CHAPTER 8
THINKING AND LANGUAGE

Alex works with psychologist Irene Pepperberg to identify colors and letters.

resembled a cherry. Critics, however, said that Alex learned by rote and did not truly use language.

So the question remains: Can animals use language? The answer seems to hinge on the definition of language. It seems clear that animals can learn to use signs and symbols and can follow some commands given to them. So if this is considered language, then yes, animals can use language.

Most psychologists use a more restrictive definition of language: the combination of symbols into original, grammatical sentences. If we use this definition, the answer becomes less clear. Whatever the final answer, though, the experiments with animals and language also raise new questions about animal intelligence. What is going on in their brains when they communicate—by whatever method—with people? Are they thinking? How does their thinking differ from ours? What is thinking, and how is it connected to language?

What do you think?

1. What did Washoe, Kanzi, and Alex learn to do?
2. How do you think language should be defined?

Chapter at a Glance

SECTION 1: Understanding Thinking

- Thinking is the mental activity that allows us to understand, process, and communicate information.
- The basic units of thought include symbols, concepts, and prototypes.
- There are three kinds of thinking: convergent, divergent, and metacognition.

SECTION 2: Problem Solving

- Problem solving involves a series of processes, including analyzing the problem, breaking it into component parts, and establishing goals.
- Algorithms and heuristics are general approaches to problem solving.
- There are specific methods of problem solving, including systematic searching, trial and error, difference reduction, means-end analysis, working backward, and use of analogy.

SECTION 3: Reasoning and Decision Making

- Reasoning is the use of information to reach conclusions. There are two main types of reasoning: deductive and inductive.
- People use a variety of methods to make decisions, including using a balance sheet and some types of heuristics.

SECTION 4: Language

- Language is the communication of ideas through symbols that are arranged according to rules of grammar.
- Language contains three basic elements: phonemes, morphemes, and syntax.
- Children everywhere learn language in the same sequence of steps. Heredity and environment both affect language learning.
- Bilingualism is the ability to understand and speak two languages.

SECTION 1

Understanding Thinking

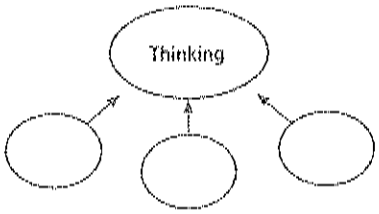
Before You Read

Main Idea
Thinking is the mental activity that allows humans to process, understand and communicate information. There are three types of thinking: convergent, divergent, and metacognitive.

Reading Focus
1. What are some basic elements related to thinking?
2. How do the three types of thinking differ?

Vocabulary
thinking
symbol
concept
prototype
convergent thinking
divergent thinking
metacognition

TAKING NOTES Use a graphic organizer like this one to take notes on the nature of thinking.



A Life-Saving Symbol

PSYCHOLOGY CLOSE UP ***How do you know a sign warns of danger even though you don't read Turkish?*** Look at the signs to the right. Are your eyes drawn immediately to the scary-looking skull with the red arrows? Would you touch something that bore such a sign? Of course not! The skull and jagged arrows are universal symbols that we can easily read as threatening death by electrocution.

There are many such symbols in our lives. They help us navigate in our world. So, for instance, finding the right restroom in a country where you don't speak the language is made easier by simplifed male and female figures on the doors. If you are driving down the high-way and see the sign with the car falling into water, you know to avoid a potential hazard ahead, perhaps a washed-out bridge. When standing at a crosswalk, you know that the orange hand tells you to wait.

Your reaction to these symbols is instant. They act like wordless thoughts in your mind—thoughts that you can act on immediately. But symbols do more than keep us on the right road and out of danger. They are also essential elements in the thinking process.

Do you know what these signs are telling you? Symbols are useful not only on signs. When we think, we use symbols.

Basic Elements of Thinking

This chapter is about thinking. When you are awake, you are probably thinking nearly all the time. But the type of thinking you are doing may vary from moment to moment. Maybe you are just reflecting on how much fun you had with your friends last night. You may be solving a problem, such as a geometry theorem or how to convince your parents to let you go on that weekend trip. Or you may be reasoning—using information to draw a conclusion. Perhaps you are making a decision, such as which after-school job to pursue. Problem solving, reasoning, and decision making are three types of thinking explored in this chapter. And because thinking often relies on language, this chapter also deals with language.

Thinking is the mental activity that is involved in the understanding, processing, and communicating of information. It is a complex process. Thinking is made possible through units of thought that include symbols, concepts, and prototypes.

Symbols When we think, we use symbols to represent the things about which we are thinking. A **symbol** is an object or an act that stands for something else. As you are probably aware, symbols are a part of our daily lives. Your school mascot and the American flag are both examples of symbols. Different types of symbols are found in mathematics. Plus and minus signs, for example, are both symbols: the plus sign signifies "add," and the minus sign signifies "subtract."

Letters and words are also symbols. After all, a word actually stands for something else—it is not the thing itself. For example, the word *plate* is not itself a plate—it only refers to an object that is called a plate in the English language.

Even your mental images are a type of symbol. If you picture a dog in your mind, that image stands for a dog, but of course it is not itself a dog. If it were not for symbols, we would be unable to think about things that were not present.

Concepts What do dogs, horses, and elephants have in common? You may say that they are all animals, or that they are all mammals. When we think, we tend to mentally group together objects, events, or ideas that have similar characteristics, as dogs, horses, and elephants do. Such a grouping is called a **concept.** "Animal" and "mammal" are both examples of concepts.

Much thinking involves categorizing new items and manipulating the relationships among them. Think of a new kind of animal, for instance—just make one up. What makes it an animal? You have used the concept "animal" to create a new item that fits into the "animal" category. Now imagine your new animal in a tree eating a piece of fruit. You are thinking about relationships among concepts (your animal, the tree, and the fruit).

People organize concepts in hierarchies, series of levels that go from broad to narrow. As we saw above, dogs, horses, and elephants can be grouped both as animals and as mammals. The "animal" concept is higher up in the hierarchy than is the "mammal" concept because it is broader, or contains more elements. Sparrows, goldfish, and spiders are all animals, but they are not mammals.

People learn concepts through experience. Simple concepts such as "ball" and "vegetable" are taught by means of examples. We point to a baseball or a basketball and say, "ball" or "This is a ball" to a child. We point to broccoli or carrots and say, "Eat your vegetables." Communication of the meaning of abstract concepts such as fairness, beauty, and goodness may require detailed explanations, a variety of personal experiences, and many examples. Even then, people may still disagree about what is fair, beautiful, or good.

Prototypes Often when we think about a concept, we have an image in our minds of a particular example of that concept, even though a concept is a category and contains many different examples. For instance, picture a shoe in your mind. What does the shoe you pictured look like? Does it have shoelaces, straps, or neither? Does it have a heel, or is it flat-soled?

The shoe you imagined was a **prototype**—an example of a concept that best exemplifies the characteristics of that concept. A prototype does not have to be an actual, experienced example, such as a particular shoe you have seen. Instead, a prototype can be more like an average of all experienced examples.

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exemplify to show or illustrate by example

Your prototype probably contains elements of many different shoes you have seen.

A prototype may provide standards of comparison for a concept. Which do you think is a better example of a shoe: a tennis shoe or a bedroom slipper? You probably said a tennis shoe. Why? Because a tennis shoe is probably closer to your "shoe" prototype than is a bedroom slipper. Most people think of shoes as items that are worn outside or in public, and bedroom slippers usually are worn only around the house. But a bedroom slipper is still a type of shoe.

Prototypes help us categorize our world and process information about it. Without prototypes, we might have to examine every unfamiliar element in our experience as a totally new thing. When we encounter an object or an experience that does not fit into the usual aspects of the prototype, we must either create a new concept or redefine what we are experiencing.

Reading Check **Identify** What are three basic elements related to thinking?

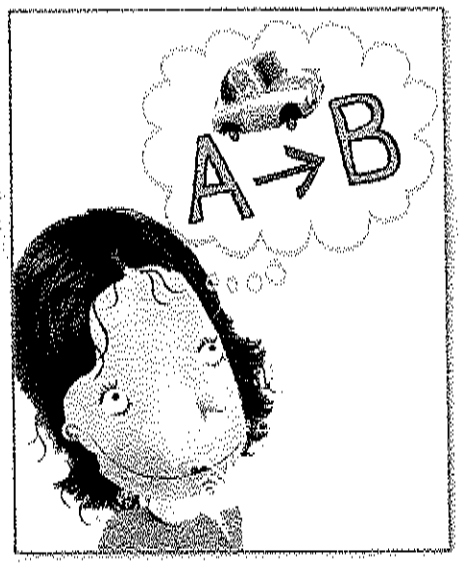
Three Kinds of Thinking

Researchers who study thought processes are interested not only in the elements that play roles in thinking, but also in the ways that we think. Psychologists have determined that in general we think in three ways: convergent, divergent, and metacognitive.

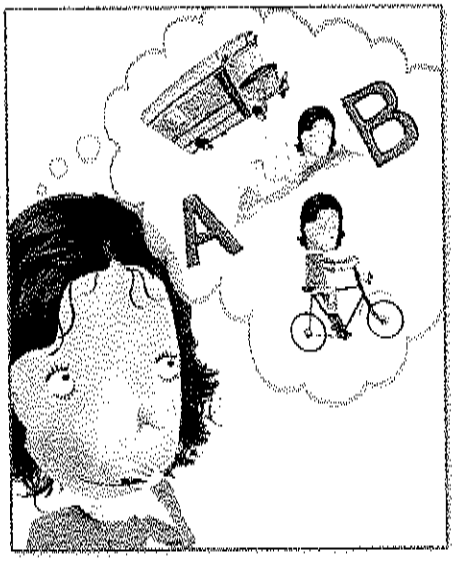
These ways of thinking can all be used to tackle a mental task. Sometimes one form is more efficient than the others. Often all three ways of thinking are involved. Suppose, for example, that you are thinking about taking a vacation with your family. You might use convergent thinking to decide if you want to go to the mountains or the seashore. Divergent thinking might be more helpful for coming up with different places you might want to go or activities to do within a certain place. Finally, metacognition involves the way you may plan the whole vacation. Do you think you will get the best information by calling a travel agent, using the Internet, or talking to friends? You may return to either convergent or divergent thinking as you complete your plans.

Three Kinds of Thinking

You use three basic types of thinking. You probably go back and forth from one type to another effortlessly throughout the day.



Convergent Thinking The thinker uses just the available facts to find the single best solution for how to get to school.



Divergent Thinking Here, she lets her mind come up with many more options for answering the question.

Metacognition When using metacognition, the thinker considers her own thought processes.

Convergent With **convergent thinking,** thought is limited to available facts. When using convergent thinking, we look at a problem or task and narrow the options to one solution. This type of thinking is important in solving specific problems and setting and achieving goals. For example, if you are looking for your house key on your key chain, you eliminate all the keys that you know are not house keys. You will pick out the correct key to open the door. Developing rules and following them is another example of convergent thinking. If you are working a math problem you use convergent thinking to find the correct answer. The next time you are taking a multiple-choice test you will use convergent thinking to narrow the choices presented to the one most likely to be correct.

Many school assignments and tests focus on this type of learning. However, convergent thinking is not particularly creative. Perhaps that is why creative thinkers often do not do well on standardized tests. Albert Einstein and Thomas Edison, two of the greatest scientific minds of the modern world, were creative thinkers, not convergent thinkers. In fact, Edison did poorly in public school. His mind wandered, and a teacher is said to have questioned his mental capacity. In high school Einstein clashed with authorities and resented the rigidity of the school curriculum. Later he wrote that the spirit of learning and creative thought were lost in strict rote learning—a type of convergent thinking—practiced at the school.

Divergent Edison and Einstein would have done better at schools where divergent thinking was encouraged. **Divergent thinking** allows the mind to associate more freely to various elements of a problem. One follows "leads" that run in different directions. Divergent thinking is at the base of creativity. Unlike convergent thinkers, divergent thinkers like open-ended questions and like to seek unique solutions to them.

Psychologist J. P. Guilford, who did groundbreaking work in this area, identified four different aspects of divergent thinking. The thinker is able to rapidly produce a large number of ideas or solutions to a problem, is flexible in approaching the problem, has ideas different from most other people, and has the ability to think through the details of an idea and carry it out.

An English psychologist named Liam Hudson devised a test for creative thinking that he administered to schoolboys. One of the questions he asked was, "How many uses can you think of for a brick?" Most of the boys could only think of three or four answers in a period of three minutes. The divergent thinkers were far more creative and generated 10 or more solutions. As you can imagine, businesses and many different fields of study need divergent thinkers to bring new ideas into their operations.

Divergent thinking sometimes occurs as day-dreaming or fantasies. A thought may emerge that you were never conscious of thinking. Have you ever worked on a problem, gotten stuck, and simply walked away only to find that when you returned to the problem later you had a solution? That is a type of divergent thinking in action.

Metacognition A third way of thinking is called metacognition. **Metacognition** consists of planning, evaluating, and monitoring mental activities. In other words, it is thinking about thinking. The concept of metacognition is not new. In the 300s BC, the Greek philosopher Aristotle was actually discussing metacognition when he pondered how people use their senses and their thought processes. Psychologist John H. Flavell brought the term into popular use in 1979.

Metacognition has two different aspects: metacognitive knowledge and metacognitive experiences. Metacognitive knowledge consists of knowing how you or others think, knowing what a task requires, and knowing what strategies to use to perform it. For example, you may realize that you learn best when you study with a friend and you quiz each other. Metacognitive experiences, on the other hand, consist of activities such as reflecting on your own thoughts. You would be having a metacognitive experience if you wonder why you thought that the answer on a history test was France even though you had known earlier that it was Germany.

A person using metacognition may work in one of three categories or stages in solving a problem. One is developing a plan, which could be called the knowledge of task category.

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standardized designed to be given under specified, standard conditions

In this category, the individual asks himself or herself a series of questions.

- What do I already know about the topic?
- What is my goal?
- What should I do first?
- What strategies will work best to do this task?
- How much time do I have to complete the task?
- How will I be evaluated?

Suppose you must prepare a plan for a Web site for your science class. Using metacognition you will think about a topic and what you know about it and where you can get more information on it. You might think about what you know about planning a Web site and how long it will take to put your ideas together. If you are working with other people you may divide up the work so that each of you has tasks that are best suited to your talents. You may find out what points you will be graded on for the project. Finally you will need to plan stages of the project so you can complete the job on time.

The second category of metacognition involves monitoring yourself to judge progress toward your goal. In this category, the individual asks another series of questions.

- How am I doing?
- Am I on the right track?
- What more might I need to know?
- How is my pacing going? Do I need to adjust my time line?
- Do I need to try something different?

At this stage in your Web site project you should be determining if you are on track and using the right set of learning strategies to get the job done. You should also have some idea if you will finish on time. If your timing is off you may need to make adjustments in the scope of the project or dedicate more time to its completion.

As you finish the project you will evaluate how you actually performed. Once again you will ask yourself a series of questions.

- How well did I do?
- What could I have done differently?
- Can I apply any of what I learned in doing this task to other problems?

Reflecting on what you have done in completing the task is important because you consider both how you did it and how you may be able to apply that knowledge to another task. In applying metacognitive thought you will become more aware of your own learning processes, how to regulate them, and how to learn more effectively.

Reading Check **Contrast** In what ways are the three ways of thinking different?

SECTION 1 Assessment

Reviewing Main Ideas and Vocabulary

1. **Define** What is thinking?
2. **Identify** What are three basic units of thought, and how do they work?
3. **Explain** How are divergent thinking and creativity related?

Thinking Critically

4. **Analyze** How are concepts and prototypes related?
5. **Explain** What activities take place when an individual uses metacognition?
6. **Predict** In what types of situations would convergent thinking be useful?
7. **Compare and Contrast** Using your notes and a graphic organizer like the one here, explain the three ways of thinking and how they differ.

Types of Thinking	Characteristics

FOCUS ON WRITING

8. **Expository** Review the text on the topic of metacognition and on the PQ4R method you learned in an earlier chapter. In a paragraph identify which aspects of the PQ4R method incorporate metacognition.

Automatic Thought Processes

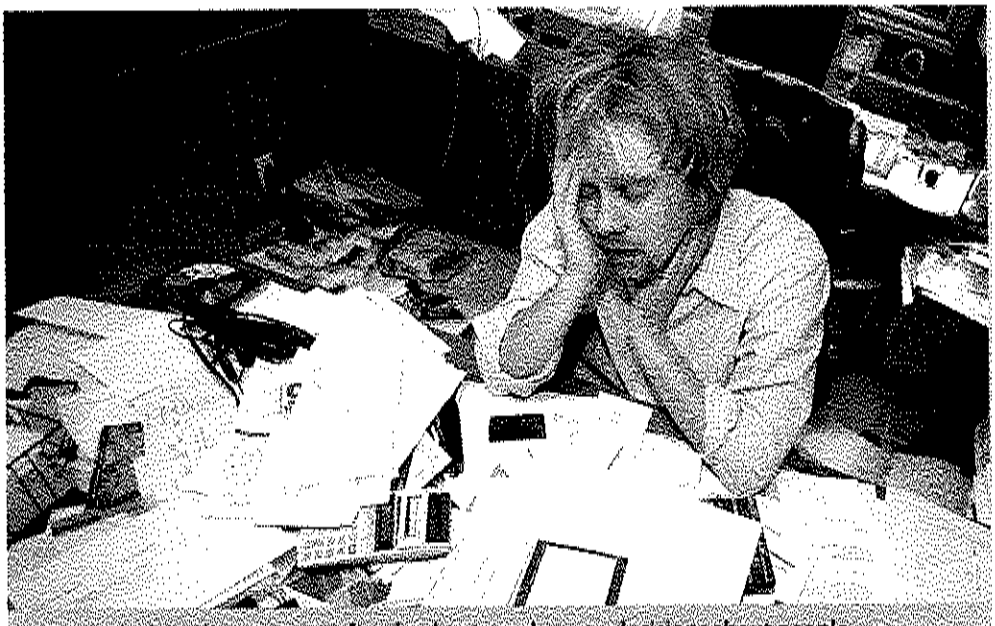
How we think has long been of interest to psychologists. How much of our thinking is done consciously? Do we really think about every single thing we do? Do we deliberately make choices in all our actions? Current research indicates that the answer is no. (Hassin, et. al, eds., 2006)

About a century ago, Sigmund Freud and Carl Jung proposed that many of our thought processes occur without our conscious intention. Their theories lost prominence, however, as academic psychologists concentrated on concepts of behavior and learning that could be tested in the lab. Now those subconscious processes are receiving new attention.

Yale psychologist John Bargh, for example, believes that some of our thinking is nonconscious and automatic. That is, the thought processes are set into motion by features of the environment, and the brain responds without conscious thought. (Bargh and Chartrand, 1999)

We are quite aware of some thought processes. For example, a job applicant might think carefully about how to behave in an interview. But there are other situations in which we have not thought about our behavior. For example, have you ever judged people by the clothing they are wearing? How does this happen?

Bargh believes that our brain has processes in which it codes environmental events and directs us to respond in a certain way. For example, an individual is likely to behave similarly to others in a group. We generally act in this way because we don't like being the "one who sticks out in a crowd." Psychologists speculate that at one point in our lives we think about the goal of being similar to others. Gradually this behavior becomes internalized and consciously thinking about the behavior stops. The brain automatically takes control and creates the behaviors necessary to fit in with the crowd. This whole process affects our behavior.



Automatic thought processes often lead us to make snap decisions about people, based on various cues. If you were this worker's employer, what do you think you would assume about his abilities?

An experiment demonstrated the automatic thought process. Test subjects were given a series of words related to stereotypes of old people—"Florida," "sentimental," and "wrinkled," for examples. As the test takers left the room after the experiment, they walked more slowly.

Some researchers call this type of automatic thinking "thinking lite." It seems to take about one third less effort to think in this way than regular thinking. This allows the brain to be engaged in more conscious ways with other tasks. Bargh suggests that these processes are "mental butlers" that know us so well that they anticipate and take care of some tasks for us, without being asked.

Thinking Critically

1. **Evaluate** Think about a situation you had not encountered before. How did your behavior at that time reflect the theory about automatic thought?
2. **Discuss** What are some dangers of automatic thought?

SECTION 2

Problem Solving

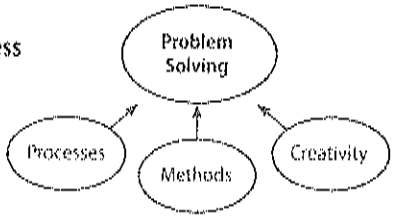
Before You Read

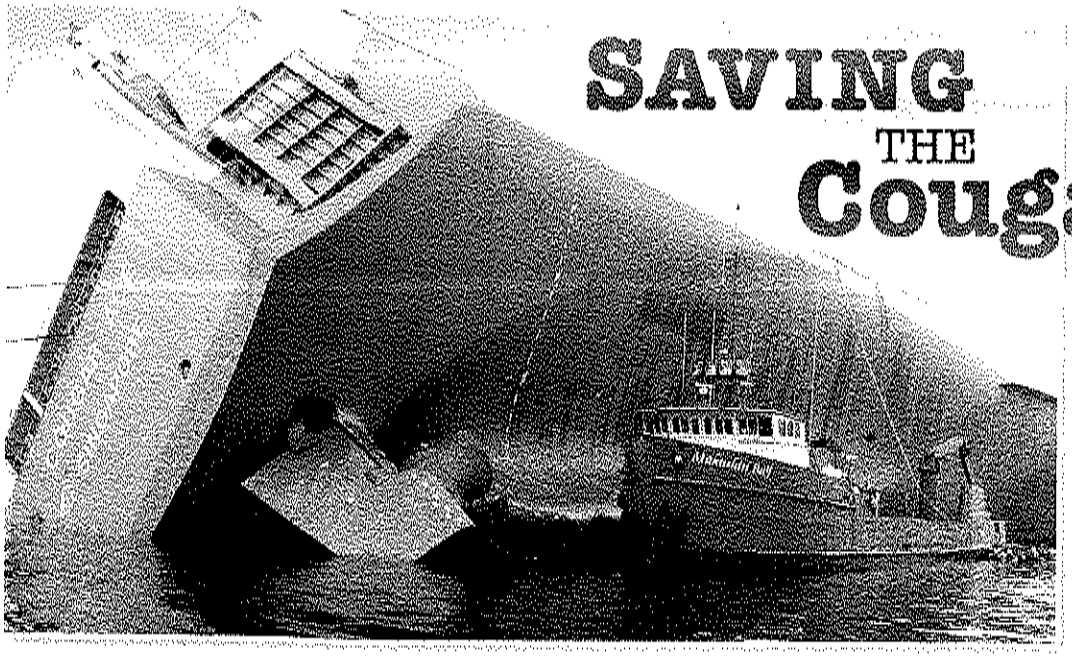
Main Idea
Solving problems can be done in logical and planned ways to achieve the best results.

Reading Focus
1. What are two basic approaches to problem solving?
2. How can certain methods help with problem solving?
3. Why do obstacles to problem solving occur?
4. What is the connection between problem solving and creativity?

Vocabulary
algorithm
heuristic
difference reduction
means-end analysis
mental set
functional fixedness
recombination
incubation effect

TAKING NOTES Use a graphic organizer like this one to take notes on problem-solving processes and methods and the role of creativity.





SAVING THE Cougar Ace

The hundreds of tons of fuel on board the *Cougar Ace* could have created an environmental disaster when the huge ship tipped over.

PSYCHOLOGY CLOSE UP

How do you pick up a ship? As it approached North America from Japan in July of 2006, a heavily loaded freight ship named the *Cougar Ace* was required to release water from its ballast tanks to prevent contaminating American waters. It is a tricky maneuver, since the water going out has to be replaced immediately with local water to keep the ship stable. Something went dreadfully wrong—perhaps a big wave hit. The water transfer was interrupted, and within minutes the ship keeled over onto its side. It appeared the ship would sink with all its cargo of almost 5,000 automobiles.

A team from a company specializing in saving ships came to the rescue. As the team plotted to move tons of water to where it needed to be, the members were very aware that one mistake could sink the ship completely.

A range of skills would come into play, from computer modeling to rock climbing. It was a slow and delicate process, but the team managed to set the ship upright. Although the cargo eventually had to be scrapped, the ship and the local marine environment had been saved.

Few of us face such huge problem-solving challenges. But we can all learn more about the problem-solving process and how to enhance our own problem-solving skills.

Approaches to Problem Solving

People solve many different kinds of problems every day. For example, a student may need to know the formula for the area of a circle or how many protons oxygen contains.

Other problems concern fitting things into a busy schedule or paying for what we need. Still other problems are social problems.

Solving problems involves a series of processes including analyzing the problem, breaking it into component parts, and establishing goals. Intermediate goals address parts of the problem that must be solved to arrive at the terminal goal—that is, the final solution to the problem.

On the following two pages you will find a series of problems. Go ahead and turn to those pages and try to solve them now. If you have difficulty with any of them, don't worry—you will learn the answers as you read.

In many cases, people do not go straight from a problem to its solution in one giant leap. Rather, they move toward the solution in a series of steps. Ideally, each step taken moves the problem solver closer to the solution. But how do people know what steps to take? If they do not know the solution, how can they know where to start?

Through experience, people know that different types of problems must be approached in different ways. By simply identifying the type of problem it is, people have an idea of which method to use—which steps to take—in solving the problem.

Algorithms Some types of problems are best approached with the use of an algorithm. You may have heard this term in math classes, but it also has a broader definition. An **algorithm** is a specific procedure that, when used properly and in the right circumstances, will always lead to the solution of a problem.

Formulas are examples of algorithms. If you know the radius (r) of a circle and you want to find the area (A) of that circle, you can apply the formula $A = \pi r^2$ to get the correct answer. As long as you know the formula and how to use it correctly, you need know nothing else to solve the problem.

Many algorithms are more complex and time-consuming than simple formulas, however. One such complex algorithm is called a systematic search. In a systematic search, each possible solution to a problem is tried and tested according to a certain set of rules.

For example, suppose that you are working on a crossword puzzle. You are trying to fill in a word for which you have all but one letter—say, C L _ F F. Using a systematic search, you would try putting every letter of the alphabet, starting with A, in that blank middle space until you found the letter that formed a word that fit the clue. In other words, first you would try C L A F F, then you would try C L B F F, then C L C F F, and so on, until you came to the right letter, which would be an I. Now you have the correct answer (C L I F F). It might take some time, but as long as you had all the other letters in the word correct and as long as you were able to recognize the word once you found it, this method would be guaranteed to work.

Heuristics While algorithms are guaranteed to work, they are not always practical. Suppose, for example, that you were missing not one, but two letters of your crossword puzzle word—C _ _ F F. In order to have success with the systematic search, not only would you have to try every letter of the alphabet in each of the two spaces, but you would have to fill in one of them with a placeholder while you tried letter after letter in the other space.

In other words, first you would have to fill the first blank space with an A, then you would have to run through all 26 letters in the second blank space. And when that did not work, you would have to try a B in the first space, and then run through all the letters *again* in the second space. By the time you arrived at C L I F F, you would have already run through 294 other possible solutions.

Needless to say, although this algorithm would eventually lead to success, it would not be a very efficient way to do a crossword puzzle, nor would it be very interesting or rewarding. This is why, for many types of problems, people use heuristics rather than algorithms. **Heuristics** are rules of thumb that often, but not always, help us find the solution to a problem. They are shortcuts.

In the first crossword puzzle problem, where only one letter is missing, you probably would use the following heuristic: in a five-letter word in which four of the letters are consonants, the fifth letter has to be a vowel.

Thus, instead of trying *eight* possible combinations before you arrived at the letter I, you would try only *two:* A and E (the only vowels that precede I in the alphabet). In the second crossword puzzle problem, in which two letters are missing, a heuristic might involve deciding that certain letters of the alphabet (B, C, D, F, and so on) would be unlikely to follow the first letter C, and thus you would not even try them as possibilities. Rather, you might focus on the letters that you know are likely to follow C.

Heuristics are faster than algorithms, but they are not as reliable. For example, we might forget that if C is the first letter of a word, the letter L (a consonant rather than a vowel) might be the second. And in some circumstances, we might miss some more unusual words. Think about a word that looks like this C _ _ C H. You mostly likely would not try a Z in the first blank space because the letter Z usually does not directly follow the letter C. Maybe as a last resort you would try the systematic approach and finally come up with the word C Z E C H—a resident of the Czech Republic or a Slavic language!

ACADEMIC VOCABULARY
circumstances situations or conditions

Reading Check **Recall** What are two basic processes used in problem-solving?

Problem-Solving Methods

Algorithms and heuristics are general approaches to problem solving. There are also specific methods of problem solving. Systematic searching, which we have already discussed, is one of these methods. Others include trial and error, difference reduction, means-end analysis, working backward, and use of analogy.

Trial and Error Trial and error is somewhat similar to systematic searching, except that it is more haphazard and less reliable. In trial and error, we often do not keep track of which possibilities we have already tried.

Sometimes we have to resort to trial and error in solving a problem. If we know what our goal is, but we have absolutely no idea how to reach it, all we can do is try different things and see what happens with each one. Eventually, we might arrive at our goal, but success is more or less by chance.

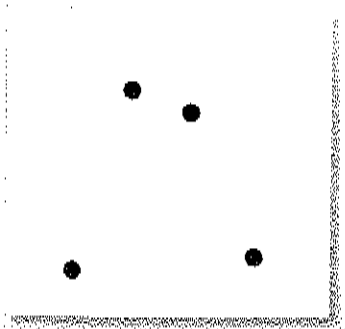
If you have ever tried to work on a maze puzzle, you probably found that the only thing you could do was just to pick one possible route and see where it took you. When you hit a dead end, you came back and tried something else until it proved to be an error.

Five Problems to Solve

Try solving these problems. You will learn the answers as you read the section.

Problem 1 Naomi, Marquita, and Kim want to get ready for a party together. The party is across the street from Naomi's home, so they meet there an hour before the party. When they are ready to leave for the party, though, it is raining heavily. None of them wants to get wet, of course, but the girls have only one umbrella, and it is big enough to protect only two people from the rain. How can all three of the girls get to the party without getting drenched?

Problem 2 Imagine that you are a doctor. One of your patients has a brain tumor that must be destroyed if the patient is to survive. Certain rays will destroy the tumor if they are intense enough. To reach the tumor, however, the rays need to pass through the healthy tissue that surrounds it, and at the intensity needed to destroy the tumor, the rays will also destroy the healthy tissue. How can you use the rays to destroy the tumor without damaging the healthy tissue?



Problem 3 Trace this dot formation or copy it exactly onto a sheet of paper. Then connect all four dots with two straight lines without lifting your pencil from the paper.

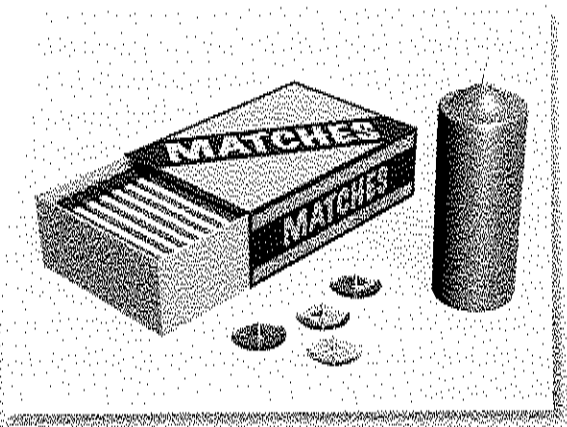
Difference Reduction In a method called **difference reduction,** we identify our goal, where we are in relation to it, and the direction we must go to move closer to it. In other words, we want to *reduce the difference* between our present situation (problem unsolved) and our desired situation (problem solved).

Suppose you are standing blindfolded on the side of a hill. Your goal is to get to the top of the hill, but because you cannot see, you do not know which way to go. So what do you do? You take a step. If you feel yourself moving downward, then you know that you are going the wrong way and that you must change direction. But if you feel a pull in your legs that means you are moving upward, you know you are getting closer to the top of the hill. You have identified which direction to go in to move closer to your goal.

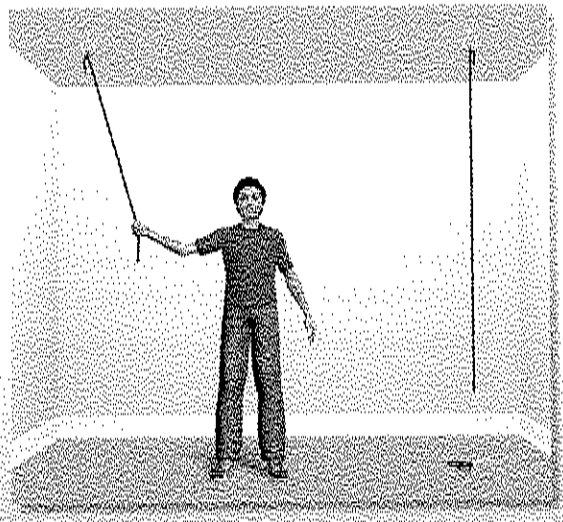
The difference-reduction method is a heuristic, however, and thus is not always reliable. Sometimes we may think we have reached our goal when we have not. Suppose, for instance, that the hillside levels off for a bit before it continues upward to the top. You may think you have reached the top when you arrive at this level place, and you may stop there. You do not know that there is more hill ahead.

Furthermore, sometimes we have to take what seems to be a step away from our goal in order to achieve that goal. For example, to organize your desk, you might have to take everything out of the drawers first, to categorize the contents—even though this would seem to be a step in the wrong direction (since at first, things will become messier rather than neater). After you have organized your things you will be able to reach your goal of a tidy and neat desk space. Similarly, what seems to be moving us closer to a goal may actually be moving us farther away.

Problem 1 highlights some of the pitfalls of the difference-reduction method. In order for Naomi, Marquita, and Kim to get to the party dry, two of them (say, Marquita and Kim) must cross the street to the party first, leaving the third one (Naomi) back at Naomi's home. But then either Marquita or Kim must *leave* the party and go back with the umbrella for Naomi. In other words, they must temporarily increase, rather than decrease, the difference between the goal (all three of them at the party) and their present situation (two of them at the party but one of them not). One of the two currently at the party must temporarily leave the party.



Problem 4 Imagine that you are in a room with a candle, a box of matches, and some thumbtacks. Your task is to use these objects to attach the candle to the wall. How do you do it?



Problem 5 Imagine that you are in a room in which two strings are hanging from the ceiling. Your task is to tie the two strings together, but they are so far apart that you cannot reach both of them at the same time. The only other object in the room is a pair of safety scissors. How can you tie the strings together?

Means-End Analysis Another heuristic problem-solving technique is called means-end analysis. In **means-end analysis,** we know that certain things we can do (means) will have certain results (ends). Using a picnic for a crowd as an example, you know that the amount of food and supplies required means you will need a car to get them to the picnic site. Taking everything on a bike won't work.

As with the difference-reduction method, means-end analysis aims to reduce the difference between where we are and where we want to be. But means-end analysis goes beyond difference reduction in its awareness that a particular action will have a particular effect. The difference-reduction user asks, "What direction do I move in order to get from here to there?" The means-end-analysis user asks, "What can I do to get from here to there?"

Users of means-end analysis often break a problem down into parts and then try to solve each part individually, recognizing that solving each of the parts will contribute to solving the entire problem.

Suppose you are in charge of getting food for a picnic. First you will have to decide what foods will be served at the picnic. Next you will need to figure out how to obtain these food items—a trip to the grocery store will be necessary. Then you will have to figure out which store to go to, how to get there, how to find what you need once you arrive at the store, and how to pay for what you bought. Finally, you will need to find a way to transport the food and any other items such as paper plates, napkins, a grill, and charcoal to the picnic location. Each of these steps is one means toward the end of having a picnic.

Working Backward Related to means-end analysis is the technique known as working backward. As in means-end analysis, working backward involves breaking a problem down into parts and then dealing with each part individually. In working backward, however, the problem solver starts by examining the final goal, then works back from the final goal to the present position to determine the best course of action.

This method is particularly useful when we know what we want to accomplish but are not sure how best to begin. Working backward helps ensure that we start off on the right path and avoid having to retrace our steps if we discover that the path we have chosen does not lead where we want to be.

Suppose that you need to drive to a city nearby, but discover that the route you planned to take is closed for construction. It is unlikely that you would just drive around until you found a street that might lead to the location you are trying to reach. That would be time consuming and costly.

A better approach might be to get a map and work backward from the final destination. Start off by identifying the street on which the address is located. Then find the street that is nearest to that one, and so on, working back to your location. This way you can avoid getting stuck in the middle of a strange city.

If you have a big project due at some time in the future, you may set out dates to have specific tasks done by working backwards. Suppose you have a paper due at the end of a grading period. You may decide that by the week before it is due you will have a rough draft finished. Working backward you will be able to establish when you must finish any necessary research and preliminary writing. Using this approach avoids the last minute struggle to finish because you did not plan appropriately.

Analogies People also solve some problems by analogy. An analogy is a similarity between two or more items, events, or situations. When people have successfully solved one problem, they may try to use the same approach in solving another problem if it is similar enough to the first one. For example, if you observe that studying early and getting a good night's rest helps you do well on a test for one class, you may try that technique again the next time you have a test, even if the next test is in a different class. Many analogies, however, are much less obvious, and the trick is to find one that works.

Problem 2 (the ray-tumor problem) is not an easy one, and people typically have difficulty solving it. However, when they are provided with a story to use as an analogy, they often can solve the problem. Such a story might be as follows:

A group of terrorists barricaded themselves in a building in the middle of a

town. Government officials considered it necessary to capture the terrorists, even though the operation would require a large force of agents to storm the building. Furthermore, the terrorists had planted mines on all of the streets that led to the building. If the entire force passed over any one of the streets, the mines would explode, killing not only the agents but also the people who lived in the surrounding area. Thus, the officials decided to divide the force into smaller units and send each unit on a different street leading to the building. Timing was arranged so that all of the units arrived at the building at the same time, and the terrorists were captured.

If you still cannot figure out the solution to the problem, look at the solution to the right.

A famous example of problem solving by analogy involves the ancient Greek scientist Archimedes (ahr-kuh-MEE-deez). As legend has it, Archimedes had been trying to find a way of measuring the volume of the king's crown, but the crown's irregular shape made it difficult, and Archimedes could not figure out what to do.

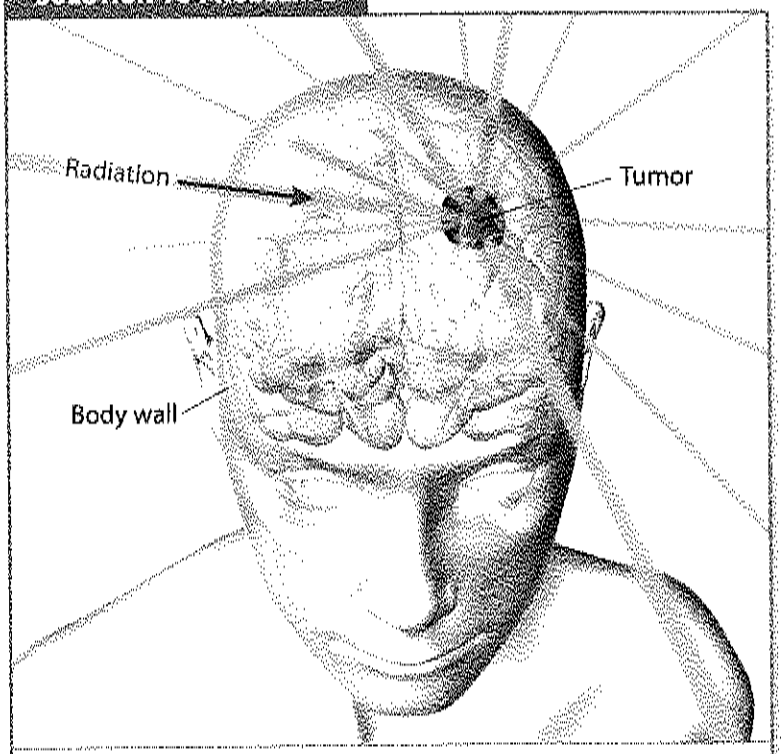
One day, as Archimedes climbed into his bath, some water overflowed from the filled tub onto the floor. Suddenly, Archimedes saw an analogy between what had just happened and the crown problem he was working on, and the solution to the problem came to him. He could measure the volume of the crown by placing it in a water-filled bowl and then collecting and measuring the amount of water that overflowed. Archimedes had realized that the volume of water displaced by an object equals the volume of the object—whether the object is a human body or a king's crown. He was said to be so happy that he shouted "Eureka!" which means, "I have found it."

Reading Check **Identify** What are five problem-solving methods?

Obstacles to Problem Solving

Sometimes we have trouble finding the solution to a problem simply because the problem is difficult or perhaps because we have little experience in solving that type of problem. At other times, particular obstacles get in our way of solving a problem. Two of these obstacles are known as mental set and functional fixedness.

SOLUTION TO PROBLEM 2

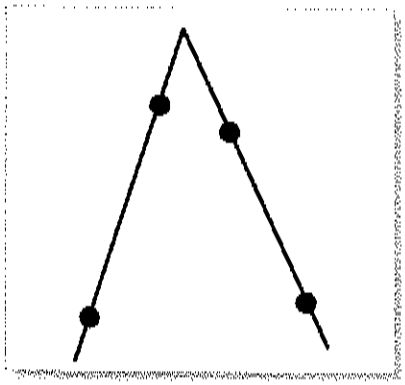


Weak rays sent from several points meet at the tumor site. Radiation will be intense at this site, thereby destroying the tumor. But because the individual rays are weak, they will not damage the healthy tissue.

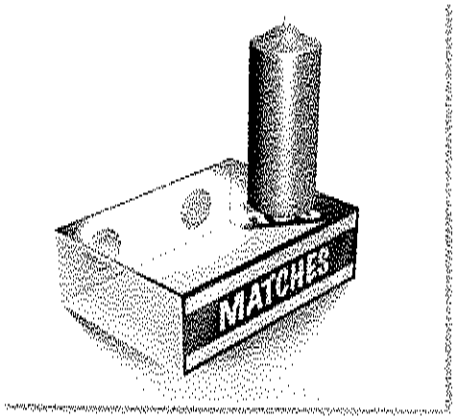
Mental Set As we know from our discussion on problem solving by analogy, people often try to solve new problems in ways that worked for similar problems. The tendency to respond to a new problem with an approach that was successfully used with similar problems is called **mental set.** While mental set can sometimes help us solve a problem, it can also sometimes get in the way.

Image that you are given an algebra quiz of six word problems. They all deal with different scenarios, so you suspect that you might use a different formula for each problem. But as you work through problems 1 through 5, you find that all of them use the same formula: $x = A - B + 2C$. So you assume that problem 6 will also use that same formula, and you use it to solve problem 6. However, because you had a mental set, you did not realize that problem 6 actually had a simpler solution.

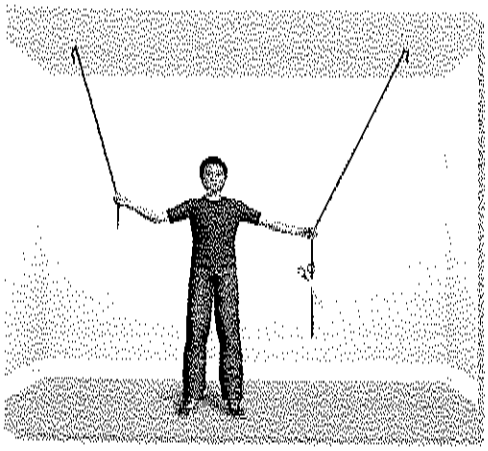
MORE SOLUTIONS



Solution to Problem 3 The lines connecting the four dots must extend beyond the dots.



Solution to Problem 4 To solve this problem, you have to overcome functional fixedness and think of the box as a platform, not as a container.



Solution to Problem 5 To solve this problem, tie the scissors to one of the strings and set the string swinging. Then catch the swinging string.

Mental set can limit our problem solving abilities in other areas also. For example, did you solve Problem 3? If not, mental set may have been responsible. From past experience, you probably perceived the four dots as the corners of a quadrilateral, and thus it may not have occurred to you that the lines could go beyond the dots. This is an example of how an incorrect assumption, caused by mental set, can elude us.

Here is another example. Do you consistently win against a certain opponent in a sport or game? Perhaps it is because your defeated opponent uses the same tactics every time, such as repeating the same defense formation. Athletic coaches often analyze the plays of other teams to see if they can detect mental set in the opponent's game plan and prepare their own teams to detect such play.

Functional Fixedness Another obstacle to problem solving is called functional fixedness. **Functional fixedness** is the tendency to think of an object as being useful only for the function that the object is usually used for.

Problems 4 and 5 are challenging because of functional fixedness. In Problem 4, the solution is to tack the box of matches to the wall and then use it to support the candle. But people have trouble arriving at this solution because they think of the box as a container and not as something they can actually use to support the candle. In other words, they are fixed on the function of the box as a container because that is usually what it is.

Similarly, in Problem 5, the solution is to tie the safety scissors to one of the strings as a weight. Then you can start the weighted string swinging so that it will reach you as you hold the other string. But again, most people are fixed on the function of the scissors as something to cut with, not as a weight to make the string swing.

In each of these examples, functional fixedness interfered in coming to a solution to the problem. To practice avoiding functional fixedness, you may want to look around your home or school and imagine other creative ways to use familiar objects.

Reading Check **Compare** In what way is functional fixedness a type of mental set?

Problem Solving and Creativity

Functional fixedness can often be overcome by creativity—the ability to come up with new or unusual ways of solving a problem. Creativity requires divergent thinking rather than convergent thinking. As you read earlier, with convergent thinking, thought is limited to available facts. With divergent thinking, however, there are many options and possible solutions to a problem. The various "leads" run in many directions; perhaps one of them leads to a solution.

Sometimes successful problem solving may require both divergent and convergent thinking. At first, divergent thinking produces many possible solutions. Convergent thinking then helps one to select the most probable solutions and to reject the others.

Flexibility Flexibility is the ability to adapt to new, different, or changing situations. Flexibility leads to original thinking. Think of the problem involving attaching the candle to the wall. Viewing the box of matches as a support platform rather than as a container, for example, is creative because this is not how matchboxes are usually used.

Test yourself on your flexibility by thinking up different use for a pencil or a metal nail file. With flexibility you move beyond functional fixedness to see new ways of using an object or approaching a problem. For example, did you think of the pen as a way to prop open a window or to puncture the shrink-wrap on the latest DVD you purchased? Could a nail file serve as an emergency screwdriver? The next time you get stuck on a problem ask yourself if you can be more flexible in your approach. Flexibility may allow you to come up with a creative solution.

Recombination Have you ever done a jumble word puzzle—one in which you rearrange the letters of one word to create another one? If so, you have practiced **recombination.** Recombination is the mental rearrangement of elements of a problem. For example, think about a musical selection. Music is made up of notes arranged in a scale. But the combination of those notes creates distinctive sounds. The same notes could be recombined to sound like a completely new piece of music. All the composer needs to do is use a different rhythm, different types of instruments, and softer or louder tones. Many creative works involve recombinations of familiar elements.

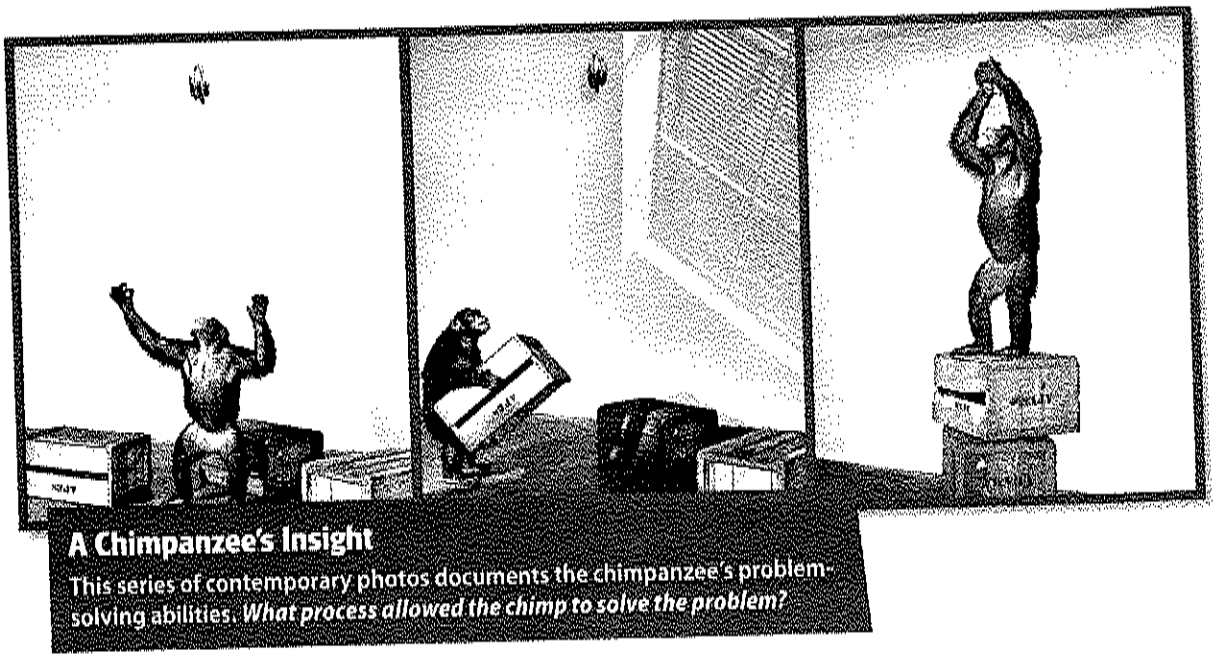
Insight and Incubation Archimedes' experiment with the crown and the water was an example of problem solving by analogy. It was also an example of insight, or sudden understanding. Usually we solve a problem by breaking it down into steps. Sometimes, however, we seem to arrive at the solution to a problem all of a sudden, as Archimedes did. Often we have little conscious awareness of how we found the solution—it just seems to come to us on its own.

Have you ever pondered a problem for a while, then had the solution come to you suddenly? Did it seem to come in a flash? When this happens, we have experienced insight. Often we express our delight and surprise by exclaiming "Aha!" or something similar. As a result, experiences of insight are also known as "Aha!" experiences.

Psychologist Wolfgang Köhler pioneered studies into this type of experience. During World War I, Köhler was marooned on one of the Canary Islands, off the northwest coast of Africa. While stranded, Köhler worked with a colony of chimpanzees that the Prussian Academy of Science kept there. His research with these animals demonstrated to him that much learning is achieved by insight.

In one of Köhler's experiments, a chimpanzee was placed in a room in which some bananas were hanging from the ceiling. The chimp clearly wanted the bananas and tried to reach them by jumping. But the bananas were too high up to be reached this way. The chimp walked around, looked at the bananas, walked around some more, noticed some boxes that were also in the room, and sat down for a while. The chimp seemed to be doing nothing related to the problem of reaching the bananas. Then, all of a sudden, the chimp got up, stacked the boxes, and climbed up on them to reach the bananas. Apparently, the chimp had suddenly seen the situation in a new way. That is, the chimp had had a flash of insight.

Köhler's findings suggested that animals and people set up problems in their minds and play with them until they are solved. Once the parts of the problem fit together in the right way, the solution seems to come in a flash.



A Chimpanzee's Insight
This series of contemporary photos documents the chimpanzee's problem-solving abilities. ***What process allowed the chimp to solve the problem?***

Sometimes, we need to get away from a problem for a while before a solution comes to us. When we arrive at the solution to a problem that we have not been consciously working on, we have experienced the **incubation effect.** One type of incubator warms eggs so that they will hatch at the right time. Incubation in problem solving means standing back from a problem for a period of time while some unconscious process within us continues to work through it. Later, the answer may occur in a flash—it will have "hatched" on its own.

Because of the incubation effect, psychologists sometimes recommend that people take a break from work on a difficult problem. Go for a walk, call a friend, or read a few chapters from a mystery novel. After taking such a break, you may come back to the problem refreshed, and a new point of view or approach may have developed.

Reading Check **Describe** What are some methods for solving problems creatively?

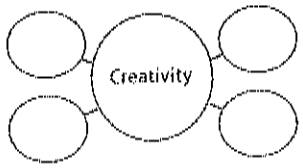
SECTION 2 Assessment

Reviewing Main Ideas and Vocabulary

1. **Define** What are algorithms and heuristics?
2. **Contrast** How is the difference-reduction method different from the means-analysis method of problem solving?
3. **Explain** How might a mental set interfere with successful problem solving?

Thinking Critically

4. **Analyze** Why might a person be forced to use a trial and error method to solve a problem?
5. **Make Generalizations** When might both divergent and convergent thinking be used in problem solving?
6. **Evaluate** Do you think there are certain situations in which insight and the incubation effect are more likely to come into play than in others? Explain your answer.
7. **Elaborate** Using your notes and a graphic organizer like the one below, identify and explain the factors of creativity.



FOCUS ON WRITING

8. **Expository** Solve this problem: "A plane crashes on the border between Mexico and the United States. Where should the survivors be buried?" Then explain your analysis of the problem.

SECTION 3

Reasoning and Decision Making

Before You Read

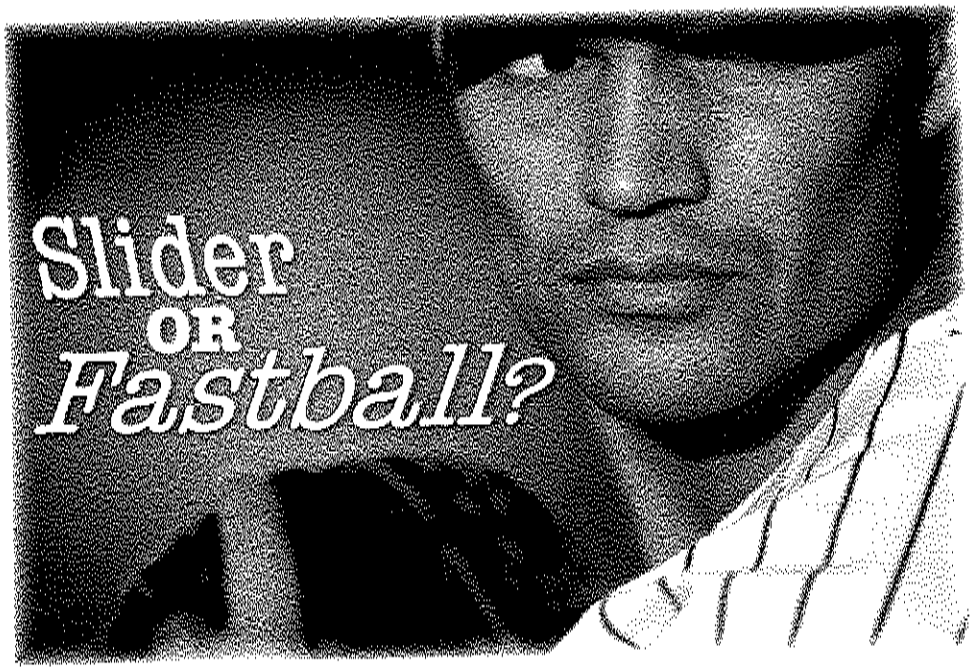
Main Idea
Deductive and inductive reasoning are used in the decision-making process. Various strategies can help us make decisions.

Reading Focus
1. What is deductive reasoning?
2. What are the steps in inductive reasoning?
3. When can weighing costs and benefits be helpful?
4. What are some shortcuts in decision making?

Vocabulary
reasoning
deductive reasoning
premise
inductive reasoning
availability heuristic
representativeness heuristic
anchoring heuristic

TAKING NOTES Use a graphic organizer like this one to take notes on reasoning and decision-making strategies.

Types of reasoning	Decision making strategies



A pitcher studies all aspects of the situation before deciding what kind of pitch to throw.

PSYCHOLOGY CLOSE UP

How does a pitcher make quick decisions? In virtually every sport, players must make split-second decisions throughout a game. A pitcher will not only assess the tendencies of the batter he is facing, but also the situation on the bases and, especially, the signals from the catcher. But if he thinks the catcher is giving a bad signal, the pitcher may shake it off or call for a conference on the mound. The pitcher makes all these decisions very rapidly.

In our lives too, we make split-second decisions, such as whether or not to react to a rude comment. We also make decisions in slower and more measured ways. You may be considering several different colleges to attend after high school. How do you select one? Just like the pitcher, you will consider a range of data about the various schools. Chances are you will also use reasoning strategies to make a final choice. In this section we will look at reasoning and decision-making strategies that we use almost every day—whether quickly or slowly.

Deductive Reasoning

Reasoning is the use of information to reach conclusions. There are two main types of reasoning: deductive reasoning and inductive reasoning. In **deductive reasoning,** the conclusion is true if the premises are true. A **premise** is an idea or statement that provides the basic information that allows us to draw conclusions. Here is an example of deductive reasoning:

1. South Korea is in Asia.
2. The city of Seoul is in South Korea.
3. Therefore, Seoul is in Asia.

The first two statements of this example are the premises, while the third statement is the conclusion. The conclusion is said to be *deduced* from the premises; if South Korea is in Asia and Seoul is in South Korea, then Seoul must be in Asia.

In deductive reasoning, the conclusion is always true when the premises are true. However, if the premises are incorrect, then the conclusion may be incorrect as well. For example:

1. Countries that are near each other have similar languages.
2. Japan and Korea are near each other.
3. Therefore, Japan and Korea have similar languages.

The first premise—that countries that are near each other have similar languages—is faulty. Countries that are near each other do not necessarily have similar languages. Thus, the conclusion is incorrect. Japan and Korea are near each other, but their languages are not very similar.

Reading Check **Identify** What is one problem with using deductive reasoning?

Inductive Reasoning

In deductive reasoning, we usually start out with a general statement or principle and reason down to specifics that fit that statement or principle. In **inductive reasoning,** we reason from individual cases or particular facts to reach a general conclusion.

In inductive reasoning, the conclusion is sometimes wrong, even when the premises are correct. For example, in the set above, the assumption that countries that are near each other have similar languages was probably based on inductive reasoning. The thinking may have been:

1. Spain and Portugal are near each other, and they have similar languages.
2. Sweden and Norway are near each other, and they have similar languages.
3. Therefore, countries that are near each other have similar languages.

But even though *some* countries that are near each other do indeed have similar languages, this does not mean that *all* countries that are near each other do. In effect, the statement that countries that are near each other have similar languages was really only a hypothesis, or an educated guess, rather than a conclusion. In the previous example the hypothesis is shown to be wrong—Japan and Korea are near each other yet do not have similar languages.

Assume for a moment that the hypothesis was correct—that countries that are near each other have similar languages. How could that hypothesis be proved? Only by comparing the languages of every single country in the world and showing that all countries that are near each other have similar languages. However, it was quite easy to prove that the hypothesis was wrong by providing only one example of countries that are near each other and have different languages.

It is often impossible to prove an assumption reached by inductive reasoning to be true. We can only prove it false. But people often fail to realize this. As a result, they seek to prove, or confirm, their hypotheses rather than disprove them.

Even though inductive reasoning does not allow us to be certain that our assumptions are correct, we use inductive reasoning all the time. And until we prove a hypothesis false, we assume it to be true. For example, if we have read two books by a particular author and enjoyed both books, we conclude that a third book by the same author also will be enjoyable. Until we find a book by that author that we do not enjoy, we will probably go on reading that author's books. Inductive conclusions do not follow logically from premises, as deductive conclusions do. Yet they are accurate often enough that we can rely on them in our daily lives.

Most sciences, including psychology, rely on inductive reasoning. Scientists gather specific pieces of information, and then come up with general theories that explain the information. However, no matter how much information scientists have to support a particular theory, they can never know for sure if the theory is true for all times and all situations. There might still be some information not yet collected that would prove the theory false.

Reading Check **Contrast** How is inductive reasoning different from deductive reasoning?

Weighing Costs and Benefits

Life is filled with decisions. Most of these decisions are fairly minor in the general scheme of things. Should you take a jacket with you? Do you want the burger or the salad?

Other decisions, of course, are major. Should you go to college or get a job right after high school? Which political candidates should you support?

Making decisions means choosing among goals or courses of action to reach goals. When we are making careful decisions, we weigh the pluses and minuses of each possible course of action. We think about the importance of our goals, and we consider our abilities to overcome whatever obstacles may lie ahead. To make good decisions, we often need to gather more information about our goals and our abilities to attain them.

The use of a balance sheet—a listing of various reasons for or against making a particular choice—can help us make sure that we have considered all the available information. A balance sheet might be a list of the costs and the benefits of taking an action. For example, if you are trying to decide whether to participate in a certain extracurricular activity, you might make a list of the advantages (such as gaining experience and having fun) and the disadvantages (such as losing time that might be needed for studying) of doing so.

A balance sheet can also be useful when a person is trying to decide between two or more alternatives. Listing all the alternatives and the reasons for each one may help the person visualize which of the alternatives is the better course of action. The balance sheet may also help indicate areas where more information is needed.

USING A BALANCE SHEET

Take a year off to travel

✓ A chance to see other parts of the world and meet new people
✓ Travel is cheaper for students.
– Travel would use up money that had been set aside for college.

Go directly to college

✓ Get to know new people and make contacts for future jobs
✓ Will still remember how to study efficiently
✓ Get started on career more quickly
– Miss out on travel

Information still needed to finalize decision

? What do my parents think?
? How much would a year of travel cost?
? If I travel, would any of my friends be able to come along?
? How important is travel experience to my future career?

A balance sheet can help you make big decisions. Here are some factors a student might consider when trying to decide what to do after graduation from high school.

A word of caution, though, is appropriate here. When using a balance sheet, one should not simply total the number of pluses and minuses and make a decision based on the numbers! The balance sheet can clarify the issues, but some of the issues may be much more significant than others.

Reading Check **Recall** What is one method for making good decisions?

Shortcuts in Decision Making

Weighing the costs and benefits may be the best thing to do whenever we want to be sure to make the right decision. But weighing costs and benefits can be time-consuming and is not always practical. Furthermore, in order to weigh costs and benefits, we need to know what they are, but we often have to make decisions based on somewhat limited information. In such cases, we use heuristics. That is, we take shortcuts.

The Availability Heuristic One way that people make decisions is on the basis of available information in their immediate consciousness. This is called the **availability heuristic.**

For example, what percentage of the students at your school would you estimate are involved in extracurricular activities? Unless you go to a very small school, your answer to this question will probably reflect your personal knowledge of students who do and do not participate in extracurricular activities. Knowledge of these individuals is available to you. Rather than going out of your way to find out whether all the students you do *not* know participate in activities, you base your answer on what you already know.

Thus, if most of the students you know participate in extracurricular activities, you may think that most of the students in the entire school do too. But this is not necessarily true—the sample of students you know may not be representative of all students.

Events that are more recent or better publicized than others also tend to be more available. For example, whenever a plane crashes, the event is very well publicized. Car accidents, however, cause far more deaths than airplane crashes in the United States. But because of the publicity given to the airplane crashes, people are more likely to fear flying than they are to fear driving. They overestimate the risk of flying and underestimate the risk of driving.

The media also tend to focus on acts of violence, such as murder. As a result, people tend to overestimate the amount of violence in the United States.

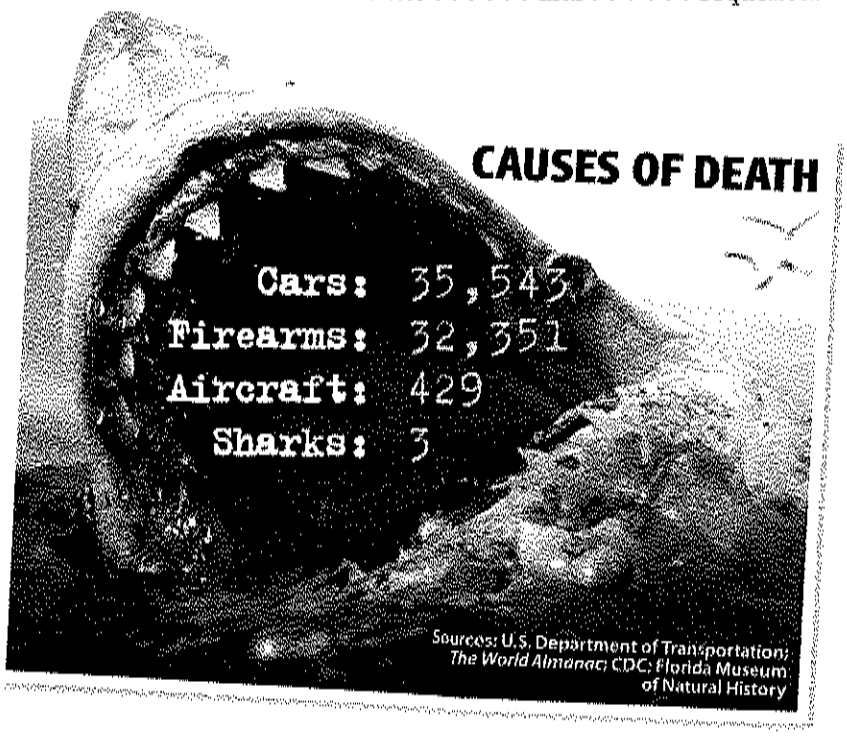
The Representativeness Heuristic Imagine that you are taking a true-false quiz. The quiz has six items. Which of the following answer sequences do you think is most likely to appear on the quiz?

T T T T T T
F F F T T T
T F F T F T

You probably said the third one. Why? For one thing, you know that six "trues" in a row are unlikely (assuming your teacher is not trying to play games with you). Second, you probably assume that your teacher wrote a quiz that had a random mix of true and false answers. The sequence T F F T F T looks random. The T T T T T T and F F F T T T sequences

Availability Heuristic

Assessing Risks The availability heuristic allows people to make decisions or judgments based on information that is immediately known to them. This information may or may not reflect reality, however. For example, people visiting a beach may worry about being killed by a shark because they recently heard about a deadly attack. Look at the figures at right listing select causes of death for the year 2014. How valid is the fear of being killed by a shark?



do not. Most people would thus select the TFTTFT sequence because it looks *representative*. It seems to represent a random sequence.

Based on the **representativeness heuristic,** people make decisions about a sample according to the population that the sample appears to represent. In the entire population of true-false tests you have seen, more answer sequences have looked like the third one (on your sample quiz) than like either of the other two. Thus, the third answer sequence best *represents* the type of sequence you have come to expect, based on your previous experiences with true-false tests.

The representativeness heuristic can be misleading, however. Assuming that your teacher really has written a quiz with a random mix of true and false answers—with a 50-50 chance of either a true or a false answer on any given quiz item—each of the three sequences listed above is *equally likely*. For each item, the chance that the answer will be true is one in two, just as the chance that the answer will be false is also one in two. The likelihood of attaining any specific sequence—whether TTTTTT or TFFTFT, say—is the same (1 in 64, in fact).

So what does this have to do with decision making? Well, imagine taking that quiz again. Suppose that you know the answers to the first five items and that they are all true. But the sixth item has you stumped, and you have to guess at the answer. Do you guess true, which would mean six "trues" in a row? Or do you guess false because you figure that it is unlikely that six "trues" in a row would occur? The temptation may be strong to go with the "false." But if the answers were assigned randomly, it really doesn't matter. Regardless of the answers to the previous five items, the answer to the final item has a 50-50 chance of being true and a 50-50 chance of being false. You might as well flip a coin.

The Anchoring Heuristic Another shortcut that people sometimes take in making decisions is called the anchoring heuristic. When using the **anchoring heuristic,** people make decisions based on certain ideas or standards they hold, ideas or standards that serve as an anchor for them. For example, people often decide to go along with the things they learn early in life. Early learning serves as an anchor in thinking.

If you have grown up in a family in which everyone else votes in elections, you probably expect to vote too. That expectation is an anchor in your life. Beliefs about politics, religion, and ways of life are common anchors. When something happens that makes people question the beliefs they have grown up with, they may change their beliefs a bit. When people form judgments or make estimates, they begin with an initial view, called a presumption. The initial view serves as the anchor. As they receive additional information, they make adjustments. But such adjustments are often difficult for people to make, and sometimes people are unwilling to make them.

Reading Check **Identify Main Ideas** What are three shortcuts in decision making?

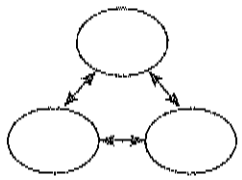
SECTION 3 Assessment

Reviewing Main Ideas and Vocabulary

1. **Define** What is a premise?
2. **Explain** What is the purpose of a balance sheet?
3. **Identify** Which heuristic is based on information in a person's immediate consciousness?

Thinking Critically

4. **Explain** Why is it impossible to prove an assumption reached by inductive reasoning to be true?
5. **Analyze** What is the biggest problem with using a representative heuristic?
6. **Draw Conclusions** How does one's upbringing as a child influence decision making?
7. **Contrast** Using your notes and a graphic organizer like the one here, contrast the three heuristic methods for making decisions.



FOCUS ON WRITING

8. **Descriptive** Think of a decision you made recently. Identify the type of reasoning you used and which heuristics you may have employed. Write a description of the issue and its context and the methods you used to make your decision.

SECTION 4

Language

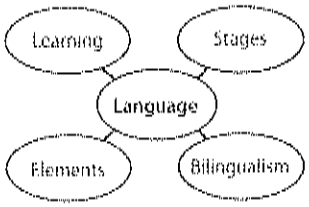
Before You Read

Main Idea
Language is a complex human activity that allows humans to communicate with others over time and space. It has specific elements, and people acquire language in specific steps.

Reading Focus
1. What are some of the basic concepts of language?
2. How do the basic elements of language build on each other?
3. What are the stages of language development?
4. Why is bilingualism a significant aspect of modern society?

Vocabulary
language
psycholinguistics
language acquisition device
phoneme
morpheme
syntax
semantics
overregularization

TAKING NOTES Use a graphic organizer like this one to take notes on language.



A Mystery
LANGUAGE

PSYCHOLOGY CLOSE UP ***What language is written on the Phaistos Disk?*** Scholars have asked that question since this 6.2-inch clay object was found on the island of Crete in 1908. Although since then doubt has been cast on the object's authenticity, many scholars think the disk does display an ancient written language. For a hundred years, scholars have tried without success to decipher the script incised on the disk. One thing they have determined is that the characters were pressed into the clay with some kind of stamp.

The unreadable message spirals like a snake from the rim to the center. Both sides of the disk are covered with symbols. There are a total of 242 symbols—45 different kinds. The symbols are arranged into 61 groups separated by lines. Are the symbols letters or syllables? Do the grouped symbols make up words or sentences? We really don't know.

Such an object raises many questions. If this disk truly represents a lost language, who spoke it? What did it sound like? What were the first words of babies born into this language's culture? How did people learn to write this language? Although mysteries will remain, we can be sure that the study of languages—both familiar and puzzling—will continue for many years to come.

Some evidence indicates that the Phaistos Disk was made between 1850 and 1600 B.C.

Basic Concepts of Language

Language is the communication of ideas through symbols that are arranged according to rules of grammar. Language makes it possible for people to share knowledge. People can use language to describe what they ate for breakfast or what they thought of the movie they just saw. They can use language to set down the learning of past generations and store it for people who will live hundreds of years in the future. Language also permits people to use the eyes and ears of other people to learn more than they ever could from their own individual experiences.

Our language ability sets us apart from other species. Although there are many ways to communicate, human beings are the only species to use language so creatively. In the Case Study for this chapter, you read about animals who did, in fact, use words and phrases and even did so in unique ways. However, most psychologists would argue that the animals did not create original, grammatical sentences that would be considered the baseline for accomplishing the use of language.

Human language is an incredibly complex mental process. Our words and sentences are composed of many parts. The way the brain processes speech sounds, the way words relate to each other, the combination of words for sentences, and the meaning of words and sentences are all a part of the psychology of language, called **psycholinguistics.**

Although early philosophers may not have used the term psycholinguistics, language and its processes have fascinated people for centuries. Areas of interest include the processes by which humans acquire, use, and understand language. Researchers ask questions like, "How does the brain actually put together the sounds and patterns of speech into something that the individual understands?" Another question is, "How do we put words in the proper order to create understanding?" But perhaps the most basic questions in psycholinguistics are, "Why do we have language?" and "Where does our facility with language come from in the first place?"

Hereditary Influences In the mid-1950s an American linguist, Noam Chomsky, proposed a theory to answer basic questions of human language acquisition. Chomsky said that we are all born with an innate ability to learn languages. He said we are also born with a knowledge of basic grammatical structure. That is, the human ability to use syntax is "hard-wired" into the brain. According to Chomsky, this inborn ability to put together language in sentences helps explain the amazing rapidity with which children learn languages. One line of argument that supports Chomsky's theory is the fact that children make certain characteristic errors as they learn their first language, while they do not make other types of errors.

ACADEMIC VOCABULARY
acquisition attainment or achievement

This natural tendency to acquire language can be called a **language acquisition device** (LAD). The LAD enables the brain to understand and use grammar. It enables people to turn ideas into sentences. People may not be ready for chemistry and algebra until high school, but the LAD makes people most capable of acquiring language between about 18 to 24 months of age and puberty. One- and two-year-olds seem to learn languages with ease. In many cases, they learn more than one language and become bilingual.

CASE STUDY CONNECTION
Animals and Language The human ability to create original, grammatical sentences is unique.

Environmental Influences People may have an inborn ability to learn language, but environmental influences are also important. Learning theorists claim that language learning is similar to other kinds of learned behavior. Children learn language, at least in part, by observing and imitating other people. For example, all babies vocalize in nonsense syllables, a process called babbling. But during their first year, babies start to babble the sounds they hear around them from speakers of the local language and drop other sounds not spoken in that language.

Billions of children have acquired the languages of their parents and have then proceeded to hand them down to their children. In this manner, languages pass, with small changes, from generation to generation.

Discussions about basic language acquisition are far from over. Chomsky has many critics, behaviorist psychologists being the most vocal among the critics. But we will leave the arguments for now to look more closely at language itself.

Reading Check **Contrast** What are the two main sources of language acquisition?

Quick Lab

Dynamic Semantics

Punctuation and pronunciation affect semantics. In this lab, sentences take on different meanings based on the punctuation or pronunciation used.

PROCEDURE

1. Write the following on the board.

   Woman without her man is lost.

2. Have volunteers punctuate the sentence. There are at least two ways the sentence can be punctuated. Read the punctuated sentences aloud.
3. Have volunteers read the following question as either a student asking another student about her idea for a science project or an annoyed mother who has found her child making a mess. Are there more ways to say the sentence that affect the meaning?

   What are you doing?

ANALYSIS

1. Study the ways the first sentence was punctuated. Ask the volunteers how they decided the meaning of the sentence. Discuss how views about women and men may have influenced the semantics of this sentence.
2. Listen to the difference in the tones of voice in the vocal exchange. Discuss how the feelings of the two people may have influenced the way the lines were delivered.
3. Summarize how more than just words influence the meaning of language.

The Basic Elements of Language

Languages contain three basic elements: phonemes (sounds), morphemes (basic units of meaning), and syntax (grammar). Combinations of these units create the words, phrases, and sentences that we use to communicate ideas. The meaning of words and sentences can vary according to semantics.

Phonemes The basic sounds of a language are called **phonemes.** (Languages that do not consist of sounds, such as American Sign Language, do not have phonemes.) Humans can produce about 100 different sounds. Some languages only have about a dozen phonemes, however. There are 26 letters in the English alphabet, but there are many more than 26 phonemes. English uses about 43 phonemes. Phonemes include consonants, such as the *d* and *g* in *dog*. They also include vowels, such as the *o* in *dog* and the *o* in *no*. Even though *no* and *dog* each contain an *o*, the *o* sound is different in each word, and thus the two *o* sounds are two different phonemes. Other phonemes in English cannot be represented by a single letter—for example, the sound *sh*.

English contains some phonemes and phoneme distinctions that are not found in other languages. French has no equivalent for the English *th*, for example, which is why native French speakers often use a *z* sound to approximate the *th* in an English word: "Zee book is on zee table." Chinese does not distinguish between a *p* sound and a *b* sound. Japanese does not distinguish between *r* and *l*.

Morphemes The units of meaning in a language are called **morphemes.** Morphemes are made up of phonemes. Some morphemes, such as *car* and *bike*, are words in and of themselves. Other morphemes are prefixes (for example *pre*, which means "before"), while still others are suffixes (for example, *-ness*, which can convert an adjective into a noun). Many words use combinations of morphemes. English uses morphemes such as *z* and *s* to make objects plural. Adding the *z* morpheme to *car* makes the word plural; adding the *s* morpheme to *bike* makes it plural.

In English, the past tense of regular verbs is formed by adding the *ed* morpheme to the end of the present-tense verb. The past tenses of *walk* and *talk*, for example, are *walked* and *talked*. Verbs such as *to be*, *to run*, and *to think* do not follow this rule, however. Thus they are considered irregular verbs.

Syntax The way in which words are arranged to make phrases and sentences is **syntax.** The rules for word order are the grammar of a language. English syntax usually follows the pattern of subject, verb, and object of the verb:

Alberto (*subject*)→*cooked* (*verb*)→*dinner* (*object*).

Many other languages have a different word order. Whereas in English the verb usually goes in the middle of the sentence, between the subject and the object, in German the verb often is placed at the end of a sentence. In the vast majority of languages, however, the subject precedes the object. And in no languages does the object appear first in a sentence.

Semantics To examine another essential concept related to language, compare these two sentences:

It will be a long time before dinner is served.

The members of Alberto's family long for a tasty dinner.

In the first sentence, *long* is an adjective. The sentence means that there is still much time before dinner. In the second sentence, on the other hand, *long* is a part of a verb—"to long for." The word *long,* therefore, clearly has more than one meaning.

The study of meaning is called **semantics.** Semantics involves the relationship between language and the things depicted in the language. Words that sound alike, such as *right* and *write,* can have different meanings, depending on how they are used. So can words that are spelled alike, as we saw with *long.*

How a sentence is structured also affects meaning. Compare these two sentences:

Alberto's chicken is ready to eat.

Alberto's family is ready to eat.

The first sentence probably means that Alberto has prepared the chicken and that it is ready to be eaten. The second sentence looks similar, but it most likely means that Alberto's family is hungry—that the members of his family want to eat as soon as possible.

Sentences have a surface structure and a deep structure. The surface structure is what you see, the actual words of a sentence. Both "ready to eat" sentences have the same surface structure. The deep structure of a sentence is its deeper meaning, the message the speaker is trying to communicate. The "ready to eat" sentences differ in meaning.

Some sentences have an unclear surface structure—you cannot be certain of the deep structure based on the surface structure. An example is the sentence, "Do you hear me?" The questioner may want to know if you are detecting sound or if you are truly hearing the message being delivered. The meaning here is only detectable in the context of the moment in which the statement is being made. In this case, the meaning of the word *hear* is at the base of understanding the question.

Reading Check **Describe** What are the three basic elements of language?

The Stages of Language Development

How do people learn languages? Children develop language in a sequence of steps. The sequence is the same for nearly all children no matter where they live or what language they learn. It begins with crying, cooing, and babbling, then moves into the learning of words, and finally, the learning of grammar.

Crying, Cooing, and Babbling Crying, cooing, and babbling are not considered true language because they do not use symbols with specific meanings. Nevertheless, crying is an effective form of verbal expression—it usually gets the attention of caregivers.

During their second month, babies begin to coo. Coos are vowel-like and resemble "oohs" and "ahs." Cooing seems to express feelings of pleasure. Tired, hungry babies do not coo. Cries and coos can communicate discomfort, hunger, or enjoyment.

At about six months of age, infants begin to babble. Unlike crying and cooing, babbling has the sounds of speech. Babies often babble consonant and vowel combinations, as in *ba, gaz,* and even the highly valued *mama* and *dada.* At first, however, combinations that actually have meaning, such as *mama* and *dada,* are just coincidental.

Crying, cooing, and babbling are basic human abilities. Children from cultures whose languages sound different all babble similar sounds, including sounds they have not heard. In fact, children babble phonemes found in languages spoken around the world. By 9 or 10 months of age, however, children pick out and repeat the phonemes used by the people around them. Other phonemes start to drop away.

Researchers have found that babies understand much of what other people are saying before they can talk. They demonstrate understanding with their actions and gestures.

Words, Words, Words After babbling comes the learning of words—the start of true language. Most children acquire new words slowly at first. After they speak their first word, there may be a gap. In fact, it may take another three or four months before they have a 10-word vocabulary. At about 18 months, children are saying about two dozen words.

Most early words are nouns—names for things. Research indicates that reading to children increases their vocabulary. It is thus a good idea for parents to pull out the storybooks and read to their children. Studies suggest that reading to children improves their awareness of phonemes and improves the child's decoding skills. It also leads to higher reading achievement and advanced oral language development, especially in the elementary grades.

Children sometimes overreach—they try to talk about more things than they have words for. Often they extend the meanings of words to refer to things for which they do not have words. This behavior is called overextension. For example, if a child sees a cow but does not know the word *cow,* she or he might call the cow a doggie.

Development of Grammar The first things children say are usually brief, but they have the meanings of sentences. That is, these utterances have a grammar. Even one word can express a complete thought, such as "Sit!" Children just starting to use language use only the words essential to communicating.

Sometimes a word will have more than one meaning, depending on the circumstances. For example, *doggie* can mean "There is a dog," "That stuffed animal looks like my dog," or "I want you to give me the dog!" Most children readily teach their parents what they mean with their utterances. They are delighted when parents do as requested and may howl when they do not.

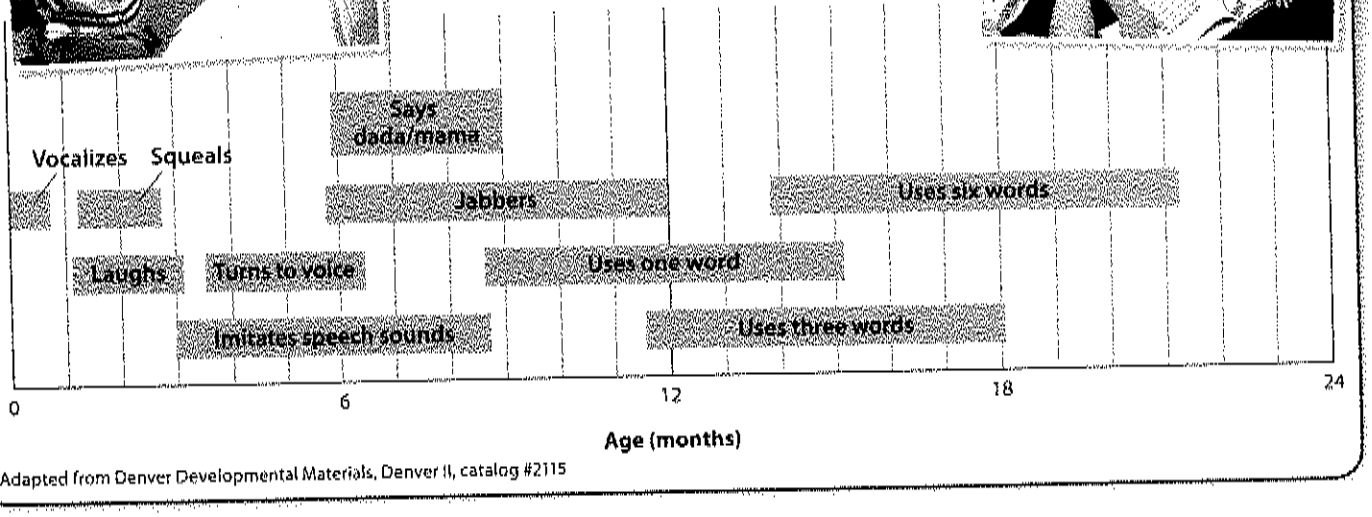
As they approach their second birthday, most children begin to use two-word sentences. "That doggie" might seem like just a phrase but is really a sentence in which *is* and *a* are implied: "That (is) (a) doggie." Two-word utterances such as this appear at about the same time in all languages.

Even brief two-word utterances show understanding of grammar. A child who wants his or her mother to sit in a chair says, "Sit chair," not "chair sit." Similarly, the child says, "my doggy," not "doggy my," to show possession. "Mommy go" means Mommy is leaving. "Go Mommy" expresses the desire to have Mommy leave.

Between the ages of two and three, children's sentences expand to include missing

Stages of Language Development

The graph shows the span of ages at which most babies develop some language skills. ***How might a doctor use this graph to calm parents who are worried that their baby's language development is delayed?***



Adapted from Denver Developmental Materials, Denver II, catalog #2115

words. They add articles (*a, an, the*), conjunctions (*and, but, or*), possessive and demonstrative adjectives (*your, her, that*), pronouns (*she, him, it*), and prepositions (*in, on, over, around, under, through*).

One interesting aspect of how children learn grammar has to do with irregular words. English has many irregular verbs and nouns. For example, the past tense of *am* is *was*, the past tense of *sit* is *sat*, and the plural of *child* is *children*. Children first learn irregular words by imitating their parents. Two-year-olds often use them correctly. But then a seemingly odd thing happens. Even though the children have used these words correctly, they soon begin to use them incorrectly.

What has happened is that they have learned the rules for forming the past tense and plurals (in English, adding *d* or *ed* morphemes to make a word past tense and adding *s* or *z* morphemes to form plurals). Once they have learned these rules, they begin to make errors. For example, three- to five-year-olds may say, "I runned away" instead of "I ran away." They are likely to talk about the "sheeps" or "gooses" they "seed" on the farm.

Children make these errors because they have applied the normal rules to all words, even the words for which the rules do not work—a process called **overregularization.** Although it may seem like a bad thing when children begin to incorrectly use words that they previously used correctly, overregularization represents an advance in the development of grammar. In another year or two, children will learn the correct forms of the irregular words as well as the regular ones, and overregularization will stop.

Reading Check **Sequence** In what order do children learn language?

Bilingualism

Many people, of course, learn more than one language. To speak two languages fluently is to be bilingual. In general, learning a second language during childhood is much easier than learning it later in life. This fact supports the theory that there is a period in childhood during which language acquisition is easiest and most effective.

Although the majority of people in the United States speak only English, the number of those who are bilingual is growing. In this respect, this country is becoming more like other parts of the world. Many people in other countries speak two or more languages. Some countries have minority populations whose languages differ from the official tongue. A large percentage of Europeans learn English and the languages of neighboring nations.

Statistically Speaking...

A Multilingual Country Hundreds of languages are spoken in the United States. The figures below show about how many people speak one of the top six languages at home, as of 2011.

291,524,091	Total population 5 years old and older
230,947,071	speak English only
37,579,787	speak Spanish or Spanish creole
2,882,497	speak Chinese
1,594,413	speak Tagalog (a language of the Philippines)
1,419,539	speak Vietnamese
1,301,443	speak French, including Patois and Cajun

Thinking Critically Some Americans fear that the English language is in danger of losing prominence in this country. Do you think the figures support this concern? Why or why not?

Source: American Community Survey (data from 2011; published in 2013)

Consider the Netherlands. Dutch is the native language, but children are also taught French, German, and English in the public schools.

For more than 60 million people in the United States, English is a second language. Millions of speakers converse each day in Asian, African, and European languages.

A century ago a common belief held that children reared in bilingual homes would be slowed in their cognitive and language development. The attitude was that people who knew two languages were crowding their mental abilities because cognitive capacity is limited. However, the U.S. Bureau of the Census reports that more than 75 percent of Americans who first spoke another language in the home also speak English "well" or "very well." Moreover, a careful analysis of older studies in bilingualism shows that the bilingual children often lived in poor families and had little education. Yet these bilingual children were compared to middle-class children who spoke English. In addition, achievement and intelligence tests were given in English, which was the second language of the bilingual children. Lack of education and poor testing methods, rather than bilingualism, accounted for the apparent differences in achievement and intelligence.

Today most psychologists believe that it is good for children's cognitive development to be bilingual—in Spanish, Russian, Chinese, or any other language. Bilingualism expands children's awareness of different cultures and broadens their outlooks on life. For example, bilingual children are more likely to understand that the symbols used in language are arbitrary. Children who speak only English are more likely to think that the word *dog* is somehow connected directly with the nature of the animal. Bilingual children therefore have somewhat more cognitive flexibility. In addition, learning a second language has been shown to increase children's expertise in their first (native) language.

Although bilingualism is a growing trend in this country, it still evokes strong emotions and occasional controversy. For example, in 2008, two Vietnamese American cousins, who were at the top of their class, spoke a few sentences of Vietnamese during their graduation speeches. The lines in Vietnamese expressed appreciation to their parents, who were in the audience and had limited English proficiency. A school board member protested, prompting the school board to consider requiring that graduation addresses be in English only.

In addition, various groups have tried to require that English be used for all public occasions in this country. No language is designated as the "official" language of the United States.

Reading Check **Make Generalizations** What are some advantages to bilingualism?

SECTION 4 Assessment

Reviewing Main Ideas and Vocabulary

1. **Identify Main Ideas** What are some examples of the uses of language?
2. **Recall** How do people learn language?
3. **Define** What are semantics?

Thinking Critically

4. **Explain** What is overregularization?
5. **Analyze** What is the purpose of grammar?
6. **Support a Position** Write a paragraph supporting or disagreeing with the following statement: "All children in U.S. public elementary schools should learn a second language." Use information from the section to uphold your views.
7. **Compare and Contrast** Using your notes and a graphic organizer like the one below, compare and contrast the three basic elements of language.

Element	Characteristics

FOCUS ON WRITING

8. **Descriptive** Think of a part of your life in which you use specialized language, such as in a sport or while learning to play a musical instrument. Identify five words unique to that experience and write a dictionary entry for each one. Then describe how you acquired this specialized language.