionist theories of language acquisition.
The interactionist view is that nature and nurture are both important to language acquisition. Maturation is thought to drive language development directly and to influence it indirectly by fostering cognitive development. Meanwhile, verbal exchanges with parents and others are also thought to play a critical role in molding language skills. The complex bidirectional relations depicted here shed some light on why there is room for extensive debate about the crucial factors in language acquisition.

Does the language you speak determine how you think? Yes, said Benjamin Lee Whorf, who argued that the Eskimo language, which has numerous words for snow, leads Eskimos to perceive snow differently than English speakers. Whorf's hypothesis has been the subject of spirited debate.

think about motion (Gennari et al., 2002), time (Boroditsky, 2001), and shapes (Roberson, Davidoff, & Shapiro, 2002).

So, what is the status of the linguistic relativity hypothesis? At present, the debate seems to center on whether the new data are sufficient to support the original, "strong" version of the hypothesis—that a given language makes certain ways of thinking obligatory or impossible—or a "weaker" version of the hypothesis—that a language makes certain ways of thinking easier or more difficult. Either way, empirical support for the linguistic relativity hypothesis has increased dramatically in recent years.

REVIEW of Key Learning Goals

8.1 The key properties of language include being symbolic, generative, and structured. Human languages are structured hierarchically. At the bottom of the hierarchy are the basic sound units, called phonemes. At the next level are morphemes, the smallest units of meaning. Rules of syntax specify how words can be combined into sentences.

8.2 The initial vocalizations by infants are similar across languages, but their babbling gradually begins to resemble the sounds from their surrounding language. Children typically utter their first words around their first birthday. A vocabulary spurt often begins around 18 months. Most children begin to combine words by the end of their second year. Their early sentences are telegraphic. Over the next several years, children gradually learn the complexities of syntax and develop metalinguistic awareness.

8.3 Research does not support the assumption that bilingualism has a negative effect on language development. Early research on bilingualism and cognitive development was flawed. When appropriate controls are used, researchers do not find significant cognitive deficits in bilingual youngsters.

8.4 Efforts to teach chimpanzees American Sign Language were impressive, but doubts were raised about whether the chimps learned rules of language. Sue Savage-Rumbaugh's work with Kanzi suggests that chimps are capable of some very basic language acquisition, but there is no comparison between the linguistic abilities of humans and other animals.

8.5 Many theorists, such as Steven Pinker, believe that humans' special talent for language is the product of natural selection because more effective communication would confer a variety of adaptive benefits. However, this assertion has been challenged.

8.6 According to Skinner and other behaviorists, children acquire a language through imitation and reinforcement. Nativist theories assert that humans have an innate capacity to learn language rules. Today, theorists are moving toward interactionist perspectives, which emphasize the role of both biology and experience.

8.7 The theory of linguistic relativity asserts that language determines thought, thus suggesting that people from different cultures may think about the world somewhat differently. Recent studies have provided new support for the linguistic relativity hypothesis.

Problem Solving: In Search of Solutions

Key Learning Goals

8.8 List the three types of problems proposed by Greeno.

8.9 Identify and describe four common barriers to effective problem solving.

8.10 Review a variety of general problem-solving strategies and heuristics.

8.11 Discuss cultural variations in cognitive style as they relate to problem solving.

Look at the two problems below. Can you solve them?

In the Thompson family there are five brothers, and each brother has one sister. If you count Mrs. Thompson, how many females are there in the Thompson family?

Fifteen percent of the people in Topeka have unlisted telephone numbers. You select 200 names at random from the Topeka phone book. How many of these people can be expected to have unlisted phone numbers?

These problems, borrowed from Sternberg (1986, p. 214), are exceptionally simple, but many people fail to solve them. The answer to the first problem is *two:* The only females in the family are Mrs. Thompson and her one daughter, who is a sister to each of her brothers. The answer to the second problem is *none*—you won't find any people with *unlisted* phone numbers in the phone book.

Why do many people fail to solve these simple problems? You'll learn why in a moment, when we discuss barriers to effective problem solving. But first, let's examine a scheme for classifying problems into a few basic types.

Types of Problems

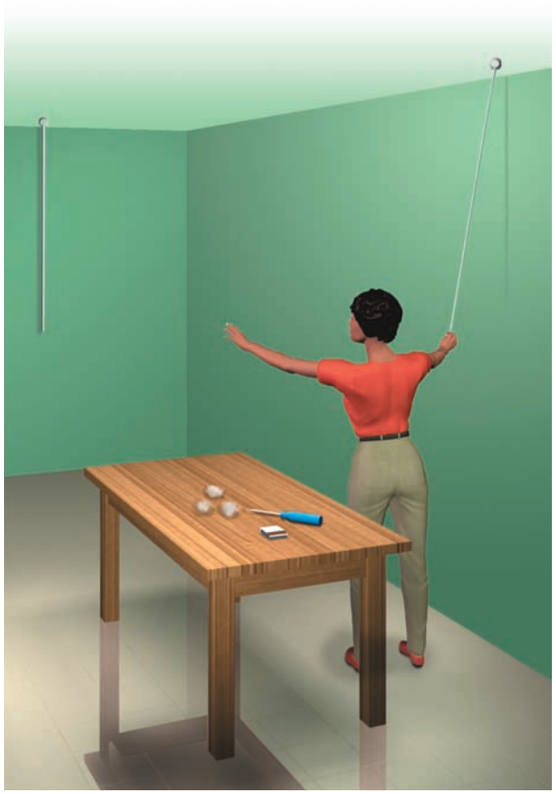
SIM7, 7e

Problem solving **refers to active efforts to discover what must be done to achieve a goal that is not readily attainable.** Obviously, if a goal is readily attainable, there isn't a problem. But in problem-solving situations, one must go beyond the information given to overcome obstacles and reach a goal. Jim Greeno (1978) has proposed that problems can be categorized into three basic classes:

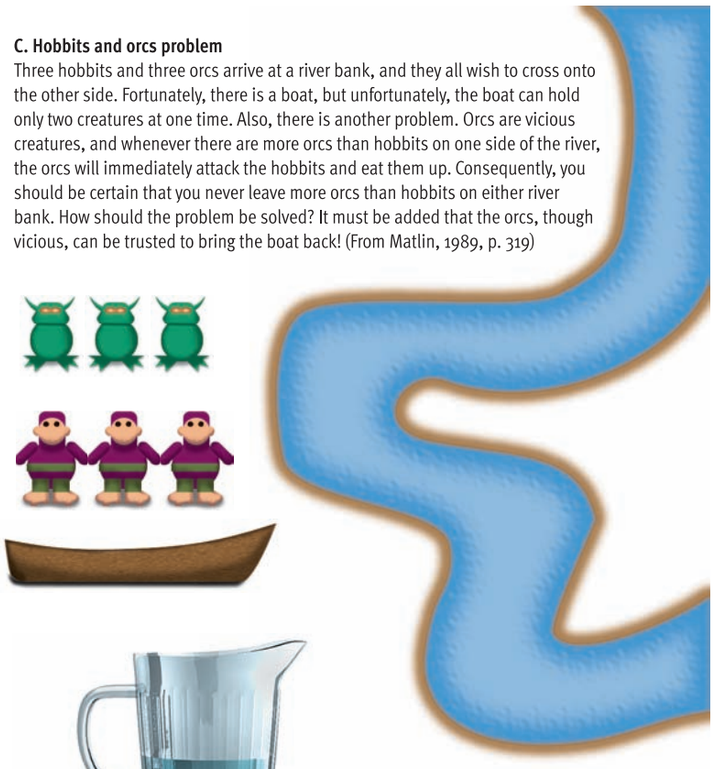
1. *Problems of inducing structure* require people to discover the relations among numbers, words, symbols, or ideas. The *series completion problems* and the *analogy problems* in Figure 8.5 are examples of problems of inducing structure.
2. *Problems of arrangement* require people to arrange the parts of a problem in a way that satisfies some criterion. The parts can usually be arranged in many

A. Analogy
What word completes the analogy?
Merchant : Sell : : Customer : _____
Lawyer : Client : : Doctor : _____

B. String problem
Two strings hang from the ceiling but are too far apart to allow a person to hold one and walk to the other. On the table are a book of matches, a screwdriver, and a few pieces of cotton. How could the strings be tied together?



C. Hobbits and orcs problem
Three hobbits and three orcs arrive at a river bank, and they all wish to cross onto the other side. Fortunately, there is a boat, but unfortunately, the boat can hold only two creatures at one time. Also, there is another problem. Orcs are vicious creatures, and whenever there are more orcs than hobbits on one side of the river, the orcs will immediately attack the hobbits and eat them up. Consequently, you should be certain that you never leave more orcs than hobbits on either river bank. How should the problem be solved? It must be added that the orcs, though vicious, can be trusted to bring the boat back! (From Matlin, 1989, p. 319)



D. Water jar problem
Suppose that you have a 21-cup jar, a 127-cup jar, and a 3-cup jar. Drawing and discarding as much water as you like, you need to measure out exactly 100 cups of water. How can this be done?

E. Anagram
Rearrange the letters in each row to make an English word.
RWAET
KEROJ

F. Series completion
What number or letter completes each series?
1 2 8 3 4 6 5 6 _____
A B M C D M _____

Figure 8.5
Six standard problems used in studies of problem solving. Try solving the problems and identifying which class each belongs to before reading further. The problems can be classified as follows. The *analogy problems* and *series completion problems* are problems of inducing structure. The solutions for the analogy problems are *Buy* and *Patient*. The solutions for the series completion problems are *4* and *E*. The *string problem* and the *anagram problems* are problems of arrangement. To solve the string problem, attach the screwdriver to one string and set it swinging as a pendulum. Hold the other string and catch the swinging screwdriver. Then you need only untie the screwdriver and tie the strings together. The solutions for the anagram problems are *WATER* and *JOKER*. The *hobbits and orcs problem* and the *water jar problem* are problems of transformation. The solutions for these problems are outlined in Figure 8.6 and Figure 8.7.

ways, but only one or a few of the arrangements form a solution. The *string problem* and the *anagrams* in Figure 8.5 fit in this category.

3. *Problems of transformation* require people to carry out a sequence of transformations in order to reach a specific goal. The *hobbits and orcs problem* and the *water jar problem* in Figure 8.5 are examples of transformation problems. Transformation problems can be challenging. Even though you know exactly what the goal is, it's often not obvious how the goal can be achieved.

Greeno's list is not an exhaustive scheme for classifying problems, but it provides a useful system for understanding some of the variety seen in problems. Although researchers have recently shown an increased interest in how people solve real-world problems in science, medicine, or law, research in this area has

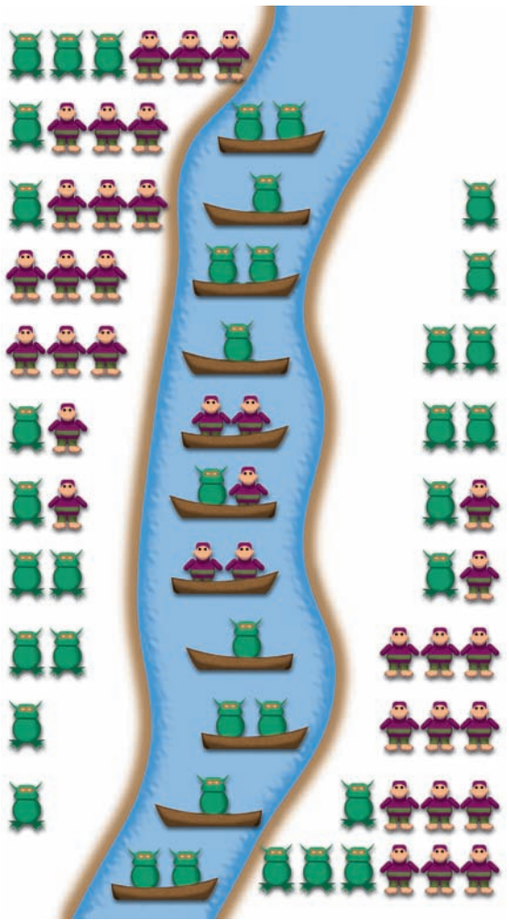


Figure 8.6
Solution to the hobbits and orcs problem. This problem is difficult because it is necessary to temporarily work "away" from the goal.

traditionally focused on "generic" problems like those in Figure 8.5, which are largely uncontaminated by variations in subjects' knowledge or expertise.

Barriers to Effective Problem Solving

On the basis of their studies of problem solving, psychologists have identified a number of barriers that frequently impede subjects' efforts to arrive at solutions. Common obstacles to effective problem solving include a focus on irrelevant information, functional fixedness, mental set, and the imposition of unnecessary constraints.

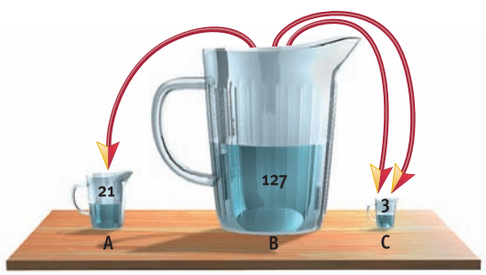


Figure 8.7
The method for solving the water jar problem. As explained in the text, the correct formula is B – A – 2C.

Irrelevant Information

We began our discussion of problem solving with two simple problems that people routinely fail to solve (see page 328). The catch is that these problems contain *irrelevant information* that leads people astray. In the first problem, the number of brothers is irrelevant in determining the number of females in the Thompson family. In the second problem, subjects tend to focus on the figures of 15% and 200 names. But this numerical information is irrelevant, since all the names came out of the phone book.

Sternberg (1986) points out that people often incorrectly assume that all the numerical information in a problem is necessary to solve it. They therefore try to figure out how to use quantitative information before they even consider whether it's relevant. Focusing on irrelevant information can have adverse effects on reasoning and problem solving (Gaeth & Shanteau, 2000). Thus, effective problem solving requires that you attempt to figure out what information is relevant and what is irrelevant before proceeding.

Functional Fixedness

Another common barrier to successful problem solving, identified by Gestalt psychologists, is ***functional fixedness*—the tendency to perceive an item only in terms of its most common use.** Functional fixedness has been seen in the difficulties that people have with the string problem in Figure 8.5 (Maier, 1931). Solving this problem requires finding a novel use for one of the objects: the screwdriver. Subjects tend to think of the screwdriver in terms of its usual functions—turning screws and perhaps prying things open. They have a hard time viewing the screwdriver as a weight. Their rigid way of thinking about the screwdriver illustrates functional fixedness (Dominowski & Bourne, 1994). Ironically, young children appear to be less vulnerable to functional fixedness than older children or adults because they have less knowledge about the conventional uses of various objects (Defeyter & German, 2003).

Mental Set

Rigid thinking is also at work when a mental set interferes with effective problem solving. **A *mental set* exists when people persist in using problem-solving strategies that have worked in the past.** The effects of mental set were seen in a classic study by Gestalt psychologist Abraham Luchins (1942). He asked subjects to work a series of water jar problems,

like the one introduced earlier. Six such problems are outlined in Figure 8.8, which shows the capacities of the three jars and the amounts of water to be measured out. Try solving these problems.

Were you able to develop a formula for solving these problems? The first four all require the same strategy, which was described in Figure 8.7. You have to fill jar B, draw off the amount that jar A holds once, and draw off the amount that jar C holds twice. Thus, the formula for your solution is B – A – 2C. Although there is an obvious and much simpler solution (A – C) for the fifth problem (see Figure 8.13 on page 334), Luchins found that most subjects stuck with the more cumbersome strategy that they had used in problems 1–4. Moreover, most subjects couldn't solve the sixth problem in the allotted time, because they kept trying to use their proven strategy, which does *not* work for this problem. The subjects' reliance on their "tried and true" strategy is an illustration of mental set in problem solving. This tendency to let one's thinking get into a rut is a common barrier to successful problem solving (Smith, 1995). Mental set may explain why having expertise in an area sometimes backfires and in fact hampers problem-solving efforts (Leighton & Sternberg, 2003).

Unnecessary Constraints 7e

Effective problem solving requires specifying all the constraints governing a problem *without assuming any constraints that don't exist.* An example of a problem in which people place an unnecessary constraint on the solution is the nine-dot problem shown in Figure 8.9 (Maier, 1930). Without lifting your pencil from the paper, try to draw four straight lines that will cross through all nine dots. If you struggle with this one, don't feel bad. When a time limit of a few minutes is imposed on this problem, the typical solution rate is 0% (MacGregor et al., 2001). The key factor that makes this a difficult problem is that most people will not draw lines outside the imaginary boundary that surrounds the dots. Notice that this constraint is not part of the problem statement. It's imposed only by the problem solver (Adams, 1980). Correct solutions, two of which are shown in Figure 8.14 on page 334, extend outside the imaginary boundary. To solve this problem you literally need

Figure 8.8

Additional water jar problems. **Using jars A, B, and C, with the capacities indicated in each row, figure out how to measure out the desired amount of water specified on the far right. The solutions are shown in Figure 8.13. (Based on Luchins, 1942)**

	Capacity of empty jars			
Problem	A	B	C	*Desired amount of water*
1	14	163	25	99
2	18	43	10	5
3	9	42	6	21
4	20	59	4	31
5	23	49	3	20
6	28	76	3	25

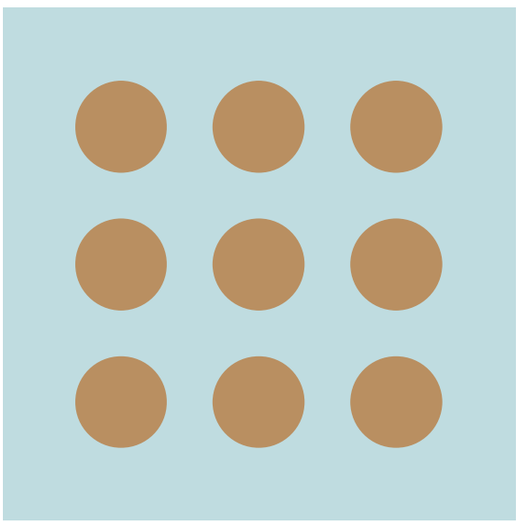


Figure 8.9

The nine-dot problem. **Without lifting your pencil from the paper, draw no more than four lines that will cross through all nine dots. For possible solutions, see Figure 8.14.**

SOURCE: Adams, J. L. (1980). *Conceptual block-busting: A guide to better ideas.* New York: W. H. Freeman. Copyright © 1980 by James L. Adams. Reprinted by permission of W. H. Freeman & Co.

to "think outside the box." This popular slogan, spawned by the nine-dot problem, reflects the fact that people often make assumptions that impose unnecessary constraints on problem-solving efforts.

The nine-dot problem is often solved with a burst of insight. ***Insight* occurs when people suddenly discover the correct solution to a problem after struggling with it for a while.** Problems requiring insight tend to be difficult for a variety of reasons. Difficulties may emerge from (1) how people structure the problem, (2) how they apply prior knowledge, or (3) how much they need to juggle information in working memory (Kershaw & Ohlsson, 2004). For example, in the nine-dot problem, the main barrier to a solution is that people tend to structure the problem poorly by imposing unnecessary boundaries. But people also struggle because their prior knowledge suggests that the "turns" in their lines should occur on the dots (rather than in the white space) and because envisioning all the options strains working memory. Although insight feels like a sudden, "aha" experience to problem solvers, some researchers have questioned whether insight solutions emerge full blown or are preceded by incremental movement toward a solution (Chronicle, MacGregor, & Ormerod, 2004). Recent studies suggest the latter—that insight breakthroughs are often preceded by gradual movement toward a solution that occurs outside of the problem solver's awareness (Novick & Bassok, 2005).

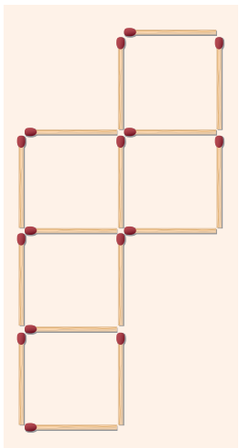


Figure 8.10
The matchstick problem.
Move two matches to form four equal squares. A solution can be found in Figure 8.15.

SOURCE: Kendler, H. H. (1974). *Basic psychology.* Menlo Park, CA: Benjamin-Cummings. Copyright © 1974 The Benjamin-Cummings Publishing Co. Adapted by permission of Howard H. Kendler.

Approaches to Problem Solving

In their classic treatise on problem solving, Allen Newell and Herbert Simon (1972) used a spatial metaphor to describe the process of problem solving. They used the term ***problem space* to refer to the set of possible pathways to a solution considered by the problem solver.** Thus, they see problem solving as a search in space. The problem solver's task is to find a solution path among the potential pathways that could lead from the problem's initial state to its goal state. The problem space metaphor highlights the fact that people must choose from among a variety of conceivable pathways or strategies in attempting to solve problems (Hunt, 1994). In this section, we'll examine some of these general strategies.

Using Algorithms and Heuristics

Trial and error is a common approach to solving problems. ***Trial and error* involves trying possible solutions and discarding those that are in error until one works.** Trial and error is often applied haphazardly, but people sometimes try to be systematic. **An *algorithm* is a methodical, step-by-step procedure for trying all possible alternatives in searching for a solution to a problem** (Dietrich, 1999). For instance, to solve the anagram IHCRA, you could write out all the possible arrangements of these letters until you eventually reached an answer (CHAIR). If an algorithm is available for a problem, it guarantees that one can eventually find a solution.

Algorithms can be effective when there are relatively few possible solutions to be tried out. However, algorithms do not exist for many problems, and they can become impractical when the problem space is large. Consider, for instance, the problem shown in Figure 8.10. The challenge is to move just two matches to create a pattern containing four equal squares. Sure, you could follow an algorithm in moving pairs of matches about. But you'd better allocate plenty of time to this effort, as there are over 60,000 possible rearrangements to check out (see Figure 8.15 on page 334 for the solution).

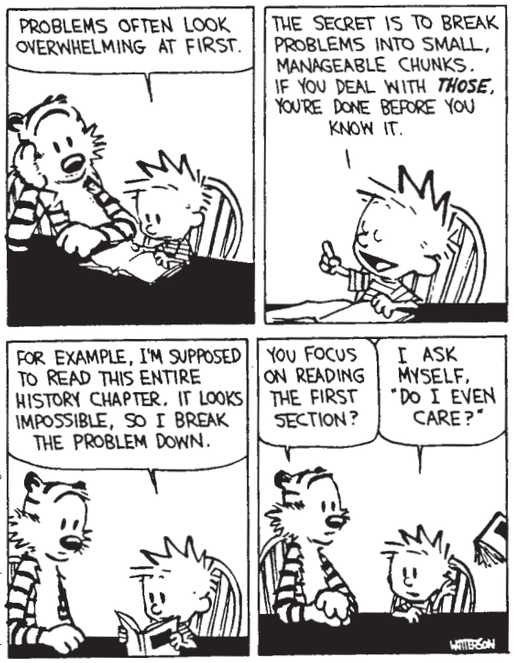
Because algorithms are inefficient, people often use shortcuts called *heuristics* in problem solving. **A *heuristic* is a guiding principle or "rule of thumb" used in solving problems or making decisions.** In solving problems, a heuristic allows you to discard some alternatives while pursuing selected alternatives that appear more likely to lead to a solution (Holyoak, 1995). Heuristics can be useful because they selectively narrow the problem space, but they don't guarantee success (Fischhoff, 1999; Hertwig & Todd, 2002). Helpful heuristics in problem solving include forming subgoals, hill climbing, working backward, searching for analogies, and changing the representation of a problem.

Forming Subgoals

A useful strategy for many problems is to formulate *subgoals,* intermediate steps toward a solution (Catrambone, 1998). When you reach a subgoal, you've solved part of the problem. Some problems have fairly obvious subgoals, and research has shown that people take advantage of them. For instance, in analogy problems, the first subgoal is usually to figure out the possible relations between the first two parts of the analogy. In a study by Simon and Reed (1976), subjects working on complex problems were given subgoals that weren't obvious. Providing subgoals helped the subjects solve the problems much more quickly.

The wisdom of formulating subgoals can be seen in the *tower of Hanoi problem,* depicted in Figure 8.11. The terminal goal for this problem is to move all three rings on peg A to peg C, while abiding by two restrictions: only the top ring on a peg can be moved, and a ring must never be placed above a smaller ring. See whether you can solve the problem before continuing.

CALVIN & HOBBES



Dividing this problem into subgoals facilitates a solution (Kotovsky, Hayes, & Simon, 1985). If you think in terms of subgoals, your first task is to get ring 3 to the bottom of peg C. Breaking this task into sub-subgoals, subjects can figure out that they should move ring 1 to peg C, ring 2 to peg B, and ring 1 from peg C to peg B. These maneuvers allow you to place ring 3 at the bottom of peg C, thus meeting your first subgoal. Your next subgoal—getting ring 2 over to peg C—can be accomplished in just two steps: move ring 1 to peg A and ring 2 to peg C. It should then be obvious how to achieve your final subgoal—getting ring 1 over to peg C.

Hill Climbing

Try the six-coin problem shown in Figure 8.12. Some people find it easy, while others struggle with the 7,426 possible sequences of moves (one solution is shown in Figure 8.16 on page 334). In one recent study, only 32% of participants solved it within 10 minutes (Chronicle et al., 2004). In any event, this problem tends to be approached with the ***hill-climbing heuristic,*** **which entails selecting the alternative at each choice point that appears to lead most directly to one's goal.** The name for this heuristic derives from the notion that if you need to climb a hill with many choice points along the pathway (and limited ability to see ahead), one simple strategy would be to always choose the path with the steepest upward slope. The hill-climbing heuristic is a logical strategy that works much of the time, but it can also backfire. Sometimes the optimal solution to a problem involves an indirect pathway or even moving backward, away from one's goal. However, people tend to be reluctant to make moves that seem to take them away from their goal-state (Robertson, 2001).

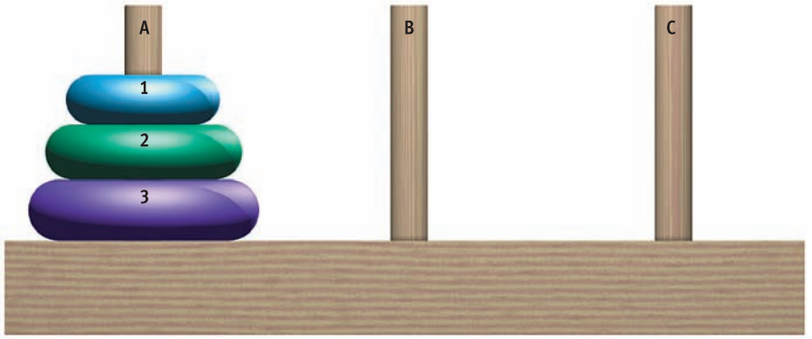


Figure 8.11
The tower of Hanoi problem. **Your mission is to move the rings from peg A to peg C. You can move only the top ring on a peg and can't place a larger ring above a smaller one. The solution is explained in the text.**

Working Backward

Try to work the *lily pond problem* described below:

The water lilies on the surface of a small pond double in area every 24 hours. From the time the first water lily appears until the pond is completely covered takes 60 days. On what day is half of the pond covered with lilies?

If you're working on a problem that has a well-specified end point, you may find the solution more readily if you begin at the end and work backward. This strategy is the key to solving the lily pond problem (Davidson, 2003). If the entire pond is covered on the 60th day, and the area covered doubles every day, how much is covered on the 59th day? One-half of the pond will be covered, and that happens to be the exact point you were trying to reach. The lily pond problem is remarkably simple when you work backward. In contrast, if you move forward from the starting point, you wrestle with questions about the area of the pond and the size of the lilies, and you find the problem riddled with ambiguities.

Searching for Analogies

Searching for analogies is another of the major heuristics for solving problems (Holyoak, 2005). If you can spot an analogy between problems, you may be able to use the solution to a previous problem to solve a current one. Of course, using this strategy depends on recognizing the similarity between two problems, which may itself be a challenging problem. Nevertheless, recent studies of real-world problem

Figure 8.12
The six-coin problem. **Your mission is to rearrange the coins so that each coin touches exactly two others. You are limited to three moves. Each move must entail sliding a coin to a position in which it touches exactly two others, without disturbing any coins. A solution is shown in Figure 8.16.**

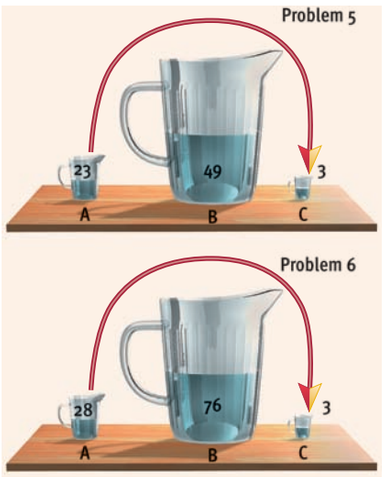


Figure 8.13
Solutions to the additional water jar problems. The solution for problems 1–4 is the same (B – A – 2C) as the solution shown in Figure 8.8. This method will work for problem 5, but there also is a simpler solution (A – C), which is the only solution for problem 6. Many subjects exhibit a mental set on these problems, as they fail to notice the simpler solution for problem 5.

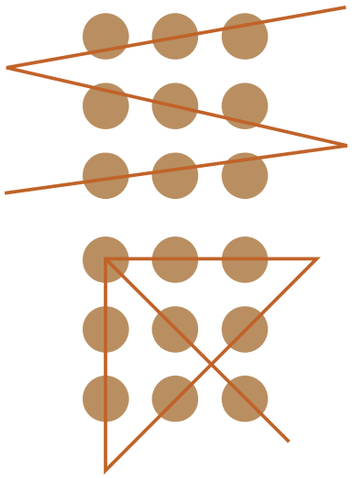


Figure 8.14
Two solutions to the nine-dot problem. The key to solving the problem is to recognize that nothing in the problem statement forbids going outside the imaginary boundary surrounding the dots.

SOURCE: Adams, J. L. (1980). *Conceptual blockbusting: A guide to better ideas.* New York: W. H. Freeman. Copyright © 1980 by James L. Adams. Reprinted by permission of W. H. Freeman & Co.

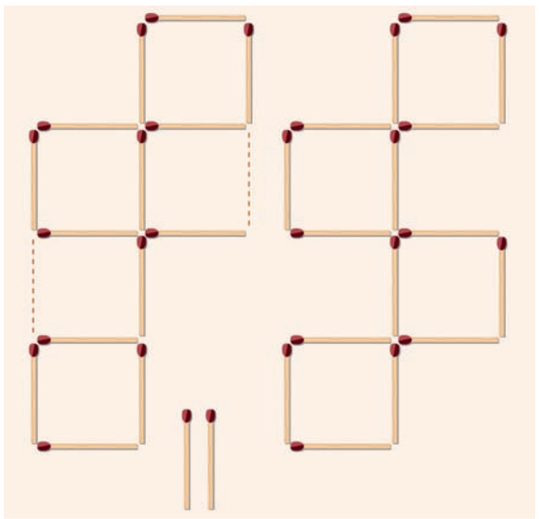


Figure 8.15
Solution to the matchstick problem. The key to solving this problem is to "open up" the figure, something many subjects are reluctant to do because they impose unnecessary constraints on the problem.

SOURCE: Kendler, H. H. (1974). *Basic psychology.* Menlo Park, CA: Benjamin-Cummings. Copyright © 1974 The Benjamin-Cummings Publishing Co. Adapted by permission of Howard H. Kendler.

solving efforts show that we depend on analogies far more than most people appreciate. For example, one study of biologists' problem solving recorded during their lab meetings found that they threw out 3-15 analogies per hour (Dunbar & Blanchette, 2001). Another study of design engineers recorded during their product development meetings found that they came up with an average of 11 analogies per hour of deliberation (Christensen & Schunn, 2007).

Unfortunately, people often are unable to recognize that two problems are similar and that an analogy might lead to a solution (Kurtz & Lowenstein, 2007). One reason that people have difficulty recognizing analogies between problems is that they often focus on superficial, surface features of problems rather than their underlying structure (Bassok, 2003). Nonetheless, analogies can be a powerful tool in efforts to solve problems. Try to make use of analogies to solve the following two problems:

A teacher had 23 pupils in his class. All but 7 of them went on a museum trip and thus were away for the day. How many students remained in class that day?

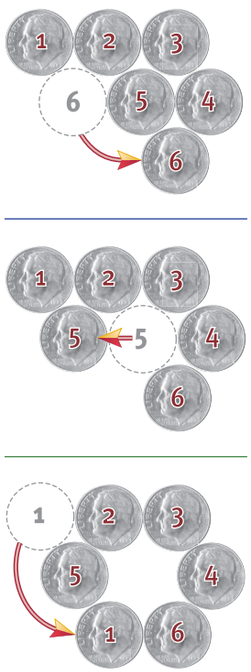


Figure 8.16
A solution to the six-coin problem. One of the two 3-move sequences that will solve this problem is shown here. According to Chronicle et al. (2004), participants tend to use the hill-climbing heuristic when working on this problem.

Susan gets in her car in Boston and drives toward New York City, averaging 50 miles per hour. Twenty minutes later, Ellen gets in her car in New York City and starts driving toward Boston, averaging 60 miles per hour. Both women take the same route, which extends a total of 220 miles between the two cities. Which car is nearer to Boston when they meet?

These problems, taken from Sternberg (1986, pp. 213 and 215), resemble the ones that opened our discussion of problem solving. Each has an obvious solution that's hidden in irrelevant quantitative information. If you recognized this similarity, you probably solved the problems easily. If not, take another look now that you know what the analogy is. Neither problem requires any calculation whatsoever. The answer to the first problem is *7.* As for the second problem, when the two cars meet they're in the same place. Obviously, they have to be the same distance from Boston.

Changing the Representation of the Problem

Whether you solve a problem often hinges on how you envision it—your *representation of the problem.* Many problems can be represented in a variety of ways, such as verbally, mathematically, or spatially. You might represent a problem with a list, a table,

an equation, a graph, a matrix of facts or numbers, a hierarchical tree diagram, or a sequential flowchart (Halpern, 2003). There isn't one ideal way to represent problems. However, when researchers compare experts and novices in a particular area of problem solving, they find that the experts strip away irrelevant details and represent problems much more efficiently (Pretz, Naples, & Sternberg, 2003). This finding highlights the importance of how problems are represented. Thus, when you fail to make progress on a problem with your initial representation, changing your representation is often a good strategy (Novick & Bassok, 2005). As an illustration, see whether you can solve the *bird and train problem* (from Bransford & Stein, 1993, p. 11):

Two train stations are 50 miles apart. At 1 P.M. on Sunday a train pulls out from each of the stations and the trains start toward each other. Just as the trains pull out from the stations, a hawk flies into the air in front of the first train and flies ahead to the front of the second train. When the hawk reaches the second train, it turns around and flies toward the first train. The hawk continues in this way until the trains meet. Assume that both trains travel at the speed of 25 miles per hour and the hawk flies at a constant speed of 100 miles per hour. How many miles will the hawk have flown when the trains meet?

This problem asks about the *distance* the bird will fly, so people tend to represent the problem spatially, as shown in **Figure 8.17** on the next page. Represented this way, the problem can be solved, but the steps are tedious and difficult. But consider another angle. The problem asks how far the bird will fly in the time it takes the trains to meet. Since we know how fast the bird flies, all we really need to know is how much *time* it takes for the trains to meet. Changing the representation of the problem from a question of *distance* to a question of *time* makes for an easier solution, as follows: The train stations are 50 miles apart. Since the trains are traveling toward each other at the same speed, they will meet midway and each will have traveled 25 miles. The trains are moving at 25 miles per hour. Hence, the time it takes them to meet 25 miles from each station is 1 hour. Since the bird flies at 100 miles per hour, it will fly 100 miles in the hour it takes the trains to meet.

concept check 8.2

Thinking About Problem Solving

Check your understanding of problem solving by answering some questions about the following problem. Begin by trying to solve the problem.

The candle problem. Using the objects shown—candles, a box of matches, string, and some tacks—figure out how you could mount a candle on a wall so that it could be used as a light. Work on the problem for a while, then turn to page 336 to see the solution. After you've seen the solution, respond to the following questions. The answers are in Appendix A.

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1. If it didn't occur to you that the matchbox could be converted from a container to a platform, this illustrates _____ _____ .
2. While working on the problem, if you thought to yourself, "How can I create a platform attached to the wall?" you used the heuristic of _____ _____ .
3. If it occurred to you suddenly that the matchbox could be used as a platform, this realization would be an example of _____ .
4. If you had a hunch that there might be some similarity between this problem and the string problem in **Figure 8.5** (the similarity is the novel use of an object), your hunch would illustrate the heuristic of _____ _____ _____ .
5. In terms of Greeno's three types of problems, the candle problem is a(n) _____ problem.

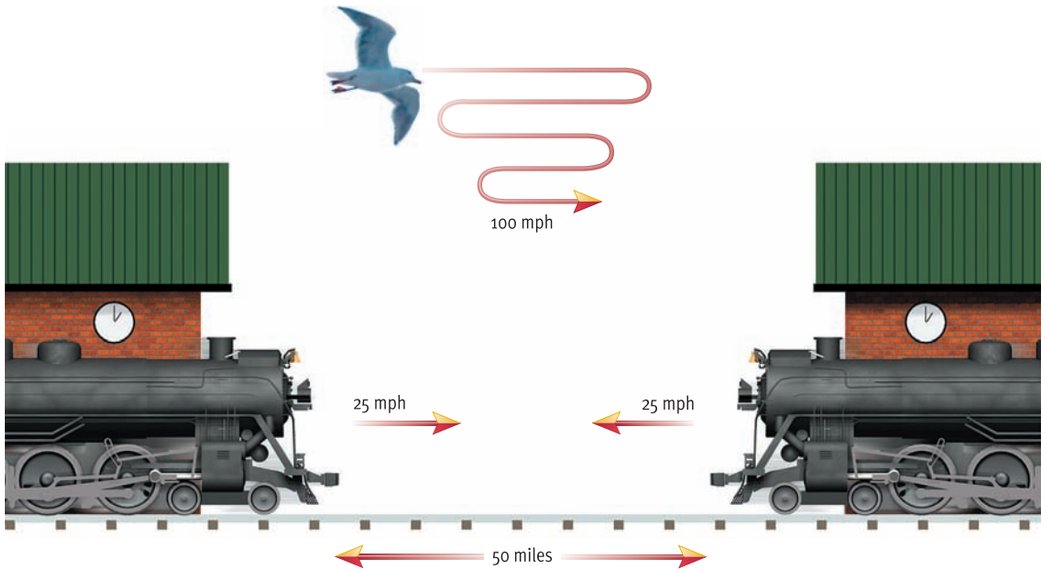

Figure 8.17
Representing the bird and train problem. The typical inclination is to envision this problem spatially, as shown here. However, as the text explains, this representation makes the problem much more difficult than it really is.


Craig McClain

The solution to the candle problem in Concept Check 8.2.

Culture, Cognitive Style, and Problem Solving

Do the varied experiences of people from different cultures lead to cross-cultural variations in problem solving? Yes, at least to some degree, as researchers have found cultural differences in the cognitive style that people exhibit in solving problems.

Richard Nisbett and his colleagues (Nisbett et al., 2001; Nisbett & Miyamoto, 2005) have argued that people from East Asian cultures (such as China, Japan, and Korea) display a *holistic cognitive style* that focuses on context and relationships among elements in a field, whereas people from Western cultures (America and Europe) exhibit an *analytic cognitive style* that focuses on objects and their properties rather than context. To put it simply, *Easterners see wholes where Westerners see parts*.

In one test of this hypothesis, Masuda and Nisbett (2001) presented computer-animated scenes of fish and other underwater objects to Japanese and American participants and asked them to report what they had seen. The initial comments of American subjects typically referred to the focal fish, whereas the initial comments of Japanese subjects usually referred to background elements (see **Figure 8.18**). Furthermore, compared to the Americans, the Japanese participants made about 70% more statements about context or background and about twice as many statements about relationships between elements in the scenes. Other studies have also found that people from Asian cultures pay more attention to contextual information than people from North American cultures do (Kitayama et al., 2003).

Cultural variations in analytic versus holistic thinking appear to influence subjects' patterns of logical reasoning, their vulnerability to hindsight bias (see Chapter 7), and their tolerance of contradictions (Nisbett, 2003). Based on these and many other findings, Nisbett et al. (2001) conclude that cultural disparities in cognitive style are substantial and that "literally different cognitive processes are often invoked by East Asians and Westerners dealing with the same problem" (p. 305).

Problems are not the only kind of cognitive challenge that people grapple with on a regular basis. Life also seems to constantly demand decisions. As you might expect, cognitive psychologists have shown great interest in the process of decision making, which is our next subject.

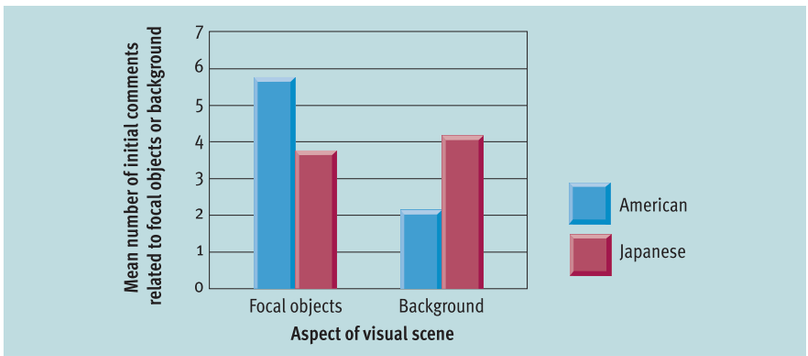

Figure 8.18
Cultural disparities in cognitive style. In one of the studies conducted by Masuda and Nisbett (2001), the participants were asked to describe computer-animated visual scenes. As you can see, the initial comments made by American subjects referred more to focal objects in the scenes, whereas the initial comments made by Japanese subjects referred more to background elements in the scenes. These findings are consistent with the hypothesis that Easterners see wholes (a holistic cognitive style) where Westerners see parts (an analytic cognitive style).

REVIEW of Key Learning Goals

8.8 Greeno distinguished between three broad types of problems: problems of inducing structure, transformation problems, and arrangement problems.

8.9 Common barriers to problem solving include being distracted by irrelevant information, functional fixedness (only seeing an item's most common use), mental set (persisting with strategies that have worked in the past), and placing unnecessary constraints on one's solutions.

8.10 An algorithm is a procedure for trying all possible alternatives in searching for a solution to a problem, whereas a heuristic is a rule of thumb. When people form subgoals, they break a problem into several parts. Hill climbing involves making step-by-step choices that lead most directly to one's goal. Sometimes it is useful to start at the goal state and work backward. Other general strategies include searching for analogies between new problems and old problems, and changing the representation of problems.

8.11 Research suggests that there are cultural disparities in typical problem solving strategies. Eastern cultures exhibit a more holistic cognitive style, whereas Western cultures display a more analytic cognitive style. In other words, Easterners see wholes where Westerners see parts.

Decision Making: Choices and Chances

Key Learning Goals

8.12 Articulate Simon's theory of bounded rationality and Schwartz's notion that choice overload undermines well-being.

8.13 Distinguish the additive and elimination-by-aspects approaches to selecting an alternative.

8.14 Discuss research on factors that influence decisions about preferences, including the Featured Study on the deliberation-without-attention effect.

8.15 Explain the nature of risky decision making and factors that influence it.

8.16 Understand the availability and representativeness heuristics.

8.17 Describe base rate neglect and the conjunction fallacy and their causes.

8.18 Assess evolutionary theorists' evaluation of cognitive research on flaws in human decision strategies.

8.19 Describe the nature of fast and frugal heuristics.

Decisions, decisions. Life is full of them. You decided to read this book today. Earlier today you decided when to get up, whether to eat breakfast, and if so, what to eat. Usually you make routine decisions like these with little effort. But on occasion you need to make important decisions that require more thought. Big decisions—such as selecting a car, a home, or a job—tend to be difficult. The alternatives usually have a number of attributes that need to be weighed. For instance, in choosing among several cars, you may want to compare their costs, roominess, fuel economy, handling, acceleration, stylishness, reliability, safety features, and warranties.

***Decision making* involves evaluating alternatives and making choices among them.** Most people try to be systematic and rational in their decision making. However, the work that earned Herbert Simon the 1978 Nobel prize in economics showed that people don't always live up to these goals. Before Simon's work, most traditional theories in economics assumed that people make rational choices to maximize their economic gains. Simon (1957) demonstrated that people have a limited ability to process and evaluate information on numerous facets of possible alternatives. Thus, Simon's ***theory of bounded rationality* asserts that people tend to use simple strategies in decision making that focus on only a few facets of available options and often result in "irrational" decisions that are less than optimal.**

Spurred by Simon's analysis, psychologists have devoted several decades to the study of how cognitive biases distort people's decision making. This focus on *biases and mistakes* in making decisions may seem a little peculiar, but as Kahneman (1991) has pointed out, the study of people's misguided decisions has illuminated the process of decision making, just as the study of illusions and forgetting has enhanced our understanding of visual perception and memory, respectively.

Making Choices About Preferences: Basic Strategies

Many decisions involve choices about *preferences,* which can be made using a variety of strategies (Goldstein & Hogarth, 1997). In a fascinating recent analysis, Barry Schwartz (2004) has argued that people in modern societies are overwhelmed by an overabundance of such choices about preferences. For example, Schwartz describes how a simple visit to a local supermarket can require a consumer to choose from 285 varieties of cookies, 61 suntan lotions, 150 lipsticks, and 175 salad dressings. Although increased choice is most tangible in the realm of consumer goods, Schwartz argues that it also extends into more significant domains of life. Today, people tend to have unprecedented opportunities to make choices about how they will be educated, how and where they will work, how their intimate relationships will unfold, and even how they will look (because of advances in plastic surgery). Although enormous freedom of choice sounds attractive, Schwartz (2004) argues that the overabundance of choices in modern life has unexpected costs. He argues that people routinely make errors even when choosing among a handful of alternatives and that errors become much more likely when decisions become more complex. And he explains how having more alternatives increases the potential for rumination and postdecision regret. Ultimately, he argues, the malaise associated with choice overload undermines individuals' happiness and contributes to depression. It is hard

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People often have to decide between alternative products, such as computers, cars, refrigerators, and so forth, that are not all that different. They often struggle with the abundant choices and delay making a decision. However, as the text explains, extra deliberation does not necessarily lead to better decisions.

to say whether choice overload is as detrimental to well-being as Schwartz believes, but it is clear that people wrestle with countless choices about preferences, and their reasoning about these decisions is often far from optimal. Let's look at some strategies that people use in making these types of decisions.

Imagine that your friend Boris has found two reasonably attractive apartments and is trying to decide between them. How should he go about selecting between his alternatives? If Boris wanted to use an *additive strategy,* he would list the attributes that influence his decision. Then he would rate the desirability of each apartment on each attribute. For example, let's say that Boris wants to consider four attributes: rent, noise level, distance to campus, and cleanliness. He might make ratings from –3 to +3, like those shown in Table 8.3, add up the ratings for each alternative, and select the one with the largest total. Given the ratings in Table 8.3, Boris should select apartment B. To make an additive strategy more useful, you can *weight* attributes differently, based on their importance (Shafir & LeBoeuf, 2004). For example, if Boris considers distance to campus to be twice as important as the other considerations, he could multiply his ratings of this attribute by 2. The distance rating would then be +6 for apartment A and –2 for apartment B, and apartment A would become the preferred choice.

People also make choices by gradually eliminating less attractive alternatives (Slovic, 1990; Tversky, 1972). This strategy is called *elimination by aspects* because it assumes that alternatives are eliminated by evaluating them on each attribute or aspect in turn. Whenever any alternative fails to satisfy some minimum criterion for an attribute, it is eliminated from further consideration. To illustrate, suppose Juanita is looking for a new car. She may begin by eliminating all cars that cost over $24,000. Then she may eliminate cars that don't average at least 20 miles per gallon of gas. By continuing to reject choices that don't satisfy some minimum criterion on selected attributes, she can gradually eliminate alternatives until only a single car remains. The final choice in elimination by aspects depends on the order in which attributes are evaluated. For example, if cost was the last attribute Juanita evaluated, she could have previously eliminated all cars that cost under $24,000. If she has only $24,000 to spend, her decision-making strategy would not have brought her very far. Thus, when using elimination by aspects, it's best to evaluate attributes in the order of their importance.

Both the additive and the elimination-by-aspects strategies have advantages, but which strategy do people actually tend to use? Research suggests that people adapt their approach to the demands of the task. When their choices are fairly simple they use additive strategies, but as choices become very complex, they shift toward simpler strategies, such as elimination by aspects (Payne & Bettman, 2004).

Table 8.3 Application of the Additive Model to Choosing an Apartment

Attribute	Apartment A	Apartment B
Rent	+1	+2
Noise level	–2	+3
Distance to campus	+3	–1
Cleanliness	+2	+2
Total	**+4**	**+6**

web link 8.3

Society for Judgment and Decision Making

The Society for Judgment and Decision Making is an interdisciplinary academic organization dedicated to the study of decision processes. The main attraction for students will be the news section, which profiles recent developments in decision research.

Making Choices About Preferences: Quirks and Complexities

Beyond the basics we've been discussing, research has turned up a number of quirks and complexities that people exhibit in making decisions about preferences. Some of the more interesting findings include the following:

- When people decide between various options (let's say two job opportunities), their evaluations of the options' specific attributes (such as salary, commute, and work hours) fluctuate more than most models of decision making anticipated (Shafir & LeBoeuf, 2004). Models of "rational" choice assumed that people know what they like and don't like and that these evaluations would be stable, but research

suggests otherwise. One reason that these judgments tend to be unstable is that they are swayed by incidental emotional fluctuations (Lerner, Small, & Loewenstein, 2004).

• Another reason these evaluations tend to be inconsistent is that *comparative* evaluations of options tend to yield different results than *separate* evaluations (assessing an option on its own, in isolation) (Hsee, Zhang, & Chen, 2004). For example, when participants directly compare a job with an $80,000 salary at a firm where one's co-workers tend to earn $100,000 against a job with a $70,000 salary at a company where peers earn only $50,000, they rate the $80,000 job as more desirable. However, when two sets of subjects evaluate the same job options in isolation, the $70,000 job is rated as more desirable (LeBoeuf & Shafir, 2005). Thus, the dynamics and implications of comparative and separate evaluations can be quite different.

• A chronic problem faced by decision makers is that although they commonly make choices based on comparative evaluations, the chosen product, activity, or event is actually experienced in isolation (Hsee & Zhang, 2004). This mismatch can lead to decisions that people regret. For example, a shopper may make precise head-to-head comparisons of several speaker systems at an audio store and decide to spend an extra $1500 on the best speakers, but at home the selected speakers will be experienced in isolation. This person may have been delighted with a much less expensive set of speakers if they had been brought to his or her home and evaluated in isolation.

• Judgments about the quality of various alternatives, such as consumer products, can be swayed by extraneous factors such as brand familiarity and price. In one recent demonstration of this phenomenon, participants tasted wines and rated their quality (Plassmann et al., 2008). In some cases, they thought they were tasting two different wines, but it was the same wine presented at two very different prices (such as $10 and $90). As you might guess, the more "expensive" wines garnered higher ratings. Moreover, brain imaging (fMRI scans) during the wine tasting showed higher activity in a brain region thought to register the actual experienced pleasantness of stimuli when subjects consumed the more "expensive" wine. These findings suggest that people really do get what they pay for in terms of subjective pleasure. And they show that decisions about preferences can be distorted by considerations that should be irrelevant.

Another line of research has looked at whether decisions about preferences work out better when people engage in conscious deliberation or go with intuitive, unconscious feelings based on minimal deliberation. Ap Dijksterhuis and colleagues argue that the answer to this question depends on the complexity of the decision, but probably not in the way you might guess, as you will see in our Featured Study for this chapter.

web link 8.4

Online Decision Research Center Experiments

Michael Birnbaum (California State University, Fullerton) presents a range of continuing and completed experiments conducted online that illustrate how people make decisions.

Intuitive Decisions Versus Careful Deliberation: Which Leads to Better Decisions?

FEATURED STUDY

"Look before you leap," we are told. Conventional wisdom suggests that important, complicated choices require thoughtful deliberation, which is more likely to lead to decisions that prove satisfying. Scientific research on decision making has tended to echo conventional wisdom in touting the benefits of thorough deliberation. But Dijksterhuis and his colleagues (Dijksterhuis, 2004; Dijksterhuis & Nordgren, 2006; Dijksterhuis & van Olden, 2006) have argued that unconscious, intuitive thought processes sometimes lead to better decisions. Why? Primarily, he indicts the limited capacity of conscious thought. As first noted by Herbert Simon and demonstrated in countless studies, people have a surprisingly finite capacity for juggling information on numerous facets of possible options. Although one might guess that careful deliberation ought to be more valuable when choices are complicated, Dijksterhuis and his colleagues hypothesized just the opposite. They predicted that deliberate decisions would be superior to intuitive decisions when choices were simple but that intuitive, unconscious decisions would be superior when choices were complex. We'll examine two of the four studies they conducted to test this proposition.

Study A

Method. Eighty undergraduate participants read information about four hypothetical cars and were asked to choose their favorite. In the simple decision, only 4 attributes of each car were described. In the complex version of the same decision, subjects were given information on 12 attributes of the cars. The desirability of the cars was manipulated by making 75% of the attributes positive for one car, 50% positive for two cars, and 25% positive for one car. So, in both versions of the choice, one of the cars should have stood out as the optimal alternative. In the conscious thought condition, participants were told to mull over their options for 4 minutes and report their choice. In the unconscious thought condition, subjects were distracted from thinking about the decision for 4 minutes (they were

SOURCE: Dijksterhuis, A., Bos, M. W., Nordgren, L. F., & van Baaren, R. B. (2006). On making the right choice: The deliberation-without-attention effect. *Science, 311*(5763), 1005–1007.

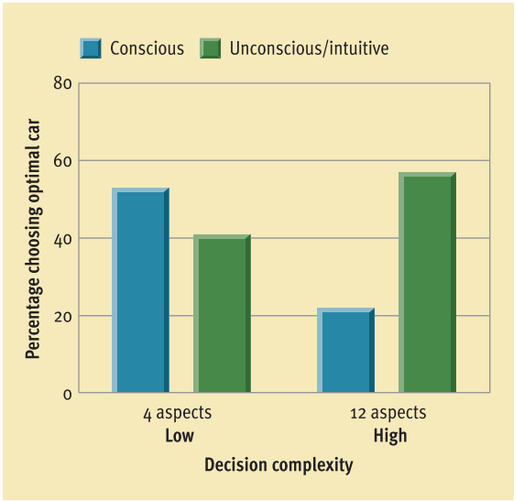


Figure 8.19

Conscious versus unconscious decision making in Study A. **The percentage of participants who selected the optimal car in each condition is shown here. When the choice was simple (only 4 aspects of the car were described), conscious deliberation proved superior. However, when the choice was more complex (12 aspects to consider), unconscious, intuitive thinking proved superior.**

SOURCE: Dijksterhuis, A., Bos, M. W., Nordgren, L. F., & van Baaren, R. B. (2006). On making the right choice: The deliberation-without-attention effect. *Science, 311*(5763), 1005–1007. Copyright © 2006 the American Society for the Study of Science. Reprinted by permission from the AAAS.

kept busy solving anagrams) and then asked for their choice of the best car.

Results. As you can see in **Figure 8.19**, when the car choice was relatively simple, conscious thought was superior to unconscious thought in selecting the optimal auto. But when the choice was more complicated, unconscious thought was notably superior to conscious deliberation in selecting the best car.

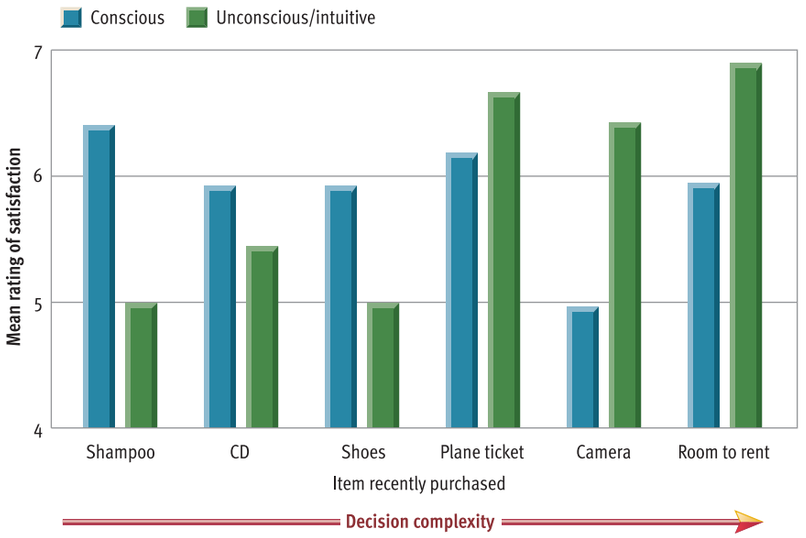


Figure 8.20

Postchoice satisfaction as a function of decision complexity in Study B. **Mean ratings of postchoice satisfaction for the six products chosen most often are shown here. The products are arranged, from left to right, in order of increasing decision complexity. For each product, participants' ratings of how much they deliberated about their purchase were split at the median, dividing them into conscious versus unconscious decision makers. When decision complexity was low, conscious deliberation was associated with greater satisfaction, but when decision complexity was high, conscious deliberation was associated with less satisfaction.**

SOURCE: Dijksterhuis, A., Bos, M. W., Nordgren, L. F., & van Baaren, R. B. (2006). On making the right choice: The deliberation-without-attention effect. *Science, 311*(5763), 1005–1007. Copyright © 2006 the American Society for the Study of Science. Reprinted by permission from the AAAS.

Study B

Method. Sixty-one student participants indicated how many facets they would evaluate in deciding to purchase 40 consumer products, such as shampoos, shoes, and cameras, yielding a *decision complexity* score for each product. Subsequently, another group of 93 undergraduates picked a product from a list of items that they recently bought and were asked about how much conscious thought they put into the decision and how satisfied they were with their choice.

Results. **Figure 8.20** depicts participants' postchoice satisfaction for the six products that were chosen from the list most frequently, with the products listed in order of decision complexity (from left to right). As predicted, conscious deliberation promoted greater satisfaction when decisions were simple, but just the opposite occurred for complex decisions.

Discussion

The results of these two studies demonstrate what Dijksterhuis calls the *deliberation-without-attention effect*—when people are faced with complex choices, they tend to make better decisions if they don't devote careful attention to the matter. Dijksterhuis believes that deliberations are taking place—but outside of conscious awareness. Thus, like studies of subliminal perception (see Chapter 4) and studies showing that sleep can enhance memory and problem solving (see Chapter 5), this study suggests that unconscious mental processes are more influential than widely assumed. The authors conclude that "there is no *a priori* reason to assume that the deliberation-without-attention effect does not generalize to other types of choices—political, managerial, or otherwise" (p. 1007).

Comment

This research was featured because it provided an elegant test of an interesting hypothesis that seems to defy common sense. It also illustrates the value of approaching an issue with different methodologies. Standing alone, the experimental study (A) on car choices might not be convincing. Four minutes of conscious thought is not much time for testing the efficacy of "careful deliberation," and one could quibble about whether the optimal car was really optimal for all subjects. But, when the carefully controlled experimental study is combined with the more realistic correlational study (B), the converging evidence provides impressive support for the authors' theory.

That said, critics note that it may be premature to broadly generalize these findings to diverse kinds of decision making in the real world (Haslam, 2007). In the studies thus far, even the "complex" choices have involved relatively simple decisions about product preferences. It is quite a leap to assume that physicians, corporate managers, and government leaders, who confront choices of profound complexity and importance, would make better decisions if they avoided careful deliberation. Although other lines of research also suggest that intuition can sometimes be superior to logic and reflection (Gladwell, 2005; Myers, 2002), the boundary conditions of this phenomenon need to be determined.

Taking Chances: Factors Weighed in Risky Decisions

Suppose you have the chance to play a dice game in which you might win some money. You must decide whether it would be to your advantage to play. You're going to roll a fair die. If the number 6 appears, you win $5. If one of the other five numbers appears, you win nothing. It costs you $1 every time you play. Should you participate?

This problem calls for a type of decision making that is somewhat different from making choices about preferences. In selecting alternatives that reflect preferences, people generally weigh known outcomes (apartment A will require a long commute to campus, car B will get 30 miles per gallon, and so forth). In contrast, ***risky decision making*** **involves making choices under conditions of uncertainty.** Uncertainty exists when people don't know what will happen. At best, they know the probability that a particular event will occur.

One way to decide whether to play the dice game would be to figure out the *expected value* of participation in the game. To do so, you would need to calculate the average amount of money you could expect to win or lose each time you play. The value of a win is $4 ($5 minus the $1 entry fee). The value of a loss is –$1. To calculate expected value, you also need to know the probability of a win or loss. Since a die has six faces, the probability of a win is 1 out of 6, and the probability of a loss is 5 out of 6. Thus, on five out of every six trials, you lose $1. On one out of six, you win $4. The game is beginning to sound unattractive, isn't it? We can figure out the precise expected value as follows:

$$\text{Expected value} = (\tfrac{1}{6} \times 4) + (\tfrac{5}{6} \times -1)$$
$$= \tfrac{4}{6} + (-\tfrac{5}{6}) = -\tfrac{1}{6}$$

The expected value of this game is $-\frac{1}{6}$ of a dollar, which means that you lose an average of about 17 cents per turn. Now that you know the expected value, surely you won't agree to play. Or will you?

If we want to understand why people make the decisions they do, the concept of expected value is not enough. People frequently behave in ways that are inconsistent with expected value (Slovic, Lichtenstein, & Fischhoff, 1988). Anytime the expected value is negative, a gambler should expect to lose money. Yet a great many people gamble at racetracks and casinos and buy lottery tickets. Although they realize that the odds are against them, they continue to gamble. Even people who don't gamble buy homeowner's insurance, which has a negative expected value. After all, when you buy insurance, your expectation (and hope!) is that you will lose money on the deal.

To explain decisions that violate expected value, some theories replace the objective value of an outcome with its *subjective utility* (Fischhoff, 1988). Subjective utility represents what an outcome is personally worth to an individual. For example, buying a few lottery tickets may allow you to dream about becoming wealthy. Buying insurance may give you a sense of security. Subjective utilities like these vary from one person to another. Interestingly, however, studies show that people often make inaccurate predictions about how much subjective utility or enjoyment various experiences will yield (Loewenstein & Schkade, 1999).

Heuristics in Judging Probabilities

PSYK TREK 7f

- What are your chances of passing your next psychology test if you study only 3 hours?
- How likely is a major downturn in the stock market during the upcoming year?
- What are the odds of your getting into graduate school in the field of your choice?

These questions ask you to make probability estimates. Amos Tversky and Daniel Kahneman (1974, 1982; Kahneman & Tversky, 2000) have conducted extensive research on the *heuristics,* or mental shortcuts, that people use in grappling with probabilities. This research on heuristics earned Kahneman the Nobel prize in economics in 2002 (unfortunately, his collaborator, Amos Tversky, died in 1996).

Availability is one such heuristic. **The *availability heuristic* involves basing the estimated probability of an event on the ease with which relevant instances come to mind.** For example, you may estimate the divorce rate by recalling the number of divorces among your friends' parents. Recalling specific instances of an event is a reasonable strategy to use in estimating the event's probability. However, if instances occur frequently but you have difficulty retrieving them from memory, your estimate will be biased. For instance, it's easier to think of words that begin with a certain letter than words that contain that letter at some other position. Hence, people should tend to respond that there are more words starting with the letter *K* than words having a *K* in the third position. To test this hypothesis, Tversky and Kahneman (1973) selected five consonants (*K, L, N, R, V*) that occur more frequently in the third position of a word than in the first. Subjects were asked whether each of the letters appears more often in the first or third position. Most of the subjects

Courtesy of Daniel Kahneman

Daniel Kahneman

"The human mind suppresses uncertainty. We're not only convinced that we know more about our politics, our businesses, and our spouses than we really do, but also that what we don't know must be unimportant."

Courtesy of Barbara Tversky

Amos Tversky

"People treat their own cases as if they were unique, rather than part of a huge lottery. You hear this silly argument that 'The odds don't apply to me.' Why should God, or whoever runs this lottery, give you special treatment?"

erroneously believed that all five letters were much more frequent in the first than in the third position, confirming the hypothesis.

Representativeness is another guide in estimating probabilities identified by Kahneman and Tversky (1982). **The *representativeness heuristic* involves basing the estimated probability of an event on how similar it is to the typical prototype of that event.** To illustrate, imagine that you flip a coin six times and keep track of how often the result is heads (H) or tails (T). Which of the following sequences is more likely?

1. T T T T T T
2. H T T H T H

People generally believe that the second sequence is more likely. After all, coin tossing is a random affair, and the second sequence looks much more representative of a random process than the first. In reality, the probability of each exact *sequence* is precisely the same ($^1/_2 \times {}^1/_2 \times {}^1/_2 \times {}^1/_2 \times {}^1/_2 \times {}^1/_2 = {}^1/_{64}$). Overdependence on the representativeness heuristic has been used to explain quite a variety of decision-making tendencies (Teigen, 2004), as you will see in the upcoming pages.

The Tendency to Ignore Base Rates

PSYK TREK 7f

Steve is very shy and withdrawn, invariably helpful, but with little interest in people or in the world of reality. A meek and tidy soul, he has a need for order and structure and a passion for detail. Do you think Steve is a salesperson or a librarian? (Adapted from Tversky & Kahneman, 1974, p. 1124)

Using the *representativeness heuristic,* subjects tend to guess that Steve is a librarian because he resembles their prototype of a librarian (Tversky & Kahneman, 1982). In reality, this is not a wise guess, because it *ignores the base rates* of librarians and salespeople in the population. Virtually everyone knows that salespeople outnumber librarians by a wide margin (roughly 75 to 1 in the United States). This fact makes it much more likely that Steve is in sales. But in estimating probabilities, people often ignore information on base rates.

Researchers are still debating how common it is for people to neglect base rate information (Birnbaum, 2004; Koehler, 1996), but it does not appear to be a rare event. Indeed, evidence indicates that people are particularly bad about applying base rates to themselves. For instance, Weinstein (1984; Weinstein & Klein, 1995) has found that people underestimate the risks of their own health-impairing habits while viewing others' risks much more accurately. Thus, smokers are realistic in estimating the degree to which smoking increases someone else's risk of heart attack but underestimate the risk for themselves. Similarly, people starting new companies ignore the high failure rate for new businesses, and burglars underestimate the likelihood that they

concept check 8.3

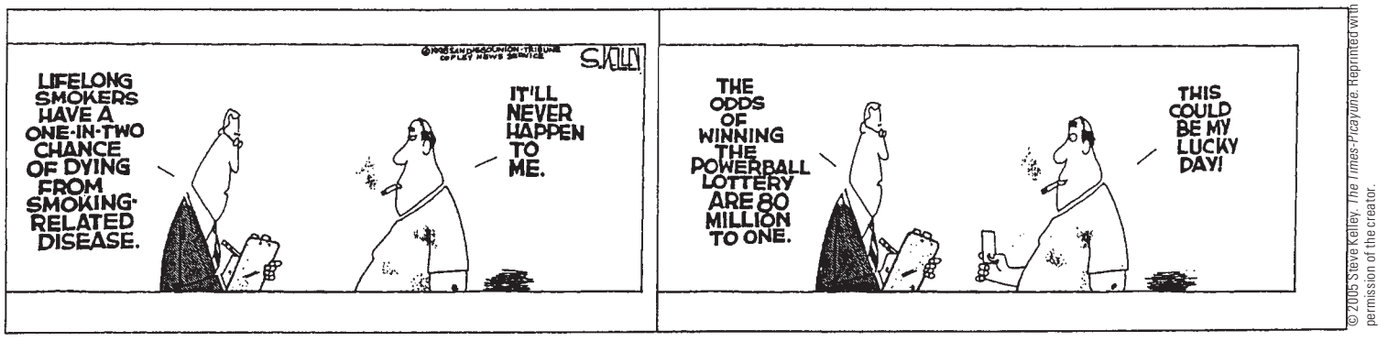
Recognizing Heuristics in Decision Making

Check your understanding of heuristics in decision making by trying to identify the heuristics used in the following example. Each numbered element in the anecdote below illustrates a problem-solving heuristic. Write the relevant heuristic in the space on the left. You can find the answers in Appendix A.

_____ **1.** Marsha can't decide on a college major. She evaluates all the majors available at her college on the attributes of how much she would enjoy them (likability), how challenging they are (difficulty), and how good the job opportunities are in the field (employability). She drops from consideration any major that she regards as "poor" on any of these three attributes.

_____ **2.** When she considers history as a major, she thinks to herself, "Gee, I know four history graduates who are still looking for work," and concludes that the probability of getting a job using a history degree is very low.

_____ **3.** She finds that every major gets a "poor" rating on at least one attribute, so she eliminates everything. Because this is unacceptable, she decides she has to switch to another strategy. Marsha finally focuses her consideration on five majors that received just one "poor" rating. She uses a 4-point scale to rate each of these majors on each of the three attributes she values. She adds up the ratings and selects the major with the highest total as her leading candidate.



will end up in jail. Thus, in risky decision making, people often think that they can beat the odds. As Amos Tversky puts it, "People treat their own cases as if they were unique, rather than part of a huge lottery. You hear this silly argument that 'The odds don't apply to me.' Why should God, or whoever runs this lottery, give you special treatment?" (McKean, 1985, p. 27).

The Conjunction Fallacy

7f

Imagine that you're going to meet a man who is an articulate, ambitious, power-hungry wheeler-dealer. Do you think it's more likely that he's a college teacher or a college teacher who's also a politician?

People tend to guess that the man is a "college teacher who's a politician" because the description fits with the typical prototype of politicians. But stop and think for a moment. The broader category of college teachers completely includes the smaller subcategory of college teachers who are politicians (see Figure 8.21). The probability of being in the subcategory cannot be higher than the probability of being in the broader category. It's a logical impossibility!

Tversky and Kahneman (1983) call this error the *conjunction fallacy*. **The *conjunction fallacy* occurs when people estimate that the odds of two uncertain events happening together are greater than the odds of either event happening alone.** The conjunction fallacy has been observed in a number of studies and has generally been attributed to the influence of the representativeness heuristic (Epstein, Donovan, & Denes-Raj, 1999), although some doubts have been raised about this interpretation (Fisk, 2004).

Evolutionary Analyses of Flaws in Human Decision Making

A central conclusion of the last 30 years of research on decision making has been that human decision-making strategies are riddled with errors and biases that yield surprisingly irrational results (Goldstein & Hogarth, 1997; Risen & Gilovich, 2007; Shafir & LeBoeuf, 2002). Theorists have discovered that people have "mental limitations" and have concluded that people are not as bright and rational as they think they are. This broad conclusion has led some evolutionary psychologists to reconsider the work on human decision making, and their take on the matter is quite interesting. First, they argue that traditional decision research has imposed an invalid and unrealistic standard of rationality, which assumes that people should be impeccable in applying the laws of deductive logic and statistical probability while objectively and precisely weighing multiple factors in arriving at decisions (Gigerenzer, 2000). Second, they argue that humans only *seem* irrational because cognitive psychologists have been asking the wrong questions and formulating problems in the wrong ways—ways that have nothing to do

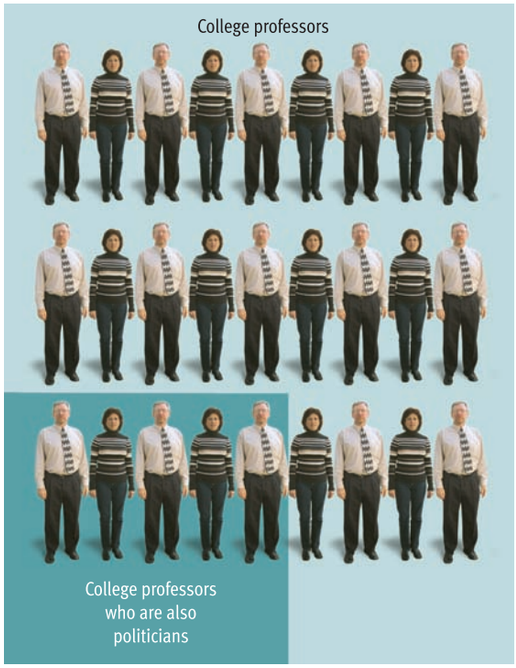


Figure 8.21
The conjunction fallacy. Subjects often fall victim to the conjunction fallacy, but as this diagram makes obvious, the probability of being in a subcategory (college teachers who are politicians) cannot be higher than the probability of being in the broader category (college teachers). As this case illustrates, it often helps to represent a problem in a diagram.

Courtesy of John Tooby

Courtesy of Gerd Leda Cosmides

John Tooby and Leda Cosmides

"The problems our cognitive devices are designed to solve do not reflect the problems our modern life experiences lead us to see as normal . . . Instead, they are the ancient and seemingly esoteric problems that our hunter-gatherer ancestors encountered generation after generation over hominid evolution."

web link 8.5

Has Natural Selection Shaped How Humans Reason?

This link will take you to a presentation by Leda Cosmides and John Tooby (University of California, Santa Barbara) in which they discuss their evolutionary perspective on human decision making.

with the adaptive problems that the human mind has evolved to solve (Cosmides & Tooby, 1996).

According to Leda Cosmides and John Tooby (1994, 1996), the human mind consists of a large number of specialized cognitive mechanisms that have emerged over the course of evolution to solve specific adaptive problems, such as finding food, shelter, and mates and dealing with allies and enemies. Thus, human decision and problem-solving strategies have been tailored to handle real-world adaptive problems. Participants perform poorly in cognitive research, say Cosmides and Tooby, because it confronts them with contrived, artificial problems that do not involve natural categories and have no adaptive significance.

For example, evolutionary psychologists argue that the human mind is wired to think in terms of *raw frequencies* rather than *base rates and probabilities* (Gigerenzer, 1997, 2000). Asking about the probability of a single event is routine in today's world, where we are inundated with statistical data ranging from batting averages to weather predictions. But our ancient ancestors had access to little data other than their own observations, which were accumulating counts of natural frequencies, such as "we had a good hunt three out of the last five times we went to the north plains." Thus, evolutionary theorists assert that many errors in human reasoning, such as neglect of base rates and the conjunction fallacy, should vanish if classic laboratory problems are reformulated in terms of raw frequencies rather than probabilities and base rates.

Consistent with this analysis, evolutionary psychologists have shown that some errors in reasoning that are seen in laboratory studies disappear or are decreased when problems are presented in ways that resemble the type of input humans would have processed in ancestral times (Brase, Cosmides & Tooby, 1998; Gigerenzer & Hoffrage, 1999; Hertwig & Gigerenzer, 1999). Although there is plenty of room for debate (Mellers, Hertwig & Kahneman, 2001; Shafir & LeBoeuf, 2002), this evidence and a couple of other lines of research are gradually reducing cognitive psychologists' tendency to characterize human reasoning as "irrational."

Fast and Frugal Heuristics

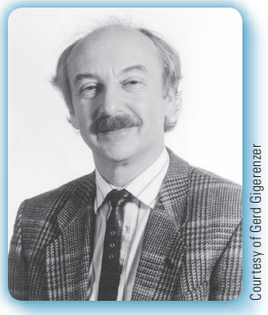
To further expand on the evolutionary point of view, Gerd Gigerenzer has argued that humans' reasoning largely depends on "fast and frugal heuristics" that are quite a bit simpler than the complicated mental processes studied in traditional cognitive research (Gigerenzer, 2000, 2004, 2008; Todd & Gigerenzer, 2000, 2007). According to Gigerenzer, organisms from toads to stockbrokers have to make fast decisions under demanding circumstances with limited information. In most instances organisms (including humans) do not have the time, resources, or cognitive capacities to gather all the relevant information, consider all the possible options, calculate all the probabilities and risks, and then make the statistically optimal decision. Instead, they use quick and dirty heuristics that are less than perfect but that work well enough most of the time to be adaptive in the real world.

To explore these fast and frugal heuristics, Gigerenzer and his colleagues have typically studied inferences from *memory,* which challenge participants to search some portion of their general knowledge, rather than inferences from *givens,* which challenge participants to draw logical conclusions from information provided by the experimenter. What has this research revealed? It has demonstrated that fast and frugal heuristics can be surprisingly effective. One heuristic that is often used in selecting between alternatives based on some quantitative dimension is the *recognition heuristic,* which works as follows: If one of two alternatives is recognized and the other is not, infer that the recognized alternative has the higher value. Consider the following questions—Which city has more inhabitants: San Diego or San Antonio? Hamburg or Munich? In choosing between U.S. cities, American college students weighed a lifetime of facts useful for inferring population and made the correct choice 71% of the time; in choosing between German cities about which they knew very little, the same students depended on the recognition heuristic and chose correctly 73% of the time (Goldstein & Gigerenzer, 2002). Thus, the recognition heuristic allowed students to perform just as well with very limited knowledge as they did with extensive knowledge.

Gigerenzer and his colleagues have studied a variety of other quick, one-reason decision-making strategies and demonstrated that they can yield inferences that are just as accurate as much more elaborate and time-consuming strategies that carefully weigh many factors. And they have demonstrated that people actually use these fast and frugal heuristics in a diverse array of situations (Gigerenzer & Todd, 1999; Rieskamp & Hoffrage, 1999). Thus, the study of fast and frugal heuristics promises to be an intriguing new line of research in the study of human decision making.

How have traditional decision-making theorists responded to the challenge presented by Gigerenzer and other evolutionary theorists? They acknowledge that people often rely on fast and frugal heuristics,

but they argue that this finding does not make decades of research on carefully reasoned approaches to decision making meaningless. Rather, they propose *dual-process theories,* which posit that people depend on two very different modes or systems of thinking when making decisions (De Neys, 2006; Kahneman, 2003; Kahneman & Frederick, 2005; Stanovich & West, 2002). One system consists of quick, simple, effortless, automatic judgments, like Gigerenzer's fast and frugal heuristics, which traditional theorists prefer to characterize as "intuitive thinking." The second system consists of slower, more elaborate, effortful, controlled judgments, like those studied in traditional decision research. According to this view, the second system monitors and corrects the intuitive system as needed and takes over when complicated or important decisions loom. Thus, traditional theorists maintain that fast and frugal heuristics and reasoned, rule-governed decision strategies exist side-by-side and that both need to be studied to fully understand decision making.



Courtesy of Gerd Gigerenzer

Gerd Gigerenzer

"These 'fast and frugal' heuristics operate with simple psychological principles that satisfy the constraints of limited time, knowledge, and computational might, rather than those of classical rationality."

web link 8.6

Simple Minds—Smart Choices

This link leads to an article from *Science News* on Gerd Gigerenzer's research, which suggests that decisions can be made quickly and accurately with remarkably simple strategies.

REVIEW of Key Learning Goals

8.12 Simon's theory of bounded rationality suggests that human decision strategies are simplistic and often yield irrational results. Schwartz argues that in modern societies people suffer from choice overload, which leads to rumination, regret, and diminished well-being.

8.13 An additive decision model is used when people make decisions by rating the attributes of each alternative and selecting the alternative that has the highest sum of ratings. When elimination by aspects is used, people gradually eliminate alternatives whose attributes fail to satisfy some minimum criterion. To some extent, people adapt their decision-making strategy to the situation, moving toward simpler strategies when choices become complex.

8.14 In making decisions, evaluations of options fluctuate more than expected. Comparative evaluations of options often yield different results than separate evaluations. Judgments of products may be influenced by their prices. Our Featured Study on the deliberation-without-attention effect showed that intuitive, unconscious decisions may be more satisfying than those based on conscious deliberation, especially when choices are complex.

8.15 Risky decision making involves making choices under conditions of uncertainty. Models of how people make risky decisions focus on the expected value or subjective utility of various outcomes.

8.16 The availability heuristic involves basing probability estimates on the ease with which relevant examples come to mind. The representativeness heuristic involves basing the estimated probability of an event on how similar it is to the prototype of that event.

8.17 In estimating probabilities, people often ignore information on base rates due to the influence of the representativeness heuristic. The conjunction fallacy occurs when people estimate that the odds of two uncertain events happening together are greater than the odds of either event happening alone.

8.18 Evolutionary psychologists maintain that many errors and biases in human reasoning are greatly reduced when problems are presented in ways that resemble the type of input humans would have processed in ancestral times.

8.19 Gigerenzer argues that people largely depend on fast and frugal decision heuristics that are adaptive in the real world. Research shows that these simple heuristics can be surprisingly effective. Dual-process theories propose that people depend on two different modes of thinking in making decisions: fast and frugal heuristics and effortful, controlled deliberation.

Reflecting on the Chapter's Themes

Key Learning Goals

8.20 Identify the four unifying themes highlighted in this chapter.

Four of our unifying themes have been especially prominent in this chapter. The first is the continuing question about the relative influence of heredity and environment. The controversy about how children acquire language skills replays the nature versus nurture debate. The behaviorist theory, that children learn language through imitation and reinforcement, emphasizes the importance of the environment. The nativist theory, that children come equipped with an innate language acquisition device, argues for the importance of biology. The debate is far from settled, but the accumulating evidence suggests that language development depends on both nature and nurture, as more recent interactionist theories have proposed.

The second pertinent theme is the empirical nature of psychology. For many decades, psychologists paid little attention to cognitive processes, because most of them assumed that thinking is too private to be studied scientifically. During the 1950s and 1960s, however, psychologists began to devise creative new ways to measure mental processes. These innovations fueled the cognitive revolution that put the *psyche* (the mind) back in psychology. Thus, once again, we see how empirical methods are the lifeblood of the scientific enterprise.

Third, the study of cognitive processes shows how there are both similarities and differences across cultures in behavior. On the one hand, we saw that language development unfolds in much the same way in widely disparate cultures. On the other hand, we learned that there are interesting cultural variations in cognitive style.

The fourth theme is the subjective nature of human experience. We have seen that decision making is a highly subjective process. The subjectivity of decision processes will continue to be prominent in the upcoming Personal Application, which discusses some more common pitfalls in reasoning about decisions.

REVIEW of Key Learning Goals

8.20 Our discussion of language acquisition revealed that all aspects of behavior are shaped by both nature and nurture. Recent progress in the study of cognitive processes showed how science depends on empirical methods. Research on decision making illustrated the importance of subjective perceptions, and we saw that cognitive processes are moderated—to a limited degree—by cultural factors.

PERSONAL APPLICATION

Key Learning Goals

8.21 Explain what is meant by the gambler's fallacy and the tendency to overestimate the improbable.

8.22 Describe the propensity to seek confirming information and the overconfidence effect.

8.23 Analyze the effects of framing and loss aversion on decisions.

Understanding Pitfalls in Reasoning About Decisions

Consider the following scenario:

Laura is in a casino watching people play roulette. The 38 slots in the roulette wheel include 18 black numbers, 18 red numbers, and 2 green numbers. Hence, on any one spin, the probability of red or black is slightly less than 50-50 (.474 to be exact). Although Laura hasn't been betting, she has been following the pattern of results in the game very carefully. The ball has landed in red seven times in a row. Laura concludes that black is long overdue and she jumps into the game, betting heavily on black.

Has Laura made a good bet? Do you agree with Laura's reasoning? Or do you think that Laura misunderstands the laws of probability? You'll find out momentarily, as we discuss how people reason their way to decisions—and how their reasoning can go awry.

The pioneering work of Amos Tversky and Daniel Kahneman (1974, 1982) led to an explosion of research on risky decision making. In their efforts to identify the heuristics that people use in decision making, investigators stumbled onto quite a few misconceptions, oversights, and biases. It turns out that people deviate in predictable ways from optimal decision strategies—with surprising regularity (Goldstein & Hogarth, 1997). As explained in the chapter, recent evolutionary research on decision making has offered a new explanation for *why* our decision making appears to be muddled. And evolutionary theorists argue that our decision strategies actually are rational—when viewed as evolved mechanisms designed to solve the adaptive problems faced in ancestral times (Cosmides & Tooby, 1996).

But, while the evolutionary explanations for our foibles in reasoning *may* be on target, the fact remains that *we do not live in ancestral times*. We live in the information age and we have to deal with base rates, probabilities, and percentages on a routine basis. In our modern world, reproductive fitness surely depends more on SAT scores than on counting berries. So, mainstream cognitive research on flaws in human reasoning about decisions remains relevant (Stanovich, 2003).

Moreover, recent research suggests that people exhibit consistent differences in the ability to reason effectively about decisions. Parker and Fischoff (2005) developed a scale to measure seven skills required for competent decision making. Their initial study indicated that people vary considerably in their talent for making sound decisions. In a follow-up study, they found that people who score relatively high on their scale tend to report fewer negative life events indicative of poor decision making than people who score relatively low (de Bruin, Parker, & Fischoff, 2007). Fortunately, research indicates that increased awareness of common shortcomings in reasoning about decisions can lead to improved decision making (Agnoli & Krantz, 1989; Fischhoff, 1982; Keren, 1990). With this goal in mind, let's look at some common pitfalls in decision making.

The Gambler's Fallacy

7f PSYK TREK

As you may have guessed by now, Laura's reasoning in our opening scenario is flawed. A great many people tend to believe that Laura has made a good bet (Stanovich, 2003; Tversky & Kahneman, 1982). However, they're wrong. Laura's behavior illustrates **the *gambler's fallacy*—the belief that the odds of a chance event increase if the event hasn't occurred recently.** People believe that the laws of probability should yield fair results. If they believe that a process is random, they expect the process to be self-correcting (Burns & Corpus, 2004). These aren't bad assumptions in the long run. However, they don't apply to individual, independent events.

The roulette wheel does not remember its recent results and make adjustments for

them. Each spin of the wheel is an independent event. The probability of black on each spin remains at .474, even if red comes up 100 times in a row! The gambler's fallacy reflects the pervasive influence of the *representativeness heuristic*. In betting on black, Laura is predicting that future results will be more representative of a random process. This logic can be used to estimate the probability of black across a *string of spins*. But it doesn't apply to a *specific spin* of the roulette wheel.

Overestimating the Improbable

7f

Various causes of death are paired up below. In each pairing, which is the more likely cause of death?

Asthma or tornadoes?
Accidental falls or shooting accidents?
Tuberculosis or floods?
Suicide or murder?

Table 8.4 shows the actual mortality rates for each of the causes of death just listed. As you can see, the first choice in each pair is the more common cause of death. If you guessed wrong for several pairings, don't feel bad. Like many other people, you may be a victim of the tendency to *overestimate the improbable*. People tend to greatly overestimate the likelihood of dramatic, vivid—but infrequent—events that receive heavy media coverage. Thus, the number of fatalities due to tornadoes, shooting accidents, floods, and murders is usually overestimated (Slovic, Fischhoff, & Lichtenstein, 1982). Fatalities due to asthma and other common diseases, which receive less media coverage, tend to be underestimated. For instance, a majority of subjects estimate that tornadoes kill more people than asthma, even though asthma fatalities outnumber tornado fatalities by a ratio of 80 to 1. This tendency to exaggerate the improbable has generally been attributed to operation of the *availability heuristic* (Reber, 2004). Instances of floods, tornadoes, and such are readily available in memory because people are exposed to a great deal of media coverage of such events.

Table 8.4 Actual Mortality Rates for Selected Causes of Death

Cause of Death	Rate	Cause of Death	Rate
Asthma	2,000	Tornadoes	25
Accidental falls	6,021	Firearms accidents	320
Tuberculosis	400	Floods	44
Suicide	11,300	Homicide	6,800

Note: Mortality rates are per 100 million people and are based on the Statistical Abstract of the United States, 2001.

As a general rule, people's beliefs about what they should fear tend to be surprisingly inconsistent with actual probabilities (Glassner, 1999). This propensity has been especially prominent in the aftermath of 9/11, which left countless people extremely worried about the possibility of being harmed in a terrorist attack (as the terrorists intended). To date, one's chances of being hurt in a terrorist attack are utterly microscopic in comparison to one's chances of *perishing* in an automobile accident, yet people worry about the former and not the latter (Myers, 2001). People tend to overestimate the likelihood of rare events when their estimates are based on descriptive information (such as media coverage) as opposed to when their estimates are based on personal experiences (Hertwig et al., 2004).

Confirmation Bias

Imagine a young physician examining a sick patient. The patient is complaining of a high fever and a sore throat. The physician must decide on a diagnosis from among a myriad possible diseases. The physician thinks that it may be the flu. She asks the patient if he feels "achey all over." The answer is "yes." The physician asks if the symptoms began a few days ago. Again, the response is "yes." The physician concludes that the patient has the flu. (Adapted from Halpern, 1984, pp. 215–216)

Do you see any flaws in the physician's reasoning? Has she probed into the causes of the patient's malady effectively? No, she has asked about symptoms that would be

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*The availability heuristic can be dramatized by juxtaposing the unrelated phenomena of floods and tuberculosis (TB). Many people are killed by floods, but far more die from tuberculosis (see **Table 8.4**). However, since the news media report flood fatalities frequently and prominently, but rarely focus on deaths from tuberculosis, people tend to assume that flood-related deaths are more common.*

consistent with her preliminary diagnosis, but she has not inquired about symptoms that could rule it out. Her questioning of the patient illustrates ***confirmation bias*—the tendency to only seek information that is likely to support one's decisions and beliefs.** This bias is common in medical diagnosis and other forms of decision making (Nickerson, 1998). There's nothing wrong with searching for confirming evidence to support one's decisions. However, people should also seek disconfirming evidence—which they often neglect to do. A closely related problem is *predecisional distortion* of information (Carlson, Meloy, & Russo, 2006). When people confront a choice, they often have an initial inclination to lean one way or the other. This slant often leads to biased evaluations of incoming information that bolster one's initial choice. Recent research demonstrates that predecisional distortion can induce participants to choose inferior alternatives (Russo, Carlson, & Meloy, 2006).

The Overconfidence Effect

7f

Make high and low estimates of the total U.S. Defense Department budget in the year 2007. Choose estimates far enough apart to be 98% confident that the actual figure lies between them. In other words, you should feel that there is only a 2% chance that the correct figure is lower than your low estimate or higher than your high estimate. Write your estimates in the spaces provided, before reading further.

High estimate: _____

Low estimate: _____

When working on problems like this one, people reason their way to their best estimate and then create a confidence interval around it. For instance, let's say that you arrived at $300 billion as your best estimate of the defense budget. You would then expand a range around that estimate—say $250 billion to $350 billion—that you're sure will contain the correct figure. The answer in this case is $439 billion. If the answer falls outside your estimated range, you are not unusual. In making this type of estimate, people consistently tend to make their confidence intervals too narrow (Epley & Gilovich, 2006; Lichtenstein, Fischhoff, & Phillips, 1982; Soll & Klayman, 2004). For example, subjects' 98% confidence intervals should include the correct answer 98% of the time, but they actually do so only about 60% of the time.

The crux of the problem is that people tend to put too much faith in their estimates, beliefs, and decisions, even when they should know better, a principle called the *overconfidence effect.* People vary considerably in their tendency to be overconfident (Stanovich, 1999), but overconfidence effects are very frequent (West & Stanovich, 1997). Studies have shown that physicians, weather forecasters, military leaders, gamblers, investors, and scientists tend to be overconfident about their predictions. As Daniel Kahneman puts it, "The human mind suppresses uncertainty. We're not only convinced that we know more about our politics, our businesses, and our spouses than we really do, but also that what we don't know must be unimportant" (McKean, 1985, p. 27). Thus, the overconfidence effect sometimes leads people to ignore useful sources of information that might well improve their predictions (Sieck & Arkes, 2005).

The Effects of Framing

7f

Another consideration in making decisions involving risks is the framing of questions (Tversky & Kahneman, 1988, 1991). ***Framing* refers to how decision issues are posed or how choices are structured.** People often allow a decision to be shaped by the language or context in which it's presented, rather than explore it from different perspectives. Consider the following scenario, which is adapted from Kahneman and Tversky (1984, p. 343):

Imagine that the U.S. is preparing for the outbreak of a dangerous disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows.

- *If Program A is adopted, 200 people will be saved.*
- *If Program B is adopted, there is a one-third probability that all 600 people will be saved and a two-thirds probability that no people will be saved.*

Kahneman and Tversky found that 72% of their subjects chose the "sure thing" (Program A) over the "risky gamble" (Program B). However, they obtained different results when the alternatives were reframed as follows:

- *If Program C is adopted, 400 people will die.*
- *If Program D is adopted, there is a one-third probability that nobody will die and a two-thirds probability that all 600 people will die.*

Although framed differently, Programs A and B represent exactly the same probability situation as Programs C and D (see **Figure 8.22**). In spite of this equivalence, 78% of the subjects chose Program D. Thus, sub-

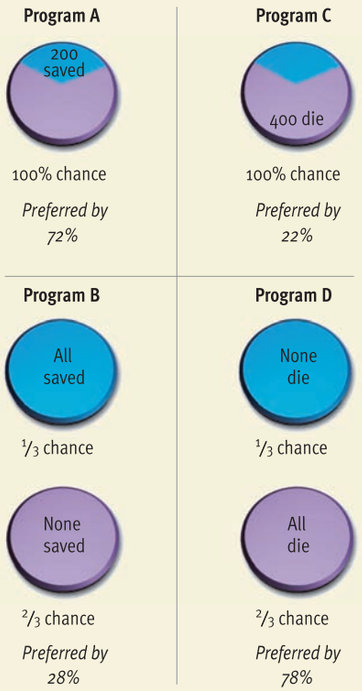

Figure 8.22
The framing of questions. This chart shows that Programs A and B are parallel in probability to Programs C and D, but these parallel pairs of alternatives lead subjects to make different choices. Studies show that when choices are framed in terms of possible gains, people prefer the safer plan. However, when choices are framed in terms of losses, people are more willing to take a gamble.

jects chose the sure thing when the decision was framed in terms of lives saved, but they went with the risky gamble when the decision was framed in terms of lives lost. Obviously, sound decision making should yield consistent decisions that are not altered dramatically by superficial changes in how options are presented, so framing effects once again highlight the foibles of human decision making.

The Specter of Regret and Loss Aversion

A surprisingly influential factor in decision making is the need to avoid regret about making a bad decision. People routinely think about how much regret they are likely to experience if the selection of a particular option backfires (Connolly & Zeelenberg, 2002). These estimates of anticipated regret are weighed heavily and often lead people to make overly cautious decisions. Interestingly, research suggests that people tend to overestimate how much regret they will experience as a result of poor decisions (Gilbert et al., 2004).

A related phenomenon is *loss aversion*—in general, losses loom larger than gains of equal size (Kahneman & Tversky, 1979; Novemsky & Kahneman, 2005). Thus, most people expect that the negative impact of losing $1000 will be greater than the positive impact of wining $1000. Loss aversion can lead people to pass up excellent opportunities. For instance, subjects tend to decline a theoretical gamble in which they are given an 85% chance of doubling their life savings versus a 15% chance of losing their life savings, which mathematically is vastly more attractive than any bet one could place in a casino (Gilbert, 2006). Loss aversion can influence decisions in many areas of life, including choices of consumer goods, investments, business negotiations, and approaches to health care (Camerer, 2005; Klapper, Ebling, & Temme, 2005). The problem with loss aversion is that, as Daniel Gilbert and his colleagues have shown, people generally overestimate the intensity and duration of the negative emotions they will experience after all sorts of losses, ranging from losing a job or romantic partner to botching an interview or watching one's team lose in a big game (Gilbert, Driver-Linn, & Wilson, 2002; Kermer et al., 2006) (see Chapter 10). Interestingly, people overestimate the emotional impact of losses because they do not appreciate how good most of us are at rationalizing, discounting, and distorting negative events in our lives. In any event, well-informed decision makers should be aware of how the specter of regret and loss aversion can sway their everyday decisions.

REVIEW of Key Learning Goals

8.21 The gambler's fallacy is the belief that the odds of a chance event increase if the event hasn't occurred recently. People tend to inflate estimates of improbable events that garner heavy coverage in the media, because of the availability heuristic.

8.22 People often exhibit confirmation bias—the tendency to only seek information that supports one's view. In making predictions and estimates people tend to be overly confident about their forecasts.

8.23 Framing refers to how decision issues are posed or how choices are structured. Decisions can be influenced by the language in which they are framed. Most people expect that the negative impact of a loss will be greater than the positive impact of a similar gain, but research shows that people overestimate the impact of losses.

CRITICAL THINKING

APPLICATION

Key Learning Goals

8.24 Recognize key language manipulation strategies that people use to shape others' thought.

Shaping Thought with Language: "Only a Naïve Moron Would Believe That"

As explained in the chapter, the *linguistic relativity hypothesis* asserts that different languages may lead people to think about things differently. Given the power of language, it should come as no surprise that carefully chosen words and labels (within a specific language) can exert subtle influence on people's feelings about various issues (Calvert, 1997; Johnson & Dowling-Guyer, 1996; Pohl, 2004; Weatherall, 1992). In everyday life, many people clearly recognize that language can tilt thought along certain lines. This possibility is the basis for some of the concerns that have been expressed about sexist language. Women who object to being called "girls," "chicks," and "babes" believe that these terms influence the way people think about and interact with women. In a similar vein, used car dealers that sell "preowned cars" and airlines that outline precautions for "water landings" are manipulating language to influence thought. Indeed, bureaucrats, politicians, advertisers, and big business have refined the art of shaping thought by tinkering with language, and to a lesser degree the same techniques are used by many people in everyday interactions. Let's look at two of these techniques: semantic slanting and name calling.

Semantic Slanting

Semantic slanting refers to deliberately choosing words to create specific emotional responses. For example, consider the crafty word choices made in the incendiary debate about abortion (Halpern, 1996). The anti-abortion movement recognized that it is better to be *for* something than to be *against* something and then decided to characterize its stance as "pro-life" rather than "anti-choice." Likewise, the faction that favored abortion did not like the connotation of an "anti-life" or "pro-abortion" campaign, so they characterized their position as "pro-choice." The position advocated is exactly the same either way, but the label clearly influences how people respond. Thinking along similar lines, some "pro-life" advocates have asserted that the best way to win the debate about abortion is to frequently use the words *kill* and *baby* in the same sentence (Kahane, 1992). Obviously, these are words that push people's buttons and trigger powerful emotional responses.

In his fascinating book *Doublespeak,* William Lutz (1989) describes an endless series of examples of how government, business, and advertisers manipulate language to bias people's thoughts and feelings. For example, in the language of the military, an invasion is a "preemptive counterattack," bombing the enemy is providing "air support," a retreat is a "backloading of augmentation personnel," civilians accidentally killed or wounded by military strikes are "collateral damage," and troops killed by their own troops are "friendly casualties." In the world of business, layoffs and firings become "headcount reductions," "workforce adjustments," or "career alternative enhancement programs," whereas bad debts become "nonperforming assets." And in the language of bureaucrats, hospital deaths become "negative patient care outcomes" and tax increases become "revenue enhancement initiatives," leading Lutz to quip that "Nothing in life is certain except negative patient care outcome and revenue enhancement." You can't really appreciate how absurd this process can become until you go shopping for "genuine imitation leather" or "real counterfeit diamonds."

Of course, you don't have to be a bureaucrat or military spokesperson to use semantic slanting. For example, if a friend of yours is annoyed at her 60-year-old professor for giving a tough exam and describes him as an "old geezer," she would be using semantic slanting. She would have communicated that the professor's age is a negative factor—one that is associated with a host of unflattering stereotypes about older people. And she would have implied that he gave an inappropriate exam because of his antiquated expectations or senile incompetence—all with a couple of well-chosen words. We are

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Semantic slanting, which consists of carefully choosing words to create specific emotional reactions, has been used extensively by both sides in the debate about abortion.

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Briefings on the status of miliary actions are renowned for their creative but unintelligible manipulation of language, which is often necessary to obscure the unpleasant realities of war.

all the recipients of many such messages containing emotionally laden words and content. An important critical thinking skill is to recognize when semantic slanting is being used to influence how you think so you can resist this subtle technique.

In becoming sensitive to semantic slanting, notice how the people around you and those whom you see on television and read about in the newspapers refer to people from other racial and ethnic groups. You can probably determine a politician's attitudes toward immigration, for example, by considering the words he or she uses when speaking about people from other countries. Are the students on your campus who come from other countries referred to as "international students" or "foreign students"? The term "international" seems to convey a more positive image, with associations of being cosmopolitan and worldly. On the other hand, the term "foreign" suggests someone who is strange. Clearly, it pays to be careful when selecting the words you use in your own communication.

Name Calling

Another way that word choice influences thinking is in the way people tend to label and categorize others through the strategy of *name calling*. People often attempt to neutralize or combat views they don't like by attributing such views to "radical feminists," "knee-jerk liberals," "right-wingers," "religious zealots," or "extremists." In everyday interactions, someone who inspires our wrath may be labeled as a "bitch," a "moron," or a "cheapskate." In these examples, the name calling is not subtle and is easy to recognize. But name calling can also be used with more cunning and finesse. Sometimes, there is an *implied threat* that if you make an unpopular decision or arrive at a conclusion that is not favored, a negative label will be applied to you. For example, someone might say, "Only a naive moron would believe that" to influence your attitude on an issue. This strategy of *anticipatory name calling* makes it difficult for you to declare that you favor the negatively valued belief because it means that you make yourself look like a "naive moron." Anticipatory name calling can also invoke positive group memberships, such as asserting that "all good Americans will agree . . ." or "people in the know think that . . ." Anticipatory name calling is a shrewd tactic that can be effective in shaping people's thinking.

Regardless of your position on these issues, how would you respond to someone who says, "Only a knee-jerk liberal would support racial quotas or affirmative action programs that give unfair advantages to minorities." Or "Only a stupid bigot would oppose affirmative action programs that rectify the unfair discrimination that minorities face." Can you identify the anticipatory name calling and the attempts at semantic slanting in each of these examples? More important, can you resist attempts like these to influence how you think about complex social issues?

Table 8.5 Critical Thinking Skills Discussed in This Application

Skill	Description
Understanding the way language can influence thought	The critical thinker appreciates that when you want to influence how people think, you should choose your words carefully.
Recognizing semantic slanting	The critical thinker is vigilant about how people deliberately choose certain words to elicit specific emotional responses.
Recognizing name calling and anticipatory name calling	The critical thinker is on the lookout for name calling and the implied threats used in anticipatory name calling.

REVIEW of Key Learning Goals

8.24 Language can exert subtle influence over how people feel about various issues. Semantic slanting refers to the deliberate choice of words to create specific emotional responses, as has been apparent in the debate about abortion. In anticipatory name calling, there is an implied threat that a negative label will apply to you if you express certain views.

CHAPTER 8 RECAP

Key Ideas

Language: Turning Thoughts into Words

- Languages are symbolic, generative, and structured. Human languages are structured hierarchically. At the bottom of the hierarchy are the basic sound units, called phonemes. At the next level are morphemes, the smallest units of meaning.
- Children typically utter their first words around their first birthday. Vocabulary growth is slow at first, but a vocabulary spurt often begins at around 18 months. Children begin to combine words by the end of their second year. Their early sentences are telegraphic, in that they omit many nonessential words.
- Over the next several years, children gradually learn the complexities of syntax and develop metalinguistic awareness. Research does not support the assumption that bilingualism has a negative effect on language development or on cognitive development.
- Sue Savage-Rumbaugh's work with Kanzi suggests that some animals are capable of some basic language acquisition, although some skeptics disagree. Many theorists believe that humans' special talent for language is the product of natural selection.
- According to Skinner and other behaviorists, children acquire a language through imitation and reinforcement. Nativist theories assert that humans have an innate capacity to learn language rules. Today, theorists are moving toward interactionist perspectives, which emphasize the role of both biology and experience.
- The linguistic relativity hypothesis suggests that language determines the nature of people's thinking to some degree. Recent research has bolstered the plausibility of this notion.

Problem Solving: In Search of Solutions

- Psychologists have differentiated among several types of problems, including problems of inducing structure, problems of transformation, and problems of arrangement. Common barriers to problem solving include functional fixedness, mental set, attending to irrelevant information, and placement of unnecessary constraints on one's solutions.
- A variety of strategies, or heuristics, are used for solving problems, including using trial and error, forming subgoals, hill-climbing, working backward, searching for analogies, and changing the representation of a problem.
- Cultural disparities in problem solving style have been observed. According to Nisbett, Eastern cultures exhibit a more holistic cognitive style, whereas Western cultures display a more analytic cognitive style.

Decision Making: Choices and Chances

- Simon's theory of bounded rationality suggests that human decision strategies are simplistic and often yield irrational results. Schwartz argues that people in modern societies suffer from choice overload, which undermines their well-being.
- An additive decision model is used when people make decisions by rating the attributes of each alternative and selecting the alternative that has the highest sum of ratings. When elimination by aspects is used, people gradually eliminate alternatives if their attributes fail to satisfy some minimum criterion.
- In making decisions, evaluations of options' pros and cons tend to fluctuate more than expected. Comparative evaluations of options often yield different results than separate evaluations. Research suggests that intuitive, unconscious choices may be superior to conscious deliberation in making some decisions.
- Models of how people make risky decisions focus on the expected value or subjective utility of various outcomes. People use the representativeness and availability heuristics in estimating probabilities. These heuristics can lead people to ignore base rates and to fall for the conjunction fallacy.
- Evolutionary psychologists maintain that many errors and biases in human reasoning are greatly reduced when problems are presented in ways that resemble the type of input humans would have processed in ancestral times. Gigerenzer argues that people largely depend on fast and frugal decision heuristics that are adaptive in the real world.

Reflecting on the Chapter's Themes

- Four of our unifying themes surfaced in the chapter. Our discussion of language acquisition revealed once again that all aspects of behavior are shaped by both nature and nurture. The recent progress in the study of cognitive processes showed how science depends on empirical methods. Research on decision making illustrated the importance of subjective perceptions. We also saw that cognitive processes are moderated—to a limited degree—by cultural factors.

PERSONAL APPLICATION Understanding Pitfalls in Reasoning About Decisions

- The heuristics that people use in decision making lead to various flaws in reasoning. For instance, the use of the representativeness heuristic contributes to the gambler's fallacy. The availability heuristic underlies the tendency to overestimate the improbable. People sometimes exhibit confirmation bias—the tendency to seek only information that supports one's view.
- People generally fail to appreciate these shortcomings, which leads to the overconfidence effect. In evaluating choices, it is wise to understand that decisions can be influenced by the language in which they are framed. Loss aversion may also distort decision making processes.

CRITICAL THINKING APPLICATION Shaping Thought with Language: "Only a Naive Moron Would Believe That"

- Language can exert subtle influence over how people feel about various issues. Semantic slanting refers to the deliberate choice of words to create specific emotional responses, as has been apparent in the debate about abortion. In anticipatory name calling, there is an implied threat that a negative label will apply to you if you express certain views.

Key Terms

Algorithm (p. 332)
Availability heuristic (p. 341)
Bilingualism (p. 323)
Cognition (p. 318)
Confirmation bias (p. 348)
Conjunction fallacy (p. 343)
Decision making (p. 337)
Fast mapping (p. 321)
Framing (p. 348)
Functional fixedness (p. 330)
Gambler's fallacy (p. 346)
Heuristic (p. 332)
Hill-climbing heuristic (p. 333)
Insight (p. 332)
Language (p. 318)
Language acquisition device (LAD) (p. 326)
Linguistic relativity (p. 327)
Mean length of utterance (MLU) (p. 322)
Mental set (p. 330)
Metalinguistic awareness (p. 322)
Morphemes (p. 320)
Overextensions (p. 322)
Overregularization (p. 322)
Phonemes (p. 319)
Problem solving (p. 328)
Problem space (p. 332)
Representativeness heuristic (p. 342)
Risky decision making (p. 341)
Semantics (p. 320)
Syntax (p. 320)
Telegraphic speech (p. 322)
Theory of bounded rationality (p. 337)
Trial and error (p. 332)
Underextensions (p. 322)

Key People

Noam Chomsky (p. 326)
Leda Cosmides & John Tooby (p. 344)
Gerd Gigerenzer (pp. 344–345)
Daniel Kahneman (pp. 341–343)
Steven Pinker (p. 325)
Sue Savage-Rumbaugh (p. 324)
Herbert Simon (pp. 318, 337)
B. F. Skinner (p. 326)
Amos Tversky (pp. 341–343)

CHAPTER 8 PRACTICE TEST

1. The 2-year-old child who refers to every four-legged animal as "doggie" is making which of the following errors?
   A. underextension
   B. overextension
   C. overregularization
   D. underregularization

2. Research suggests that bilingualism has a negative effect on:
   A. language development.
   B. cognitive development.
   C. metalinguistic awareness.
   D. none of the above.

3. Based on the work with Kanzi, which statement best summarizes the current status of the research on whether chimps can learn language?
   A. Chimps can acquire the use of symbols but cannot combine them into sentences or learn rules of language.
   B. Chimps are nearly as well suited for learning and using language as humans.
   C. Chimps are incapable even of learning the symbols of a language.
   D. Chimps can learn some basic language skills, but the linguistic capacities of humans are far superior.

4. Chomsky proposed that children learn language swiftly:
   A. because they possess an innate language acquisition device.
   B. through imitation, reinforcement, and shaping.
   C. as the quality of their thought improves with age.
   D. because they need to in order to get their increasingly complex needs met.

5. The linguistic relativity hypothesis is the notion that:
   A. one's language determines the nature of one's thought.
   B. one's thought determines the nature of one's language.
   C. language and thought are separate and independent processes.
   D. language and thought interact, with each influencing the other.

6. The nine-dot problem is:
   A. often solved suddenly with a burst of insight.
   B. difficult because people assume constraints that are not part of the problem.
   C. solved through fast mapping.
   D. both a and b.

7. Problems that require a common object to be used in an unusual way may be difficult to solve because of:
   A. mental set.
   B. irrelevant information.
   C. unnecessary constraints.
   D. functional fixedness.

8. A heuristic is:
   A. a flash of insight.
   B. a guiding principle or "rule of thumb" used in problem solving.
   C. a methodical procedure for trying all possible solutions to a problem.
   D. a way of making a compensatory decision.

9. Which of the following is *not* a heuristic used in solving problems?
   A. Hill climbing
   B. Fast-mapping
   C. Forming subgoals
   D. Searching for analogies

10. According to Nisbett, Eastern cultures tend to favor a(n) _____ cognitive style, whereas Western cultures tend to display a(n) _____ cognitive style.
   A. analytic; holistic
   B. holistic; analytic
   C. heuristic; algorythmic
   D. algorhythmic; heuristic

11. The theory of bounded rationality was originally developed by:
   A. Herbert Simon.
   B. Noam Chomsky.
   C. Steven Pinker.
   D. Gerd Gigerenzer.

12. When you estimate the probability of an event by judging the ease with which relevant instances come to mind, you are relying on:
   A. an additive decision-making model.
   B. the representativeness heuristic.
   C. the availability heuristic.
   D. a noncompensatory model.

13. The belief that the probability of heads is higher after a long string of tails:
   A. is rational and accurate.
   B. is an example of the "gambler's fallacy."
   C. reflects the influence of the representativeness heuristic.
   D. b and c.

14. The tendency to overestimate the probability of events that get heavy media coverage reflects the operation of:
   A. framing effects.
   B. the representativeness heuristic.
   C. the availability heuristic.
   D. mental set.

15. If someone says, "Only a congenital pinhead would make that choice," this use of language would represent:
   A. confirmation bias.
   B. syntactic slanting.
   C. anticipatory name calling.
   D. telegraphic speech.

Answers

1 B p. 322
2 D pp. 323–324
3 D pp. 324–325
4 A p. 326
5 A pp. 327–328
6 D pp. 331–332
7 D p. 330
8 B p. 332
9 B pp. 332–333
10 B p. 336
11 A p. 337
12 C p. 341
13 D pp. 346–347
14 C p. 347
15 C p. 351

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