Thinking and Language

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RESOURCES

Introducing Thinking and Language

Classroom Exercise: The Limits of Human Intuition

The limits of everyday intuition are easily demonstrated in class (rather than use this to introduce the discussion of thinking, you may prefer to hold it for later when you discuss intuition). For example, Shane Frederick (cited by Kahneman, 2003) suggests a simple puzzle: “A bat and a ball cost $1.10 in total. The bat costs $1 more than the ball. How much does the ball cost?” Most people report an initial tendency to answer “10 cents” because the sum $1.10 separates easily into $1 and 10 cents and because 10 cents is about the right magnitude. Frederick reported that 50 percent of Princeton students and 56 percent of University of Michigan students gave this wrong answer. Simple subtraction convinces students of their error: $1.00 for the bat – $0.10 for the ball = $0.90, not $1.00. The correct answer is $1.05 for the bat, $0.05 for the ball.

Or, present the classic “horse-trading” problem.

A man bought a horse for $60 and sold it for $70. Then he bought the same horse back for $80 and again sold it, for $90. How much money did he make in the horse business?

Although the problem seems simple enough, most American college students answer incorrectly. David Myers reports that even most German banking executives get it wrong. The most common answer is $10. Respondents apparently reason that when the man buys the horse back for $80 he lost the $10 he made in the original deal. The man actually made $20. You can show this by comparing the total amount paid out ($140) with the total amount taken in ($160). Alternatively, present the problem in modified form. Instead of having the man buy the horse back for $80, state that he bought firewood for $80 and then sold it for $90. The problem suddenly becomes easier. You can also use this manipulation to introduce the importance of framing discussed later.

Keith Stanovich uses the “Anne problem” (drawn from the work of Hector Levesque, 1986) to demonstrate how we are all cognitive misers who fail to consider all possible states or alternatives when solving a problem. Pose the following scenario and question to your students:

Jack is looking at Anne but Anne is looking at George. Jack is married but George is not. Is a married person looking at an unmarried person? Is the answer yes, no, or it cannot be determined?

Stanovich reports that over 80 percent of people answer incorrectly; they claim that the answer cannot be determined. The correct answer is yes, a married person is looking at an unmarried person. If you consider all the possible alternatives, the answer becomes clear. If Anne is unmarried, Jack who is married is looking at her. If Anne is married, she is looking at George who is unmarried. Indeed, a married person is looking at an unmarried person.

Alternatively, present the following premises: All members of the cabinet are thieves. No composer is a member of the cabinet. Ask your class what logical conclusion can be drawn. Massimo Piattelli-Palmarini reports that a vast majority of thoughtful, intelligent respondents will say that one can draw no logical conclusion. Yet there is a valid conclusion, namely, that some thieves are not composers (or, there are thieves who are not composers). Having had some practice, see if your students do better with the following provided by Steven Pinker: Some archaeologists, biologists, and chess players are in a room. None of the archaeologists are biologists. All of the biologists are chess players.

What follows? Pinker reports that a majority of students conclude that none of the archaeologists are chess players, which is not valid. About one-fifth claim that the premises allow no valid inference. However, one valid inference is that some of the chess players are not archaeologists.


Classroom Exercise/Student Project: The Need for Cognition Scale

Introduce the literature on thinking with Handout 1, John Cacioppo and Richard Petty’s Need for Cognition Scale. The scale attempts to identify differences among individuals in their “tendency to engage in and enjoy thinking.” To calculate scores, students should reverse the numbers they placed before items 3, 4, 5, 7, 8, 9, 12, 16, and 17. That is, change 1 to 5, 2 to 4, 4 to 2, and 5 to 1. They should then add the numbers before all items to obtain a total score. The higher the score, the greater the need for cognition.

John Cacioppo and Richard Petty’s Need for Cognition Scale

The psychology of rational thought. New Haven: Yale University Press.
In constructing and validating the scale, Cacioppo and Petty found that total scores successfully discriminated between university faculty (people who presumably engage in and enjoy thinking for a living) and factory workers on assembly lines (people who perform repetitive, monotonous tasks for a living). In addition, scores correlated positively with field independence (preferring internal rather than external sources of information in both perceptual and social situations) and general intelligence and negatively with dogmatism, and were unrelated to test anxiety and social desirability. As predicted, those high in need for cognition preferred a complex problem-solving task over a simple one. Studies have also found that those high on this dimension are more likely to desire and actively seek out issue-relevant information in forming their attitudes.

Relative to those low in need for cognition, those high in this need express opinions more quickly when they have a great deal of prior knowledge and more slowly when they have little prior knowledge. In general, those high in cognition are more agentic and conscientious in cognitive domains but are not more or less sociable, emotional, or extraverted compared with people who are low in need for cognition. Cacioppo and his colleagues state that those high in need for cognition see themselves as more in control of their own fate, are more open to experience, and are, indeed, more effective problem solvers.

Need for cognition correlates positively with self-esteem, masculine sex-role attitudes, various measures of curiosity, and effective problem solving. It is unrelated to feminine or androgynous sex-role attitudes, sociability, shyness, and years of formal education. A factor analysis of the Cacioppo and Petty scale identified three major components: cognitive persistence, cognitive confidence, and cognitive complexity.

More recently, Michael Sargent has reported that people high in need for cognition are more sensitive to the fact that behavior, even criminal behavior, has multiple causes (biological, psychological, social-cultural) and thus in some cases may recommend less severe punishment.


Sargent, M. J. (2004). Less thought, more punishment: Need for cognition predicts support for punitive respons-

### Thinking

**Classroom Exercise: Cognitive Complexity**

Cognitive complexity refers to how simple or elaborate a person’s system of personal constructs is. Some people seem to use a very limited number of constructs to make sense of their social world, while others use a large number of constructs. Young children, for example, may have a very limited number of constructs at their disposal: Another child is either a “friend” or “not a friend,” a game is either “fun” or “not fun.” Because they do not have constructs that allow them to make finer distinctions, their view of the world is limited. All playmates who fall into the “friend” category are treated alike, as are all children in the “not-a-friend” category.

To demonstrate the most popular method for measuring cognitive complexity, have your students think of a person they like and a person they dislike, then take a total of 10 minutes to write descriptions of these people. They should pay special attention to the person’s “habits, beliefs, ways of treating others, manerisms, and similar attributes”—any aspect of the person’s personality or behavior but not physical characteristics. Finally, they should add the total number of different constructs they used for the two descriptions. With this technique, researchers typically obtain a wide variation of scores from college students. In one study, the scores ranged from 5 to 43, with a mean of 16.

What difference does cognitive complexity make? Jerry Burger describes a number of implications. For example, among politicians and world leaders, cognitive complexity has been related to political ideology. In describing the issues of the day, conservative U.S. senators make significantly fewer complex statements than do moderate and liberal senators. Among members of the British House of Commons, extremists from either side tend to see things in the simplest manner.

A cognitively complex person is also better able to take the perspective of others, that is, to see the world through their eyes. Research also suggests that cognitively complex people are more persuasive than those low on this variable. They seem to match their arguments to the audience they are trying to persuade. Finally, people who are high in cognitive complexity are better able to deal with ambiguity. Because they are better able to make sense of events in their world, they are less likely to become anxious when confronted with unexpected or unstructured situations.

PsychSim 5: My Head Is Spinning

This activity demonstrates thinking with verbal concepts and mental images, using the concept of mental rotation, thus you may want to hold this until you cover thinking with images. The issue of mental rotation is introduced and explained with reference to the classic studies by Roger Shepard and his colleagues. Students participate in a simulation involving mental rotation of the letter “R” in the picture plane. Their results are graphed and compared with the pattern of results from Cooper and Shepard (1973).

Classroom Exercise: Introducing Prototypes

Betsy Decyk has devised an exercise for introducing prototypes. Tell your students that even though you have known most of them for only a short time, you already know much about what and how they think. Have them take out a piece of paper and respond to the categories you are about to list with the very first example that comes to mind.

1. a bird
2. a color
3. a triangle (drawing a picture is just fine)
4. a motor vehicle
5. a sentence
6. a hero
7. a heroic action
8. a game
9. a philosopher
10. a writer

After students have finished, say that you will predict many, if not most, of their answers even before they reveal them. Give the following:

1. a robin, sparrow, or eagle
2. red or blue
3. a picture of an equilateral triangle
4. a car
5. a short declarative statement, e.g., “The boy ran home.”
6. Superman, Batman, or possibly a fireman
7. a single act by a male, e.g. a rescue by a fireman
8. Monopoly or some other board game
9. Socrates or Aristotle
10. Stephen King, or some other white male author

Explanation: We tend to think in terms of the “best example” of a category, or “prototype.” Within a given culture, there tends to be considerable agreement, in fact near consensus, on some prototypes. However, they may vary across cultures. As Diane Halpern explains, if you live in Australia, you might name “kiwi” as a bird, whereas most Russians would probably name Pushkin, Tolstoy, or Chekhov as an example of a writer.


Solving Problems

Student Project: The Tower of Hanoi Problem

Douglas Medin and Brian Ross use the Tower of Hanoi to introduce and illustrate several features of problem solving. The problem is represented below. You can draw it on the chalkboard or prepare an overhead or PowerPoint slide.

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Your task is to move the tower from the left peg to the right peg, moving only one disk at a time and never putting a larger disk on a smaller one. According to Medin and Ross, problem solving is taking place if a person is (a) trying to attain a goal (the three disks on the right peg arranged in the specified order), (b) starting from some set of conditions (disks on the left peg arranged from largest to smallest), (c) with some means of transforming these conditions (moving the pegs one at a time, not putting a larger disk on a smaller), and (d) with no immediately available knowledge of a solution (the problem is not solved in a single step).

The problem space is the problem solver’s internal representation of the problem. It has an initial state that is the representation of the givens in the problem, a goal state, which is the representation of the desired outcome, and a number of intermediate states must be “passed through” in moving from the initial state to the goal state. The problem has various routes to a solution. Or, see below for a solution involving only seven moves.

Solution to Tower of Hanoi problem:

1. Move smallest disk to third peg.
2. Move middle disk to second peg.
3. Place smallest disk on top of middle disk.
4. Move largest disk to third peg.
5. Move smallest disk to first peg.
6. Place middle disk on top of largest disk.
7. Place smallest disk on top of middle disk, which is on top of largest disk. The problem is solved.

Medin and colleagues note that it is important to distinguish between the complete problem space, or objective problem space, and the representation used by the problem solver. Because of memory limitations, only a small portion of the objective problem space is likely to be represented at any one time. Thus, in solving even this relatively easy problem, a human problem solver might represent only a part of the full objective problem space. Conclude by asking volunteers to describe the specific strategy they used in solving the Tower of Hanoi problem.


Classroom Exercise: Dice Games to Demonstrate Problem Solving

G. William Hill IV uses a simple dice game to demonstrate typical stages in solving problems. Begin by telling your students that they will be playing a game called “Petals Around a Rose.” You will be throwing dice and after each throw you will tell how many petals are around the rose. A specific rule determines the number of petals, and students are to discover the rule. Also tell them that the name of the game itself provides a clue to the rule.

For the first few throws of the dice (in larger classes use overheads to show the dice throws or quickly draw them on the chalkboard), simply identify the correct number of petals. After the first three throws, have students attempt to guess the number of petals before telling them the correct answer. Simply inform them whether their guess is correct or incorrect; do not confirm a particular rule. Begin by throwing five dice. To facilitate acquisition of the rule, progressively reduce the number of dice. Most students will figure out the rule by the time you reduce the number to two or one. The rule is very simple—a rose is defined as a die with a center dot (always an odd number). The total number of petals is the sum of all the dots that occur around the center dot (on all the dice thrown that have the dot).

After completing the game, ask volunteers to describe how they solved the problem. Some may refer to insight. Others are likely to describe a process of hypothesis formation, testing, and revising. Also ask what information they attended to in attempting to solve the problem and why. Do obstacles in problem solving reflect problems in isolating relevant information or are they also the result of frustration or performance anxiety?

You may want to use the exercise to introduce Marvin Levine’s theory of hypothesis testing as it relates to concept formation. Levine suggests that we begin a concept-formation task with a “pool” of hypotheses. From this pool, we select a “working hypothesis” that determines our initial responses. As long as the feedback is consistent with our working hypothesis we retain it. If the feedback contradicts our hypothesis, we shift and choose a new working hypothesis that is consistent with the current feedback, and also consistent with as much of the previous feedback as we can remember. According to Levine’s global focusing strategy, people are able to keep track of many hypotheses at the same time and reject those not consistent with the feedback. Research supports the global focusing strategy when the subjects are intelligent adults and when the task is relatively simple. People who have more limited memory skills or who are faced with a more complex task often adopt another strategy.


Student Project: Problem-Solving Strategies

Handout 2 presents specific problems to discuss in class. You may want students to complete them at home and then discuss problem-solving strategies in the following class period.

1. If a problem can be broken down into categories, it may be best to represent it in a matrix. Diane Halpern suggests the following three-by-three matrix to solve the Fred, Ed, and Ted problem:

<table>
<thead>
<tr>
<th></th>
<th>Joan</th>
<th>Sally</th>
<th>Vickie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fred</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ted</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Joan cannot be Ed’s wife because she is his sister so we can place a “No” in the Joan-Ed cell. Ed weighs more than the man married to Vickie and thus is not married to Vickie. Ed must be married to Sally. So we have the following:

Source: Figure from Cognition (4th ed.), by Margaret Matlin, p. 352. Copyright © 1998 by Holt, Rinehart and Winston. Reproduced by permission of the publisher.
The problem contains additional clues. Because Fred lives in Ann Arbor and Joan lives in Detroit, they are probably not married. Because Fred is not married to Joan or Sally, he must be married to Vickie. And, by the process of elimination, Joan must be married to Ted. The matrix is complete and the problem is solved.

### Joan Sally Vickie

<table>
<thead>
<tr>
<th></th>
<th>Joan</th>
<th>Sally</th>
<th>Vickie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fred</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Ed</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Ted</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>


2. The Buddhist Monk problem demonstrates how some problems are most easily solved by representing them graphically or visually. As the graph below indicates, one line can be drawn to show the monk going up the mountain on the first day, and another line to show him coming down several days later. The point at which the lines cross identifies the spot the monk will pass at the same time on each of the two days. Regardless of the monk’s walking rate, the two paths must cross at some point.

Simply picturing the monk moving up and down the hill helps many students. It becomes clear that the two figures must meet at some point regardless of their speed or how often they stop.

3. We often approach a problem by dividing it into a number of subproblems, or smaller problems. Each of the subproblems is solved by determining the difference between the initial state and goal state and then eliminating the difference. Sometimes this is called means-ends analysis. You determine the “ends” you want and then decide what “means” you will use to attain those ends. In studying the Hobbits-and-Orcs Problem, James G. Greeno found that people stop at different points in the problem and plan their strategy for the next few moves. Subjects took a long time before the first move and before two other critical moves. At each stage, they reported tackling a subproblem and needing time to organize their moves.

The Hobbits-and-Orcs Problem also demonstrates that the strategy of continuously moving forward to the goal may prove to be an obstacle. For example, if you simply think of moving creatures from the right bank to the left bank, you will ignore steps crucial to the solution. In solving many problems we sometimes find that to move forward, we must temporarily move backward. The solution?

1. Move 2 Orcs, R to L.
2. Move 1 Orc, L to R.
3. Move 2 Orcs, R to L.
4. Move 1 Orc, L to R.
5. Move 2 Hobbits, R to L.
6. Move 1 Orc, 1 Hobbit, L to R.
7. Move 2 Hobbits, R to L.
8. Move 1 Orc, L to R.
9. Move 2 Orcs, R to L.
10. Move 1 Orc, L to R.
11. Move 2 Orcs, R to L.

4. As John Hayes suggests, a good way to solve the “Truth tellers and Liars Problem” is to propose hypotheses. You might first consider, “If the first person was a liar, what would he have said?” Well, he would have lied about himself and said he was a truth teller. Alternatively, hypothesize for the moment that he was a truth teller. He would have to tell the truth about himself and say that he was a truth teller. In testing these hypotheses, you learn that the first person must have said he was a truth teller. The second man then must have been a truth teller and so was the first man since the second man said so.

**Classroom Exercise: The “Aha!” Experience**

Michael Wertheimer describes a classroom activity that is intended to demonstrate the “Aha!” experience of achieving insight. The exercise involves the presentation of a series of brain teasers that begins with the call for simple reorganization of perceptions and proceeds...
to the demand for the more challenging restructuring of abstract problems.

Before class, carefully draw the following figures on the chalkboard:

![Figure 1](image1.png)


Explain to your class that in solving problems, the pieces sometimes suddenly fall together and we perceive the solution. A reorganization or restructuring of perception produces the “aha!” experience we call insight. For example, the first line drawing might be viewed as a side view of a squinting face. But you can reorganize it into a soldier and a dog passing an archway; the mouth becomes the dog’s tail and the squinting eye a rifle with a bayonet. Similarly, the second figure may first appear to be a ghoul looking over a fence and a couple of ears sticking up over a fence. But with restructuring we may see a custodian cleaning mud off the floor (the ghoul’s eyes become the soles of the janitor’s shoes, and the ears become the sides of a bucket).

Rebuses necessarily require reorganization. Write the following three words on the board and ask your class what the phrase means. If necessary, provide the hint, “What is the relative position of ‘just’?”

you just me

Describing the relative positions of the words produces the phrase, “just between you and me.”

Now write the following on the board:

stood
well
view

What do the words communicate? As a hint, tell your class, “stood” is above well and both words are above “view.” With proper reorganization, most will suddenly recognize “well understood overview.”

After drawing the five sets of links shown below (in a single row) on the chalkboard, ask students, “What is the smallest number of links that needs to be opened and resoldered to make a single continuous chain of 15 links?” To most, it will seem that at least four links need to be cut and closed again. Erase one set of links and center it below the other four sets and ask again. Many, if not all, will suddenly recognize that all three links in one set can be opened and used to close the gaps between the remaining four sets.

Present the classic story of the wealthy desert dweller whose caravan is approaching an oasis after a long, hot day. He says to two of his lieutenants, “To the one of you whose horse gets to the oasis last, I’ll give this camel laden with gold.” Immediately, they both stop. By the time the rear guard of the caravan reaches the two lieutenants, they have dismounted their horses and each is waiting on the sand for the other to become so hot and thirsty that getting to the oasis cannot be resisted. Finally, they tell the guard their dilemma and ask for help. He says two words to them, whereupon the lieutenants jump onto the horses and race toward the oasis. What did the guard tell them? Most will be stumped. (If any have heard the story before, ask them not to divulge the answer to the rest of the class.) The guard’s recommendation? “Trade horses.”

Finally, tell your class the popular story of the hunter who sees a bear 1 mile due south. He shoots, misses, and the bear runs off. The hunter walks the 1 mile south to where the bear had been, then 1 mile due east, then 1 mile due north—at which point the hunter is standing again at exactly the same spot from which the gun had been fired. Question: “What color was the bear?” If necessary, provide the additional question, “Where on the globe is the hunter? Where can one go, successively, 1 mile due south, then 1 mile due east, then 1 mile due north, and end up at the same place one started from?” Only the North Pole satisfies this requirement. The bear is a polar bear and thus white.

Classroom Exercise/Lecture Break: Experts Solving Problems

Like most concepts, problem solving is most easily understood if students are able to relate it to their own lives. Have students form small groups to discuss and write a response to a couple of questions related to the concepts of problem solving, decision making, biases, algorithms, and/or heuristics. You can ask them as many or as few as you wish, depending on how much time you have to devote to a lecture break. Here are some suggestions:

1. Do you have a strategy that you tend to rely on more than others when trying to solve a problem? Why do you use it? Estimate how well this strategy works for you (give a success percentage).

2. Many individuals have to make “split-second” decisions in life-threatening situations (e.g., emergency medical personnel, firefighters, police officers, hostage negotiators).
   a. Name two issues in decision making and problem solving that would be important for these individuals to understand.
   b. Explain how these professionals could take advantage of these two issues to improve the accuracy, efficiency, or effectiveness of their decision making and problem solving in crisis situations.
   c. Name and explain two specific variables or issues that could lead to mistakes in the decision making and problem solving of these emergency responders. These should be different from the issues you named in part (b).

Related Reading:


3. How do you think people’s use of problem solving heuristics and algorithms might be influenced by their expertise in a particular domain? That is, are experts in a particular subject area likely to use heuristics and algorithms differently from novices? Develop a specific hypothesis about the relationship between expertise and problem-solving strategies. Identify at least one independent variable and one dependent variable in your hypothesis. Then, design a quick experiment to test it. Draw a graph to show what your expected results would be.
   a. Hypothesis:
   b. Independent variable (and operational definition):
   c. Dependent variable (and operational definition):
   d. Describe the tasks, materials, and methodology you would use in an experiment to test your hypothesis:
   e. Draw a graph to show your expected results:

Related Reading:


4. How might research in problem solving and decision making be useful or relevant to college students?

Related Reading:

See an excellent website “Teaching Outside the Classroom: Teaching Students to Solve Problems” maintained by the Center for the Integration of Research, Teaching, and Learning (CIRTL), an NSF Center for Learning and Teaching in higher education at www.cirtl.net/node/2622. It describes some of the obstacles to academic success that “novice” students face in their studies.


Lecture/Discussion Topic: Jokes, Riddles, and Insight

The text notes that insight provides a sense of satisfaction. The solution to a riddle or the joy of a joke may come in our sudden comprehension of an unexpected ending or a double meaning. A great example of double meaning to read in class follows. It’s an urban legend from Snopes.com (See www.snopes.com/travel/airline/obnoxious.asp):

An award should go to the United Airlines gate agent in Denver for being smart and funny, and making her point, when confronted with a passenger who probably deserved to fly as cargo.

During the final days at Denver’s old Stapleton airport, a crowded United flight was cancelled. A single agent was rebooking a long line of inconvenienced travelers.

Suddenly an angry passenger pushed his way to the desk. He slapped his ticket down on the counter and said, “I HAVE to be on this flight and it has to be FIRST CLASS.”

The agent replied, “I’m sorry, sir. I’ll be happy to try to help you, but I’ve got to help these folks first, and I’m
sure we’ll be able to work something out.” The passenger was unimpressed. He asked loudly, so that the passengers behind him could hear, “Do you have any idea who I am?”

Without hesitating, the gate agent smiled and grabbed her public address microphone. “May I have your attention please?” she began, her voice bellowing throughout the terminal. “We have a passenger here at the gate WHO DOES NOT KNOW WHO HE IS. If anyone can help him find his identity, please come to Gate 17.”

With the folks behind him in line laughing hysterically, the man glared at the United agent, gritted his teeth and swore “(Expletive) you.”

Without flinching, she smiled and said, “I’m sorry, sir, but you’ll have to stand in line for that, too.”

The wonderful game Mindtrap (manufactured by Great American Puzzle Factory, Inc., a division of Fundex, P.O. Box 421309, Indianapolis, IN 46242, and available in many toy departments and gift shops) provides dozens of examples to lighten any class. A few examples are provided below. They will elicit laughter, serve to illustrate that sudden flash of inspiration we call insight, and provide good openings for discussing fixation as an obstacle to problem solving.

1. The maker doesn’t want it, the buyer doesn’t use it, and the user doesn’t see it. What is it? **Ans:** A coffin.
2. What number is next in this series: 10, 4, 3, 11, 15 . . . ? a. 14 b. 1 c. 17 d. 12. **Ans:** 14. When spelled out, each number in the series is longer than the previous number by one letter.
3. (On the chalkboard, draw six glasses in a row. Shade the contents of the first three to indicate water and leave the last three empty. Then pose the question.) Six glasses are in a row. The first three are filled with water, and the last three are empty. By moving only one glass, can you arrange them so that the full and the empty glasses alternate? **Ans:** Pour the water from the second glass into the fifth glass.
4. What is so unusual about the sentence below? (Aside from the fact it does not make a lot of sense.) “Jackdaws love my big sphinx of quartz.” **Ans:** It’s the shortest sentence in the English language that includes every letter of the alphabet.
5. How can you physically stand behind your father while he is standing behind you? **Ans:** Stand back to back.
6. Something extraordinarily unusual happened on the 6th of May, 1978, at 12:34 p.m. What was it? **Ans:** At that moment, the time and day could be written as: 12:34, 5/6/78.
7. Can you translate the following into a sentence? 100204180 **Ans:** I ought naught to owe for I ate nothing.

8. What occurs once in every minute, twice in every moment, yet never in a thousand years? **Ans:** The letter M.
9. A man left home one morning. He turned right and ran straight ahead. Then he turned left. After a while, he turned left again, running faster then ever. Then he turned left once more and decided to go home. In the distance he could see two masked men waiting for him. Who were they? **Ans:** The umpire and the other team’s catcher.
10. Can you translate the following? Y Y U R Y Y U B I C U R Y Y U B I C U R Y Y U 4 M E **Ans:** Too wise you are, Too wise you be, I see you are, Too wise for me.

### Biases and Heuristics in Reasoning and Problem Solving

**Classroom Exercise: Confirmation Bias**

We all have a tendency to search for information that confirms our preconceptions. If students have read the text discussion of thinking, you may want to see if they can apply what they’ve learned to Peter Wason’s four-card problem. Draw circles and triangles on four cards as follows: (1) a black circle (with a black triangle on the other side), (2) a red circle (with a black triangle on the other side), (3) a red triangle (with a black circle on the other side), and (4) a black triangle (with a red circle on the other side). Instruct students: “Assuming that each card has a triangle on one side and a circle on the other, which card or cards need to be turned over to test this statement: ‘Every card that has a black triangle on one side has a red circle on the other?’” Most people answer “black triangle” or “black triangle and red circle” attempting to confirm the rule. The correct answer is black triangle (which would confirm the rule) and black circle (which would disprove the rule).

Another way to demonstrate the confirmation bias is to play an inverse game of “Twenty Questions.” This can be done either as a classroom exercise or as a student project. In this game, contestants are provided the general category and need to discover the specific instance. In the inverted game they are given the specific instance, say, “a Siamese cat,” and must discover the general category, say, “all living things.” Questioners should be told to announce an answer when they are confident they have discovered it. A tendency to verify rather than disconfirm their hunches will lead many questioners to announce a category that is too narrow.

**Lecture/Discussion Topic: The Confirmation Bias and Social Judgments**

Our tendency to search for confirming information may have important implications for our social judgments. Eldar Shafir presented research participants with the following scenario.
Imagine that you serve on the jury of an only-child sole custody case following a relatively messy divorce. The facts of the case are complicated by ambiguous economic, social, and emotional considerations, and you decide to base your decision entirely on the following few observations. To which parent would you award sole custody of the child? Parent A, who has an average income, average health, average working hours, a reasonable rapport with the child, and a relatively stable social life, or Parent B, who has an above-average income, minor health problems, lots of work-related travel, a very close relationship with the child, and an extremely active social life. (p. 549)

Most participants chose to award custody to Parent B. Interestingly, however, when a different group is given the same scenario and asked to which parent they would deny custody, the majority also select Parent B. Paradoxically, Parent B is thought to be both more and less worthy of caring for the child. Why? When asked who should be awarded custody, people look primarily for positive qualities and pay less attention to negative qualities. This perspective leads them to favor Parent B (because of the close relationship with the child and the high income). When asked who should be denied custody, people look primarily for negative qualities and pay less attention to positive qualities. This, too, would lead them to Parent B (because of the health problems and extensive absences due to travel).

If you want to further extend your discussion of common cognitive biases, use David Levy’s Tools of Critical Thinking, an excellent resource for both teachers and students. Separate chapters are devoted to each of the thinking errors. In his chapter on the confirmation bias, Levy explores its implications for social and clinical judgment.

Levy explains how we often employ strategies for eliciting information from others that support our initial beliefs about them. For example, in one study students were instructed to conduct interviews with other students to assess the presence of certain personality traits. Half were asked to determine if the interviewee was an extravert and the other half were asked to determine if he or she was an introvert. Findings indicated that the subjects who were asked to ascertain whether their interviewee was an extravert chose extraversion-related questions (e.g., “What would you do if you wanted to liven things up at a party?”), whereas those seeking to determine if the interviewee was an introvert asked introversion-related questions (e.g., “What factors make it really hard for you to open up to people?”). As a result, those who were tested for extraversion actually appeared more extraverted; those who were tested for introversion appeared more introverted. Interviewers found the personality traits for which they were probing, simply on the basis of the questions they chose to ask.

In similar ways, argues Levy, therapists may selectively elicit clinical information that affirms their initial diagnostic impressions. For example, therapists who think a new therapy patient may be suffering from alcohol dependence may ask questions regarding his drinking habits (“Have you ever had occasion to drink alone?”), his history of substance use (“Have you ever had hangovers?”), any lapses of memory (“Have you ever forgotten events that happened to you the night before?”), experiences with depression (“Do you sometimes feel very sad?”), and possible marital conflicts (“Do you have arguments with your wife?”). All the responses may confirm the belief that the patient is a closet drinker. The problem, of course, is that many people who are not suffering from alcohol dependence drink by themselves, have endured hangovers, have occasional lapses in memory, suffer through periods of depression, and argue with their wives.

More generally, therapists’ own personal and professional beliefs may lead them to elicit information from clients that confirms their particular theoretical orientation. Thus, Freudians may search and be more likely to find unconscious motivational conflicts, behaviorists may find maladaptive learning patterns, and cognitive theorists may discover irrational belief systems.


Classroom Exercise: Functional Fixedness: A Type of Fixation

The text presents the matchstick problem to illustrate fixation, our inability to see a problem from a new perspective. One type of fixation is functional fixedness, the tendency to see the functions of objects as fixed and unchanging. An example involves the presentation of an old phonograph record, a pad of typewriter paper, some transparent tape, a sewing kit, and a newly sharpened pencil. For added effect, you might throw in some other readily available items, say, a piece of chalk, a glass of water, a book, and a stapler. You can either present the actual materials or merely write the names of the items on the chalkboard. Have your class as a whole or assign small groups to play the record using only the items given (assuming that students still have some familiarity with phonographs and turntables!).

The solution is to roll a sheet of paper into the form of a cone, taping it to hold that shape. A needle from the sewing kit is then taped perpendicular to the outside surface of the narrow end of the cone. The needle should extend about an inch beyond the cone. The pencil goes through the hole in the record so that the flat
erased can rest on a firm surface. The record can now be rotated clockwise in a level plane. Holding the large end of the cone, rest the needle on the record. Turning the record will produce audible sound.

Classroom Exercise: Mental Set and Luchin’s Water Jug Problem

As noted in the text, human problem solving and decision making (for good and for bad) can be directed and influenced by a variety of biases. The text briefly describes fixation, which can obstruct problem solving by preventing us from seeing alternative uses to objects or from approaching problems in new ways. A related concept is einstellung (in German, literally, “attitude”), or a mechanized, set way of thinking about a problem. Abraham Luchins investigated einstellung using the “water jug problem,” which has become a classic.

In the water jug problem, participants are told to imagine that they have three different water jugs of varying capacities and an unlimited supply of water. They are instructed to figure out how to derive a certain amount of water using these three jugs for a series of problems. In Luchins’ research, participants were divided into two groups such that one (the experimental group) was given practice solving the problems before they were asked to solve a set of critical test problems. The other (control) group was not given any practice problems. All the practice problems were designed to be solved in the same way: Fill up jug B, then pour out enough to fill jug A, then pour out enough to fill jug C twice (2 x C).

The critical test problems did not require the B – A – 2C solution. Some could be solved two ways, using the B – A – 2C solution or a simpler solution (A – C or A + C). Others required a new solution altogether. Luchins was interested to see how participants would attempt to solve the critical test items as a function of previous practice.

Experimental participants—those with the B – A – 2C experience—tended to “stick” with that solution strategy on the critical test problems even though simpler solutions were possible. As a result, they took longer to finish the task, and they found it difficult to successfully solve some of the test items. On the other hand, the control participants had no problem recognizing and using the more direct solutions, and so they were faster and had more correct solutions. Thus, Luchins and his wife Edith (1970) argued, prior experience with the practice problems established a set “state of mind” for solving the problems, and this set prevented the future use of more efficient solutions.

The water jug problem has been adapted for classroom use here. Handout 3 contains two different versions of the problem. Prepare half as many copies of the handout as you have students and cut the copies in half. Then shuffle the half pages so that the two versions are distributed across the class in the manner you prefer. It may be best to distribute the pages face down and instruct students not to turn over the page or work on the problems until you say to begin. Give students enough time so that they feel pressure to work on the solutions quickly (5–7 minutes should be enough time). You may have students work individually on this task, or you can have students pair up (one student serves as the “solver” and the other serves as the “observer,” who times the solver and scores the solutions).

The top half of Handout 3 is for the experimental group. In this version, Problem 1 is a test item and can be solved by filling up Jug A and subtracting Jug B three times. Problems 2 through 6 are practice items and can be solved by filling up Jug B, then subtracting Jug A once, and then subtracting Jug C twice. These problems are the ones meant to establish a mental set for solving the problems with the B – A – 2C solution. Problems 7 and 8 can also be solved using B – A – 2C, but they can both be more efficiently solved by filling up Jug A first. Problem 9 is a critical problem that requires a brand new kind of solution. To successfully solve it, one has to “break out” of the mental set.

The bottom half of Handout 3 is for the control group. Problem 1 is the same test problem that begins the experimental version. The rest of the problems are in a different order. In this version, Problems 2 and 3 are the critical test items that can be solved using B – A – 2C or a simpler way. Problem 4 is the one that requires a “release” from B – A – 2C. Problems 5 through 9 are the practice items that require B – A – 2C.

After you collect your data from the class, you should find that the experimental group took longer than the control group. On average, the experimental group should complete fewer solutions overall and make more errors. You may want to ask your students to graph the class results from this exercise and/or discuss alternative explanations or other variables that they would want to include if you were to conduct a follow-up investigation.


Classroom Exercise: The Availability Heuristic

The role of vividness in shaping availability is demonstrated in Handout 4. Baruch Fischhoff, Paul Slovic,
and Sarah Lichtenstein report that the more quiet cause of death is actually more prevalent. However, people perceive the more publicized and easily pictured cause to be more common. Similarly, Norman Brown and Robert Siegler report that less familiar countries have greater populations but respondents judge those that are familiar to them to be more populous. Finally, larger or more familiar cities are judged to have a higher crime rate. (The exercise is also structured to provide an example of overconfidence. Students will generally be confident of their answer even though they are usually incorrect.)

Deaths per 100,000
All accidents (39.3) vs. strokes (45.8)
Suicide (10.9) vs. blood poisoning (11.4)
Homicide (6.0) vs. diabetes (24.2)
Motor vehicle accidents (14.9) vs. colorectal cancer (18.8)
Drowning (1.3) vs. leukemia (7.4)

Largest Population
Morocco (34 million) vs. Saudi Arabia (28 million)
Myanmar (48 million) vs. Australia (21 million)
Vietnam (86 million) vs. South Africa (49 million)
Sri Lanka (21 million) vs. Libya (6 million)
Tanzania (40 million) vs. Iraq (28 million)

Highest Crime Rate
Chicago (15.6) vs. Kansas City (26.1)
Las Vegas (11.3) vs. Stockton, CA (14.6)
Miami (13.9) vs. Phoenix (15.0)
Honolulu (1.7) vs. Raleigh (6.0)
New York (6.6) vs. Aurora, CA (9.5)


By a show of hands, ask how many answered all questions correctly. Rarely will a single hand go up. In fact, some students will get every question wrong. To demonstrate overconfidence, have students compare the percentage of questions they answered correctly with their average confidence level. How many were more confident than correct? Virtually every hand will go up.

You might cite other examples that demonstrate the persuasive power of vivid information. Most of us are more fearful of flying than driving because airplane crashes are vivid and memorable, but flying is in fact safer. Seeing the vivid movie Jaws produced a fear of sharks in swimmers that no factual data would support. When Abraham Lincoln met Harriet Beecher Stowe, whose Uncle Tom’s Cabin dramatically described the effects of slavery, he commented, “I’m happy to meet the little lady who started the Civil War.” When you are thinking of buying a new car, whose testimony is most persuasive—a neighbor who has had problems with a particular model or Consumer Reports, which on the basis of dozens, perhaps hundreds of reports, recommends the car?

Do the media sometimes lead us to have a distorted view of the frequency of certain events by overexposing us to some events and underexposing us to others? Pose the following questions to your students.

The FBI classifies crime in the United States into two categories—violent crimes, such as murder, rape, robbery, and assault, and property crimes, such as burglary, larceny, or car theft. What percentage of crimes would you estimate are violent rather than property crimes? What percentage of accused felons plead insanity? What percentage are acquitted? What percentage of convictions for felony crimes are obtained through trial instead of plea bargaining?

In 2009, there were 1,318,398 violent crimes and 9,320,971 property crimes. Violent crimes were 12.3 percent of the total of all crimes. (Note that crime has been decreasing in recent years, with violent crime in 2010 decreasing by 5.5 percent since 2009 and property crime decreasing by 2.8 percent). Less than 1 percent of all accused felons plead insanity and only a quarter of those are ultimately acquitted. Less than 10 percent of convictions for felony crimes are obtained through a trial; more than 90 percent result from plea bargaining. However, aided by the news media’s reporting, we tend to overestimate the number of violent crimes, pleas of insanity, and trials, because they are more available to memory.


Classroom Exercise: The Representativeness Heuristic
As a supplement to the text discussion of the availability heuristic, you may want to discuss the representativeness heuristic, which involves judging the likelihood
of things in terms of how well they seem to represent or match a particular prototype. Although “representativeness” works well much of the time, it leads to error when its conclusions run counter to the laws of chance. You can demonstrate the power of the representativeness heuristic in class with another of Amos Tversky and Daniel Kahneman’s problems. Read the following in class and ask students to write down their answer—either “a” or “b.”

Linda is 31, single, outspoken, and very bright. She majored in philosophy in college. As a student, she was deeply concerned with discrimination and other social issues, and she participated in antinuclear demonstrations. Which statement is more likely?

a. Linda is a bank teller.
b. Linda is a bank teller and active in the feminist movement.


By a show of hands, ask how many chose “b.” The overwhelming majority will, since feminism seems more representative of Linda than being a bank teller. In noting that the answer is “a,” point out that the probability of any two uncertain events occurring together is always less than the odds of either happening alone. For example, the chance of flipping two heads in a row is less than the chance of flipping one. Thus, the probability that Linda is both a bank teller and a feminist must be less than that she is a teller, regardless of how unsuitable that career may seem for her. You might try the following alternative to make the same point: Ernest is extraverted and literary. Which of the following is more likely? (a) Ernest majored in engineering. (b) Ernest majored in engineering but took a job as a newspaper reporter. Most students will again opt for “b,” although “a” is actually more likely.

You can also demonstrate how representativeness leads to error by asking students to imagine they are offered a bet. A die with four green sides and two red sides will be rolled several times. They can be paid 25 dollars if

RGRRR or GRGRRR

occurs. (Write each one on the chalkboard.) Which sequence do they think is more likely to pay off? Most will choose

GRGRRR

In fact, when Tversky and Kahneman posed this choice, either hypothetically or by offering hard cash, at least two-thirds chose that sequence. Although the sequence is more representative of a die with four green faces (because green sides outnumber red sides), in actuality it is only two-thirds as likely because it is the same as the first alternative with the addition of a “G” (which has the probability of two-thirds on any given roll).


Classroom Exercise: The Base-Rate Fallacy

You may want to extend the text discussion of heuristics to include the base-rate fallacy—the tendency to ignore or underuse base-rate information and instead to be influenced by the distinctive features of the case being judged.

Ask your students this question (Ward Casscells, Arnold Shoenberger, and Thomas Graboys gave the same problem to physicians and medical students at four Harvard Medical School teaching hospitals): If a test to detect a disease whose prevalence is 1 in 1000 has a false positive rate of 5 percent (a false positive rate is the percentage of times the test mistakenly indicates that the disease is present), what are the chances that a person found to have a positive result actually has the disease, assuming that you know nothing else about the person?

Casscells and his colleagues obtained an average response of 55.9 percent; the most common answer was 95 percent. The correct answer is about 2 percent. The physicians and students gave too much weight to the case information and too little to the base-rate information.

Explain to your students that only 1 in 1000 has the disease. However, when the test is given to the 999 who do not have the disease, it will indicate that 50 of them have it (.05 x 999). Yet, of the 51 patients testing positive, only 1 (approximately 2%) will actually have it. In summary, the base rate indicates that the overwhelming majority of people do not have the disease. The vast majority of positive tests will have been from people who do not have the disease.

Alternatively, or in addition, read Alan Swinkels’ example to your class:

Dr. Swinkels’ cousin, Rudy, is a bit on the peculiar side. He has unusual tastes in movies and art, he is married to a performer, and he has tattoos on various parts of his body. In his spare time, Rudy takes yoga classes and likes to collect old 78 rpm records. An outgoing and rather boisterous person, he has been know to act on a dare on more than one occasion. What do you think Rudy’s occupation most likely is?

A) Farmer  B) Librarian  C) Trapeze Artist  D) Surgeon  E) Lawyer
Rudy’s peculiar habits are suggestive of a performer and thus a trapeze artist. However, the base rate of any of the other options is significantly higher, making it more likely that Rudy is a member of any one of the other occupations.


**Lecture/Discussion Topic: The Projective Way of Knowing**

You can extend the text discussion of the availability heuristic to another heuristic—what Raymond S. Nickerson calls “the projective way of knowing.” What we know about what other people know influences our behavior in many ways. For example, effective conversation depends not only on shared knowledge but also on each person making reasonably accurate assumptions about what the other person knows.

Research suggests that we use our own knowledge as the basis for developing models of what other people know. In other words, we tend to assume that other people know what we know.

People’s tendency to assume that others are like themselves is evident from the finding that people who practice a particular behavior tend to think that behavior is more prevalent than do those who do not engage in the same behavior. Moreover, when attempting to assess the attitudes of specific groups, people tend to project their own attitudes onto those groups. They also see their own attitudes and behaviors as rational or normative and those that differ as irrational or deviant. Political extremists on both sides of the spectrum question the rationality and even the mental health of their counterparts.

Because people often react similarly in specific situations, the heuristic, like availability and representativeness, makes sense. The idea that we are wise to assume others are like ourselves is captured by the principle of humanity. It states that when trying to understand what someone has just said, especially something ambiguous, we should impute to the speaker beliefs and desires similar to our own. Obviously, this simplifies life. If we could not assume that other people are like ourselves, communicating effectively would become overwhelmingly difficult.

Conversely, assuming that others possess knowledge they do not have can impede communication and mutual understanding. For example, classroom instruction fails if teachers underestimate the difference between their own knowledge and that of their students. Designers of technology fail in their creation of market-able products if they underestimate how much difficulty other people will have in learning to use their creations. Supporters of political candidates may exert too little electoral effort if they overestimate the popularity of their favored candidate.

Research suggests that experts often overestimate what others may know about their area of expertise. For example, specialists were more likely than those with only an intermediate level of expertise to underestimate the amount of time novices would need to complete a particular task. Experts even seemed resistant to debiasing techniques that would reduce their tendency to fall victim to such underestimating. Research participants in laboratory studies who are given privileged information sometimes behave as if other participants have that information even when, if asked, they readily acknowledge that others do not have the same knowledge.

A particularly clever demonstration of overimputing one’s knowledge to others comes from a study in which participants tapped the rhythms of well-known songs that others tried to identify. Tappers estimated the likelihood that listeners would identify the songs to be about 0.5. In fact, correct identification was about 0.025. The illusion of simplicity refers to the mistaken impression that something is simple just because one is familiar with it. For example, people are likely to judge prose to be appropriate for a lower-grade reading level if they have previously read it than if they have not.


**Classroom Exercise: The Anchoring Heuristic or Bias**

In his book *Predictably Irrational*, Dan Ariely introduces readers to another heuristic that affects our everyday judgments, namely, the anchoring bias. It refers to the human tendency to use initial information as the standard, or “anchor,” for judgment and decision making.

Amos Tversky and Daniel Kahneman were among the first to demonstrate the power of the anchoring heuristic. In an early study, they asked some respondents whether the percentage of African nations that are members of the United Nations was more or less than 45 percent? Others were asked whether the number was more or less than 65 percent. When all respondents were asked to estimate the actual percentage, those who had been asked the former question gave lower estimates than those asked the latter. This pattern has held in other studies for a variety of different estimates, including fair prices. Tversky and Kahneman described anchoring as a process in which people start from an initial value, then adjust it to yield a final estimate. When the initial value is low, of course, the adjusted value is typically insufficient.
Interestingly, even arbitrary anchors affect the estimates people provide. For example, Dan Ariely and his colleagues found that asking people to provide the last two digits of their social security numbers affects their estimate of the price they are willing to pay for an item. In their study, they distributed forms to students that listed five items: A bottle of Jaboulet La Chapelle, 1996 wine; a cordless trackball (TrackMan Marble FX by Logitech); a cordless keyboard and mouse (iTouch by Logitech); a design book (The Perfect Package: How to Add Value Through Graphic Design); and a 1-pound box of Belgian chocolates by Neuhaus.

Participants were first asked to write the last two digits of their social security numbers at the top of the page, then next to each item write those numbers in the form of a price. For example, if the last two numbers were 23, they would write $23 next to each item. Next, they were asked to indicate whether they would be willing to pay that price for the item. Finally, the students were asked to write the maximum amount they were willing to pay for each product. In analyzing the results, the researchers found a strong positive correlation between social security numbers and the price a person would bid for a product. Students whose last two social security digits were between 00 and 19 were willing to pay $9.55 for the chocolates, whereas those whose digits were in the range between 80 and 99 were willing to pay $20.64. Similarly, those in the range between 00 and 19 were, on average, willing to pay $16.09 for the cordless keyboard; those in the range between 80 and 99 were willing to pay $55.64.

This study can be readily replicated in class. The items you list should, of course, be somewhat unfamiliar to your students and moderately priced. Ariely and his colleagues brought each item to class and briefly described it—for example, “for those of you who don’t know much about wines . . . 1996 Hermitage received a 92-point rating from the Wine Advocate magazine. . . . it has the flavor of red berry, mocha, and black chocolate . . . only 8100 cases of it were made.” After students have responded with the last two digits of their social security numbers and prices they would be willing to pay, collect the forms and analyze the data. Report the results at your next class meeting.


Lecture/Discussion Topic: The Sunk Cost Fallacy

Another frequent error in everyday decision making is the sunk cost fallacy. Students will readily recognize from their own behavior this tendency to invest resources after some have already been made. Even when initial investments sour, we “throw good money after bad.” Probably everyone has had the experience of making a phone call and being put on hold. You need to decide whether to hang up or continue waiting. Many of us continue to wait because of the time we have already invested. Or take the decision to fix an automobile. After investing money in a muffler, brakes, and new tires, we may discover that we have the much larger expense of needing a new transmission. Because we have already invested so much money in fixing the car, we feel trapped into replacing the transmission rather than buying a new car.

As Diane Halpern explains, making decisions in light of previous decisions demands that we consider why the value of the investment has been so high in terms of time or money, and whether, at this point in time, the phone call is worth an additional 10 minutes on hold or the car is worth the additional sum of money. She provides the following example that you might read in class to illustrate how people respond in sunk cost situations:

You and a friend just spent $10 to see a movie. About a half hour into the movie, you both realize that it’s “two thumbs down”—a really bad movie. What do you do? List some good reasons for staying until the end of the movie, then list some good reasons for leaving after a half hour.

Those who indicate that the investment of $10 is a good reason for staying demonstrate the sunk cost fallacy. The $10 is gone regardless of what one now decides, so it is actually not relevant to the decision of staying or leaving. Staying means not only enduring a bad movie but missing out on a pleasurable activity that one could be doing instead. Thus, there is a dual cost to staying—seeing a bad movie and missing out on a better activity.

As Halpern indicates, examples of the sunk cost fallacy (or entrapment) are often found in government budget hearings. One example she cites is the argument in favor of continuing to support the development of the MX missile: The millions of dollars that have already been invested would be lost if we decided to discontinue the project. Politicians sometimes aim to minimize the appearance that they have wasted money by continuing to fund projects that should be discontinued. If more of us were sensitive to sunk costs, we might save valuable resources that could be put to better uses.

**Classroom Exercise: The Overconfidence Phenomenon**

The tendency to overestimate the accuracy of our current knowledge is a powerful phenomenon and readily demonstrated in class.

a. Perhaps the simplest demonstration of the tendency is to have students predict their score on a multiple-choice or another type of short-answer test immediately after they have completed it (have them note their estimate at the top of the test). The majority will overestimate the number of questions they got right. While the strength of this tendency will depend to some degree on the amount of feedback they have received on previous tests, I have found students continue to overestimate throughout the semester.

b. Handout 5 presents several questions like those used by Kahneman and Tversky in assessing overconfidence. If your students are as correct as they are confident, only 2 percent of their responses should be wrong. Thus, if each of 50 students responds to the 10 questions, there should be a total of 10 errors ($50 \times 0.02 = 10$). The actual proportion of errors will be more than 10 times that. After students have completed the questions, you may wish to collect, shuffle, and redistribute them so that students need not report their own mistakes. By a show of hands, count the number of errors for each item after providing the correct answers below. Overconfidence will be obvious.

1. 3.6 million square miles
2. 32.7 million people
3. 3.01 billion dollars
4. 385 deaths
5. 11,803 female commissioned officers
6. 439 nuclear plants
7. 33,300 suicides
8. 92 (yes, just 92) vehicles
9. 91.6 million bushels
10. 29 medals

c. An experiment by James Milojkovic and Lee Ross is readily adapted to provide an amusing and memorable demonstration of how overconfidence contaminates our judgment of others.

Distribute Handout 6 to the entire class and explain that you are going to test their ability to distinguish truth from lies. Explain that you have put 10 slips in a hat, 5 of which say “Tell the truth,” and 5 of which say “Tell a lie.” Solicit a volunteer for each of the 10 topics, having each person draw one of these slips. Then invite each person to stand and tell his or her truth or lie, after which the remainder of the students are to guess whether it was a truth or a lie, and to indicate their confidence. When all the stories are told, have the volunteers reveal which statements were truthful and which were lies. Have the students then compute (a) their percentage correct out of 10 and (b) their average confidence level. Finally, ask for a show of hands: “How many of you were more correct than confident?” (Few hands will rise.) “How many of you were more confident than correct?” (Most hands will rise.) You may further wish to compute the class average; Milojkovic and Ross report that their Stanford students were 52 percent correct and 73 percent confident, a result close to what we have obtained using these materials. Milojkovic and Ross also report that when people were 90 to 100 percent confident, they were no more correct than when they were only 50 to 65 percent confident.


**Classroom Exercise: Framing Decisions**

The importance of wording (framing) questions properly in survey research was discussed in the Thinking Critically With Psychological Sciences unit of these resources, and you may want to refer back to the examples and the exercise if you did not use them earlier. Alternatively, you can use Handout 7 to illustrate the concept of framing. Prepare half as many copies of the handout as you have students and cut the copies in half. Distribute the top halves to students on the right side of the classroom and the lower halves to those on the left side. Have them complete the problems.

On Question 1, students who receive the top half will strongly prefer Route 1, whereas those with the lower half will strongly prefer Route 2. A show of hands will confirm this difference. Read both forms of the question slowly and demonstrate that they really pose the same alternatives.

Question 2 will help to explain the results to Question 1 and to introduce a discussion of factors that motivate people to gamble or not to gamble. Mathematicians in the seventeenth and eighteenth centuries observed that people seemed reluctant to accept “fair” risks. For example, not many were willing to pay $50 to enter a lottery with a one-half chance of winning $1000, although mathematically that’s a fair price. In 1738, the Swiss mathematician Bernoulli offered an explanation. He proposed that the first dollar (or ducat) one acquired was worth slightly more than the second, the second more than the third, and so on, until those with a lot of money valued each additional dollar very little. To most people, the $500 it cost to enter the lot-
tery was worth more than the additional $500 they might win. Thus, they demanded better odds (or a lower ante).

The idea that people are “risk averse” persists into the twenty-first century. Evidence for this is found in the success of insurance companies, because millions of us are willing to pay premiums that are obviously more expensive than the mathematically fair price. Kahneman and Tversky have shown that such an analysis is too simplistic. While responses to Question 2 in the top half of Handout 7 show people to be risk averse, responses to the turned-around question are the opposite. On the top version, most students will go for the gain of $3000, even though the alternative has a higher expected payoff \((0.8 \times \$4000 = \$3200)\). (Demonstrate this preference with a show of hands.) On the lower half, 90 percent gambled, risking a larger loss for the possibility of losing nothing at all. Again, demonstrate this preference with a show of hands. Conclusion? People tend to avoid risks when seeking gains but choose risks to avoid sure losses. This is reflected in the different responses to Question 1 as well. Most of us avoid risk when seeking to save lives but prefer them when seeking to avoid deaths.

We are not “risk averse,” suggest Kahneman and Tversky; we are “loss averse.” Losses loom larger than gains. Thus, people avoid fair bets because the prospect of gain isn’t worth the pain of loss. Practically, it makes better sense for businesses to provide a “discount for cash” than a “credit surcharge.” People find it easier to give up a discount (forgo a gain) than to pay a surcharge (suffer a loss).

The “loss averse” tendency can sometimes lead to poor decisions. Ask students to imagine that they face the following pair of concurrent decisions. In each case, which choice would they prefer?

**Decision I.**

Choose between:

- a. a sure gain of $240
- b. a 25 percent chance of winning $1000 and a 75 percent chance of winning nothing.

**Decision II.**

Choose between:

- c. a sure loss of $750
- d. a 75 percent chance of losing $1000 and a 25 percent chance of losing nothing.

In choosing a sure gain but gambling to avoid a loss, three-quarters of the respondents in previous research picked choices “a” and “d.” The advantages these choices give can be shown by regrouping the pairs and adding the options together. The total outcome of “a” and “d” is a 25 percent chance of winning $240 and a 75 percent chance of losing $760. The total outcome of “b” and “c” is a 25 percent chance of winning $250 and a 75 percent chance of losing $750.

The effect of framing can be demonstrated with additional examples. For example, pose these alternatives to different members of your class.

a. You’ve decided to see a Broadway play and have bought a $75 ticket. As you enter the theater, you realize you’ve lost your ticket. You can’t remember the seat number so you can’t prove to the management that you bought a ticket. Would you spend $75 for a new ticket?

b. You’ve reserved a seat for a Broadway play for which the ticket price is $75. As you enter the theater to buy your ticket, you discover you’ve lost $75 from your pocket. Would you still buy the ticket, assuming you have enough cash left to do so?

Most people will buy a ticket after losing cash but not after losing the ticket. Why? Tversky suggests that people set up a mental account for going to the theater. In problem (a), that account has already been charged $75; to replace that ticket would double the account, which is more than most are willing to pay. In the second problem the $75 loss is charged to some other account, such as next month’s lunch money or next year’s vacation.


**Classroom Exercise: Framing Alternatives and Human Irrationality**

Dan Ariely opens his helpful book *Predictably Irrational* with an excellent example of how the framing of alternatives influences people’s judgments and decisions. Presenting the results of his study in class not only illustrates the power of framing but also reinforces the text’s emphasis on the limits of human intuition and rationality.

Replicating what he had found on the Internet, he offered 100 students at MIT’s Sloan School of Management the following subscription options to the Economist:

1. Internet-only subscription for $59.
2. Print-only subscription for $125.
3. Print-and-Internet subscription for $125.

Ariely reports that 16 students chose the Internet-only subscription and 84 students chose the print-and-
Internet subscription for $125. Obviously, the latter alternative represented a huge advantage over the print-only subscription.

But what happens when a comparable group of respondents are offered only alternatives 1 and 3? Do they respond as before (16 for the Internet only and 84 for the print-Internet combination)? The option no one selected has simply been removed. Remarkably, the results were now quite different. Sixty-eight students chose the Internet-only option for $59 and only 32 students chose the combination subscription for $125. Obviously, the chosen alternative depends on the context. As Ariely concludes, the best choice is relative.

The study is one you can readily replicate in class. Simply prepare two sets of written subscription options to a popular magazine such as Time, Newsweek, or Psychology Today. Present half your class with each set of options. You can collect their written responses and report the results at the next class period. Alternatively, you can more simply use an immediate show of hands to report the specific choices of each group on the chalkboard.

Businesses exploit the principle of alternative framing (and human irrationality) with regularity. Ariely reports how, given three choices, customers are strongly inclined to pick the middle option. So, in selling television sets, retailers may price the ones they really want to sell in the middle. If they want to sell a 42-inch Toshiba for $850, they place it between a 36-inch Panasonic for $690 and a 50-inch Philips for $1480. Similarly, a restaurant consultant who prepares menu pricing knows that customers are unlikely to choose the most expensive item, but they will choose the second most expensive dish. By creating an expensive dish, a restaurateur can lure customers into ordering the second most expensive, providing the restaurant with a higher profit margin.

Finally, research by Nicholas Epley and his colleagues’ reveals that referring to money given to college students as a “rebate” or as a “bonus” can affect their tendency to spend it. Epley’s research team reasoned that if research participants were given a $50 check as a “bonus,” they would interpret it as a positive change from the status quo. In contrast, the same check given as a “tuition rebate” would be coded as a return to a previous wealth state. The researchers further hypothesized that framing money as a bonus would lead to more immediate spending than framing it as a rebate. The results confirmed the prediction. Epley, a University of Chicago business professor, has suggested that if the U.S. Congress and the president want to stimulate the economy by getting people to spend more, they should label the money that the government gives to taxpayers as a “tax bonus” rather than as a “tax rebate.”


Lecture/Discussion Topic: The Disjunction Fallacy or Irrational Prudence

A good way to extend the text discussion of thinking errors is to describe the disjunction fallacy or what might be called irrational prudence. Amos Tversky describes how he became aware of this particular error when he and his colleagues were interviewing candidates for two new positions in their department. Two were finally chosen to be offered the chairs. One candidate was slightly better than the other. Tversky and his colleagues decided not to offer the professorship to the second candidate until the first had accepted or refused. In fact, as Tversky admits, whatever the first candidate decided, the second appointment would be made. Their prudence made little sense.

Tversky’s subsequent experiments demonstrated human vulnerability to the disjunction fallacy. Read the following scenario to your students to illustrate. Ask them how they might answer.

You’ve just handed in a difficult exam. You’ll know the day after tomorrow whether you passed or failed. You are offered a real bargain in the form of a vacation in Hawaii for less than $200, but you have to decide by tomorrow and hand in a nonreimbursable deposit of $50. You can put off the decision for a day (by which time you will know for sure whether you passed or failed) for an additional $15, which is neither reimbursable nor deducted from the total price of your package. What do you decide to do?

After students have responded, also ask them what they would decide to do if (a) they knew they had passed, or (b) they knew they had failed.

Tversky found that the majority of students, not knowing the results of the exam, would defer the decision, gladly spending the extra $15 to await the outcome. In short, the students fell victim to excessive prudence. Asked what they would do if they knew they had passed the exam, the majority said they would pay the deposit immediately. An even larger majority said they would pay the deposit if they knew they had failed (the vacation being a form of consolation). So, in both cases, they would pay the deposit and not throw $15 away by deferring.

The choice to delay in this case seems to reflect the more general belief that to act we require a good
reason. Two possible reasons, equally valid, but different, do not suffice. Even when we know that tomorrow we will have a specific reason and that, whatever it is, it will dictate the same choice, we delay. A real danger is that when tomorrow comes, we may no longer have the opportunity to choose.


Lecture/Discussion Topic: Thinking Errors and International Conflict
You can extend the text discussion of thinking errors as well as illustrate their importance in everyday life with Daniel Kahneman and Jonathan Renshon’s provocative essay, “Why Hawks Win.” The essay anticipates some additional cognitive biases that will be discussed later in the text, including self-serving bias (in the Personality unit) and the fundamental attribution error (in the Social Psychology unit). Kahneman and Renshon’s central thesis is that a bias in favor of hawkish beliefs and preferences is built into the fabric of the human mind.

For example, self-serving bias (the tendency to see ourselves favorably) leads us to exaggerate our strengths. The overwhelming majority of respondents, research indicates, believe they are better than average. The bias leads politicians and generals to accept the judgment of personal advisors who tell them that the war they begin will have a favorable outcome, that is, will be won. In effect, the advisors are confirming the judgments of the politicians and generals. When both sides to a conflict hold to this bias, war is likely.

The fundamental attribution error is the tendency of observers to underestimate the situational causes and overestimate the dispositional (or trait) causes of another’s behavior. In conflict, we are likely to see our opponents’ negative behavior as evidence of their underlying hostility rather than their response to the current situation, including our own negative behavior. The tendency of both sides to view themselves as peace-loving and others as hostile characterizes not only our interpersonal (e.g., marital) conflicts but also international tensions.

Excessive optimism is a third thinking error. We tend to overestimate the likelihood of our future success. As a result, we assume that victory will come easily and swiftly. The suggestion that the Iraq war would be a “cakewalk” is merely the latest in a long string of bad hawkish predictions. Washington elites viewed the first major battle of the U.S. Civil War as a social outing, so certain were they that federal troops would rout rebel forces.

Naturally, pessimism marks our evaluation of our opponents’ prospects. Moreover, we are likely to see any concessions offered by somebody perceived as hostile as an indication of their weakness. This intuition that something is worth less simply because the other side has offered it has sometimes been identified as reactive devaluation.

Finally, our deep aversion to avoid losses may lead us to continue a conflict even when things are going badly. Research indicates that people prefer to avoid a certain loss in favor of a potential loss, even if they risk losing significantly more. Our tendency to be loss averse as well as wishful thinkers can prolong conflict. U.S. policymakers, many analysts would argue, demonstrated this thinking error in the Vietnam War as well as the Iraq War and thus prolonged both conflicts.


Lecture/Discussion Topic: Risks in Everyday Life
Laura Lee’s 100 Most Dangerous Things in Everyday Life and What You Can Do About Them provides a good extension of the text discussion of how we assess risk. Lee notes that human beings tend to overestimate the dangers of rare, vivid events while disregarding the dangers of everyday, commonplace events. Here are a few of the latter that you might present to your students.

1. Books. Each year 10,683 U.S. citizens lose their battle with what the U.S. Consumer Product Safety Commission’s National Electronic Injury Surveillance System calls “books, magazines, albums, or scrapbooks.” Another 1490 are clobbered by magazine racks or bookends. What’s happening? Karen Miller of the American Library Association explains, “I could offer up things like broken toes when books fall, losing one’s balance when reaching for books, and repetitive stress from shelving them. Magazines could also become dangerous if the staples are loose and scrape the skin.” Back injuries from moving overloaded books is common. Heavy school bags are also a problem. In 2003, a Hong Kong schoolboy died when his heavy book bag pulled him over the railing of a high-rise apartment building.

2. Chairs. Chairs are more than 13 times as likely to cause injuries as chain saws. More than 410,000 Americans have seating mishaps each year. Most are injuries from falls as people, for example, lean back too far in their office chairs. Most lower-back pain is caused by long stretches of chair sitting. Five children met their death by unzipping bean bag chairs, crawling inside, and suffocating.

3. Cotton swabs. These bathroom tools send more people to the hospital than razor blades or shavers. Why? Contrary to directions on the package, people use them to clean their ears. Experts claim that using cotton swabs to remove earwax is like using a broom on a dirt floor. You merely move things
around. The swab pushes the gunk farther down
the ear canal where it causes bigger problems. And
between 1992 and 1997, more than 100 people in
the United States experienced a serious ear drum
injury as a result of cleaning their ears with swabs.
4. Hospitals. Deaths attributable to hospital-acquired
infections kill more people annually than car crash-
es and homicides combined. In fact, 1 of every 20
people who enter a hospital leaves with an infec-
tion he or she did not have before. Infections affect
nearly 2 million people each year; between 20,000
and 90,000 die from them.
5. Natural foods. Healthy fruits and vegetables, even
those grown without pesticides, contain cancer-
causing nitrates. The National Academy of Science
reports that 72 percent of nitrate exposure to the
mouth and esophagus comes from vegetables and
only about 9 percent comes from cured meats. The
only difference between processed and organic
foods is that the former have synthetic chemicals
and the latter get their chemicals from nature.
6. Stairs. An estimated 1091 American stair climb-
ers are killed annually and an astounding 769,400
are injured. Missteps can kill you. An extensive
study of stair use revealed that a noticeable mis-
step occurs every 2222 steps. Generally, people
misjudge the distance and plant one of their feet
wrong. It takes just one-quarter of an inch differ-
ce between where the stair is and where you
expect to be to throw you off balance.
7. Staying in bed. Annually, 411,689 people in the
United States experience injuries related to beds,
mattresses, and pillows. How about putting up side
rails, the kind used in hospitals and nursing homes?
From 1985 to 2001, the U.S. Food and Drug
Administration received 479 reports of patients
becoming trapped in hospital beds, and of these,
297 died.

Lee, L. (2004). 100 most dangerous things in every-
day life and what you can do about them. New York:
Broadway Books.

Lecture/Discussion Topic: Perceiving Risk and the Fear
of Global Warming

Ask your students, “How concerned are you about
global warming?” A March 2008 Gallup poll reported
that 75 percent of Americans believe that global warm-
ing has already begun or will begin within their life-
time. Still, only 40 percent believe that global warming
will pose a serious threat to their own way of life, even
though the emerging scientific consensus indicates that
global climate change is likely to have serious conse-
quences for human and animal life.

Elke Weber reports that we use two main
information-processing systems to perceive risk. An
experience-based processing system relates the current
situation to personally or vicariously experienced situ-
ations that have elicited strong emotional reactions. A
vivid image of danger leads to a strong and automatic
response. So, seeing rising flood waters leads a commu-
nity to stack sandbags, an approaching hurricane leads
people to head inland, and a severe electrical storm has
them quickly seek shelter. In contrast, a slower
analysis-based system relates the current situation to
previously processed collections of concrete experi-
ences. These experiences are processed consciously
through a series of learned decision-making procedures
that elicit little emotion. So wearing seatbelts regularly,
learning to quit smoking, and checking our residence
for radon levels are hardly automatic for many of us.
Unlike the experienced-based system, this alternative
system involves a more complex analysis that does not
lead us to respond automatically to a perceived threat.

The global warming crisis seems to be processed
by the analysis-based system. Statistical information
on the dangers of global warming does not elicit vivid
images. In most people’s minds, the causes and effects
of climate change remain unclear. Although we agree
that the atmosphere is warming, we’re not sure how that
change will affect us personally. Even the image of a
polar bear on a melting icecap is an effect that remains
outside most people’s day-to-day experiences.

This analysis suggests that to encourage people
to act to help prevent global warming, experts should
provide more vivid imagery of its effects. Researchers
suggest we can also try to connect the problem with
other problems of concern to most people. For example,
advertisements in the Washington D.C. Metrorail sta-
tions are linking concern for the environment with
concern for the economy. One ad makes the point that
building and operating more windmills, which produce
clean energy, would create more jobs. Finally, people
need to be encouraged to take multiple actions. Weber
has coined the term single-action bias to describe
people’s tendency to take only one action to reduce
the fear they feel when perceiving a risk. For example,
people may feel that if they replace the incandescent
light bulbs in their home with compact fluorescent light
bulbs, they are doing their part to reduce energy use.
They need to know that they can also turn off lights
when they are not in use, turn down the heat in winter
and the air conditioning in summer, use public trans-
portation, ride a bicycle rather than drive, and so on.
Global warming is a complex issue that calls for a vari-
ety of actions.

Mariconti, C. (2009, February). Understanding the dis-
connect on global warming. APS Observer, pp. 16–19.

**Intuition**

*Classroom Exercise: Differences in Thinking Styles*

Seymour Epstein and his colleagues designed the Rational-Experiential Inventory (REI), Handout 8, to measure individual differences in the extent to which people rely on analytical-rational versus intuitive-experiential thinking. The scale and the research associated with it provide an interesting extension of the text exploration of intuition. Items 1–5 of the handout constitute a shortened version of the rational (or “need for cognition”) scale (see Handout 1), and items 6–10 form a shortened version of the experiential (or “faith in intuition”) scale. To score the rational scale, respondents should reverse the numbers they place before statements 1, 2, and 5 (1 = 5, 2 = 4, 3 = 3, 4 = 2, 5 = 1) and then add the numbers in front of the first 5 items. Scores can range from 5 to 25, with higher scores reflecting greater preference for the rational processing of information. To score the experiential scale, respondents should simply add the numbers they give in response to items 6 to 10. Total scores range again from 5 to 25, with higher scores reflecting greater confidence in one’s feelings and immediate impressions as a basis for decisions and actions. The absence of a strong correlation between scale scores suggested that rational and experiential processing are independent.

As Epstein and colleagues note, many psychologists have proposed two fundamentally different modes of processing information about the world. One has been referred to as intuitive, automatic, implicit, or experiential and the other as analytic, effortful, explicit, or rational. For example, cognitive-experiential self-theory (CEST) proposes that we process information through parallel, interactive systems. The rational system operates primarily at the conscious level and is intentional, analytical, primarily verbal, and relatively affect-free. The experiential, on the other hand, is assumed to be automatic, preconscious, holistic, associationistic, primarily nonverbal, and strongly connected with affect. In addition to individual differences in preference for one system over the other, different life problems may call for use of one system instead of the other. Mathematical problems are primarily the responsibility of the rational system, while interpersonal problems are more likely to call for a response of the experiential system.

Epstein and his colleagues examined relationships between the two thinking styles and a number of variables. Among their significant findings have been the following:

- Rational processing seems to be associated with constructive, action-oriented coping, whereas experiential processing is linked with affectively positive, although naively optimistic, thinking patterns.
- Conscientious men tended to be high on rational processing; conscientious women tended to be high on intuitive processing.
- Rational processing was negatively correlated with racist attitudes, depression, anxiety, stress in college life, and alcohol consumption and positively correlated with dominance, self-esteem, satisfaction with health, SAT scores, and GPA.
- Intuitive processing was positively associated with dominance and self-esteem and negatively correlated with depression, anxiety, and stress in college life.
- Rational processing was positively correlated with degree of traumatization and abuse, especially emotional abuse before the age of 16. Perhaps, the researchers suggested, distressing experiences stimulate people to think seriously about their lives. In the absence of such experiences, people may be less likely to develop such an interest.
- Rational and intuitive processing contributed independently to predicting adjustment and thus supported the researchers’ hypothesis that positive adjustment requires the appropriate use of both systems. Rational processing, however, seemed to be a strong predictor of adjustment. This may suggest that people cannot afford to be irrational (to have low rationality), whereas they have more flexibility in their use of intuitive processing.


**Animal Thinking**

*Lecture/Discussion Topic: Do Animals Plan Ahead?*

The text provides several examples of animals’ remarkable capacity to think. For example, apes not only demonstrate the ability to use tools but also the foresight to store a tool that they can use to retrieve food the next day. Recently Mathias Osvath provided additional evidence of animals’ capacity to plan for the future.

Santino, a male chimpanzee at Sweden’s Furuvik Zoo, plans rock-throwing attacks at zoo visitors. He began attacking people at the age of 19, about the time that male chimps become aggressive and seek to establish dominance. Each morning, before visitors arrive, Santino explores his outdoor enclosure looking for small stones. He has also learned to make his own stones by tapping on weak areas of surrounding concrete walls. Sometimes the chimp shapes his
weapons into discs so they sail through the air more accurately. He stockpiles them and waits until midday before throwing them at human visitors who observe him from across the moat that encircles his enclosure. Interestingly, Santino does not attack his fellow chimps, perhaps because he is at ease with his position as group leader. Fortunately, chimps have poor aim and even visitors who have been hit have not suffered serious injury.

Osvath concludes that his observations, as well as those of three caretakers who have worked with Santino for 10 years, “convincingly show that our fellow apes do consider the future in a very complex way. It is very special that he first realizes that he can make these stone missiles and then plans how to use them.”


Lecture/Discussion Topic: Kanzi: A Remarkable Bonobo

Two chimps, Sherman and Austin, have been taught by Duane Rumbaugh and Sue Savage-Rumbaugh to communicate via a computer keyboard. They use geometric symbols called lexigrams, each of which stands for a word. The lexigrams are printed on touch-sensitive plates arranged on a board, which is in turn attached to the computer. Every touch of a symbol by teacher or chimp can be recorded. The chimps have learned to use the board to request such things as food and tools. In addition, when their instructors touch a symbol, the chimps will give the requested item to them. The chimps, however, have learned their lessons very slowly. In fact, it took them three years to understand that the lexigrams were a means of communicating about things that weren’t present.

As noted briefly in the text, Savage-Rumbaugh has reported her remarkable findings from research with Kanzi (which means “treasure” in Swahili), a pygmy chimp, or bonobo, a species related to Sherman and Austin’s species. “Once we began studying the pygmy chimp,” states the researcher, “all the things I learned about how other chimpanzees acquire language disappeared.”

Kanzi spent his first two years in the laboratory with his mother, who was learning to use the lexigrams. When she was removed to breed, he began using the lexigrams spontaneously within a week. Without any specific instruction, Kanzi had apparently mastered the connections between symbols and objects. While Sherman and Austin had learned through reward, Kanzi had learned much like a child, that is, by imitation.

“If Kanzi could learn without instruction, I wondered, why teach?” says Savage-Rumbaugh. From then on, Kanzi learned by going through the ordinary activities of his day while humans spoke in English and pointed to the appropriate lexigrams on the portable boards. Soon he used the lexigrams to request games, treats, and activities. Eventually, he learned to combine two or more symbols to communicate his desires. For example, he asks for “Fire TV” to watch a favorite movie, Quest for Fire. Unlike most chimps, Kanzi can make requests of the form agent-verb-recipient in which he is neither the agent nor the recipient. The requests of other chimps are limited to simple verbs in which the agent is the addressee and the chimp, the recipient. Thus, they have no need to indicate a specific agent or recipient.

Most significant, Kanzi, born in 1980, has been able to demonstrate a grasp of grammatical concepts such as word order. Moreover, Kanzi not only deduces meaning from syntactical structure, he goes beyond the literal meaning of a sentence. When asked to “go to the potty and get the sparklers,” he retrieves the sparklers from the potty rather than first using the potty and then getting them, as a word-by-word decoding of the sentence would mean. Savage-Rumbaugh compared the responses of Kanzi with those of a 2-year-old girl named Alia to commands expressed in 660 English sentences. The sentences combined objects in ways that the two subjects were unlikely to have heard before: “Put the melon in the potty,” or “Go get the carrot that’s in the microwave.” Through most of the experiment, Kanzi’s ability matched that of Alia’s. Eventually, however, the girl’s language skills began to outpace the chimp’s. Kanzi’s grammatical comprehension topped out at the level of a 2½-year-old.

Kanzi’s real significance is that critics are more willing to accept the results as valid because of the careful controls exercised in the studies. For example, a one-way mirror prevented Kanzi and Alia from seeing who gave them commands, and those assessing the performance of the ape and the toddler wore earphones to prevent them from hearing the requests. Each sentence was also entirely new to both ape and child. All these procedures removed earlier concerns that the animals were merely responding to cues from their trainers.

Kanzi’s achievements include tool manufacturing and tool use. For example, he has demonstrated skills as a stone toolmaker and seems quite proud of his ability to flake Oldowan-style cutting knives. He mastered this skill from Nick Toth, an anthropologist with The Stone Age Institute in Bloomington, Indiana. Kanzi’s stone knives are very sharp, and he is able to cut hide and thick ropes with them. The remarkable bonobo has also shown musical skill, having played with Sir Paul McCartney and Peter Gabriel.

Sue Savage-Rumbaugh joined the Great Ape Trust of Iowa, a nonprofit organization that studies the cognitive and communicative abilities of all four types of apes.
great apes—bonobos, chimpanzees, gorillas, and orangutans. She brought a brood of seven bonobos with her, including Kanzi. All seven occupy a new $10 million, 13,000-square-foot home close to Des Moines. Savage-Rumbaugh retired from her position at the Great Ape Trust in 2007, succeeded by William M. Fields, but remains associated with the Trust as Scientist with Special Standing, continuing and expanding her research. Duane Rumbaugh is Scientist Emeritus.

The bonobos are able to cook in their own kitchen, use vending machines for snacks, take walks in the woods, and communicate with researchers through their computer touchscreens. The decor in their 18-room home includes an indoor waterfall and climbing areas 30-feet high. Visitors are permitted, but the bonobos choose through their touchscreens who can actually come into their secured viewing area. Bonobos have a life expectancy of 50 years and they are allowed to mate and have families. Savage-Rumbaugh claims that the animals will develop cultures that will be studied for generations to come.

Researcher Lou Herman suggests that the bonobos’ accomplishments raise basic issues about animal thinking, particularly about the relationship between intelligence and language. “The real question,” says Herman, “is whether language in humans is governed by a language ‘box,’ or is just an expression of our superior cognitive abilities. I believe there are biological mechanisms for human beings to learn language, but they are laid on a larger base of cognitive skill. Many animals may have that underlying base.”

Innovative studies are now probing chimps’ brains for structures and patterns of activity that produce language in humans. For example, at Mount Sinai School of Medicine in New York, neurobiologist Patrick Gannon and his associates have examined the preserved brains of chimps that died natural deaths while in captivity. They were looking for the planum temporale (PT), a small structure in the auditory-association cortex that in humans is used to understand and generate language. In 17 of 18 animals, the PT was larger on the left side of the brain than on the right. A similar pattern is found in most people. Lateralization indicates that the structure has developed a special function. The researchers concluded that “chimpanzees possess the anatomic neural substrate for ‘language’ . . . essentially identical to that of humans.” In studying the brains of living chimps, William Hopkins of the Yerkes Regional Primate Research Center has found exactly what Mount Sinai researchers discovered in cadaver brains—the language-controlling PT is larger on the left side than on the right.

Steven Pinker of MIT observes that although the function of the PT in humans is language, in chimps it might just process and recognize calls. He argues that “just because two computer chips are the same size and have 16 wires coming out of them doesn’t mean they perform the same function. To know that you’d have to look at the wiring diagram inside.” Savage-Rumbaugh is using PET scans to study the brains of chimps Lana and Panzee. Her goal is to see whether areas corresponding to humans’ language circuits turn on when Lana uses lexigrams and Panzee responds to speech. If the brain scans show that doing a linguistic task activates circuits that mere hearing or remembering do not, says Pinker, “that would be interesting.”

More recently, graduate student Janni Pedersen applied linguistic tools normally used to analyze human language to a conversation between a human and a bonobo. Her results indicated that bonobos may exhibit greater linguistic competency in ordinary conversation than in controlled experimental settings.

In her study, Pedersen analyzed a videotaped conversation (made more than 20 years ago) between the bonobo Panbanisha and Sue Savage-Rumbaugh. In the video, Panbanisha was in the forest with Savage-Rumbaugh and an assistant, who had a dog along that Panbanisha didn’t like. Although the bonobo and Savage-Rumbaugh moved from topic to topic in the conversation, Panbanisha repeatedly used the lexigrams to express her wish to be carried by the assistant, who was tending to the dog. Savage-Rumbaugh offered other resolutions. Nonetheless, Panbanisha remained firm. Ultimately, the bonobo prevailed and was carried from the forest by the assistant.

In applying conversational analysis tools, Pedersen claimed that language is more than the simple act of transferring information. Rather, it is a conversational interaction between active participants. Pederson reports that linguistic aspects of the conversation included turn taking, negotiation, pauses, and repetition. It went far beyond information sharing made possible through the use of lexigram symbols.

“Panbanisha was using language to get at what she wanted,” Pedersen said. “She is very, very clever and is fully capable of following the conversation the same way a human does. This tells me that Panbanisha’s knowledge of language is far beyond understanding the words, to understanding how to use them in a conversation to get what she wants.”


**Language**

*PsychSim 5: Dueling Brains*

This activity is appropriate for use here or in conjunction with the text discussion of hemispheric specialization. It opens with a brief review of research on left-hemisphere specialization for language and then presents a simulation of a classic word recognition experiment that typically demonstrates a right visual field advantage in identifying words.

**Lecture/Discussion Topic: Vanishing Languages**

In introducing the topic of language, you might present the following facts provided by Worldwatch Institute (cited in Loviglio, 2004), which your students are likely to find both interesting and important.

- Linguists estimate that 6800 languages exist in the world today (about one dies out every two weeks).
- 250 languages are spoken by more than 1 million people. Eighty-three languages are spoken by 80 percent of the world’s people. About 3500 languages are spoken by 0.2 percent of the world’s population.
- Only 600 languages have speaking populations robust enough to support their survival past the end of the century. Languages need at least 100,000 speakers to survive the ages, reports the United Nations Educational, Scientific, and Cultural Organization.
- 66 percent of the world’s children are raised as bilingual speakers.
- Only 6.3 percent of U.S. residents are bilingual.

In snapshots of language losses worldwide, Worldwatch Institute reports the following:

- Eighty percent of the 260 native languages still spoken in the United States and Canada are not being learned by children. Eyak, native to the coast of Alaska’s Prince William Sound, had one remaining speaker—88-year-old Marie Smith, who lamented “It’s horrible to be alone. I have a lot of friends. I have all kinds of children, yet I have no one to speak to” in Eyak. Marie died on January 21, 2008.

- In South America, hundreds of languages died as a result of the Spanish conquest. Of the remaining 640, 80 percent are spoken by fewer than 10,000 people. Many languages from the Amazon region have fewer than 500 speakers. Arikapu has only six.
- In Africa, the birthplace of nearly a third of the world’s languages, 54 are believed dead and 116 more are nearing extinction.
- In Europe, nearly 90 percent of Russians speak Russian, the language enforced during the Soviet era. As a result, most of the country’s 100 other native languages, most of them Siberian, including Udihe, are near extinction.

K. David Harrison, a Swarthmore College linguist, is co-director of the Enduring Voices project, a collaboration between the National Geographic Society and the Living Tongues Institute for Endangered Languages of Salem, Oregon. In attempting to assemble the latest statistics on global language loss, Harrison and his colleagues are taking a geographic approach, identifying those areas in the world where languages are disappearing the fastest. They have identified five language hotspots, including Oklahoma (along with parts of Texas and New Mexico); northern Australia; central South America (Ecuador, Colombia, Peru, Brazil, and Bolivia); Northwest Pacific plateau (Washington, Oregon, and British Columbia); and eastern Siberia.

Three factors were important in identifying the “hotspots”: The diversity of languages spoken, the number of living speakers (including their ages), and the extent to which the languages have been documented. In these hotspots, alternative colonial languages such as English, Spanish, or Russian are considered more prestigious, and children quickly learn which one is better.

As languages disappear, notes Harrison, we lose a treasure trove of ecological insights, culinary and medicinal secrets, and cultural histories. For example, in Brazil only 4000 people speak Kayapo. The language distinguishes among 56 types of bees. The information will be lost to biologists if the language disappears.

The Enduring Voices project sends researchers to find and document the remaining speakers of languages in critical condition. In certain cases, the last available information about the language is 30 to 40 years old, reports Harrison, “so just establishing that there are speakers is a scientific finding.” And for undocumented languages, just collecting the 100 most common words is a big step. Interestingly, Harrison reports that “Eighty percent of the world’s languages have not been documented, so if they disappeared tomorrow, we wouldn’t know anything about them.”

Harrison has traveled to central Siberia to study the language of the Middle Chulym, a small hunter-gatherer community living in a half-dozen villages.
Steven Pinker. Although not an exhaustive list, the "crown of cognition," according to cognitive scientist language but also show how it "is the jewel in the shared by all languages. They not only help to define Mark Ashcraft identifies a number of characteristics out documenting it, it leaves a huge gap in our under ken in the world. Every time we lose a language with decline in the number and diversity of languages spo perfect." Harrison. The writing system was "so clever, so recreate it for Harrison. "It was stunning," reported erers, he destroyed it. Nonetheless, he has been able to in a hunting journal. When ridiculed by fellow villag made Russian their sole spoken language for a variety of reasons. In fact, they conclude that their ancestral language is inferior, even embarrassing, and so it is no longer taught to their children.

Middle Chulym was not a written language with the exception that the community’s 52-year-old speaker once created a writing system that he used for two years in a hunting journal. When ridiculed by fellow villagers, he destroyed it. Nonetheless, he has been able to recreate it for Harrison. “It was stunning,” reported Harrison. The writing system was “so clever, so perfect.”

Harrison concludes, “There is a catastrophic decline in the number and diversity of languages spoken in the world. Every time we lose a language without documenting it, it leaves a huge gap in our understanding of the complex structures the human mind is capable of producing.”


Weise, E. (2007, September 19). Researchers speak out on languages on the brink of extinction. USA Today, p. 7D.


**Lecture/Discussion Topic: Universals of Language**

Mark Ashcraft identifies a number of characteristics shared by all languages. They not only help to define language but also show how it “is the jewel in the crown of cognition,” according to cognitive scientist Steven Pinker. Although not an exhaustive list, the following are among the most important features of language.

1. **Semanticity.** The sounds of human language convey meaning. Other sounds we make, such as coughing or clearing our throats, are not part of our language because they do not usually convey meaning.

2. **Arbitrariness.** There is no inherent connection between the symbols in a language and the meanings they convey. For example, the word *dog* bears no inherent resemblance to the four-legged furry creature named by the word. Whale is a small symbol for a very big thing; *microorganism* is just the reverse. Knowledge of a language must involve knowing the arbitrary connections.

3. **Flexibility of symbols.** The principle of arbitrariness makes the connection between symbol and meaning changeable and “inventable.” We rather routinely shift our terms for the objects in our world. Early in this century we called cars *automobiles* but that is now a rather archaic term. People also used to play “LPs on their hi-fis.”

4. **Naming.** A corollary to arbitrariness and flexibility is naming. We assign names to all the objects in our environment, to all the feelings and emotions we experience, and to all our ideas and concepts. As students look around the room, each object has a name. In a strange setting, we may not know the name of everything, but it never occurs to us that something might therefore not have a name. We are constantly generating or inventing names for the new objects and ideas we need to talk about. Imagine how meaningless the sentence, “I am texting on my cell phone,” would have sounded 50 years ago.

5. **Displacement.** Language enables us to talk about something other than the present moment. By means of verb constructions denoting past and future we can talk about things that are not present but are remembered or anticipated.

6. **Productivity.** This feature, also referred to as generativity, is perhaps the most notable characteristic of language. Aside from customary greetings and perhaps some trite phrases, our utterances are ever new. We *generate* sentences rather than repeat them. Language is a creative system as opposed to a repetitive system. The number of possible sentences in a language is infinite. The novelty of language and the productivity it implies formed the basis of Chomsky’s critique of Skinner’s work.

Language Development

Lecture/Discussion Topic: Language Development
Ronald Macaulay discusses the interesting complexity of language development in his fascinating book *The Social Art*.

Macaulay notes that children do not learn language totally anew, nor do they learn it like a parrot by memorizing complete utterances. Rather, in the early stages, they do a little of both. What they say is clearly related to adult language and yet is not straightforward imitation, as seen in the following examples: “Her got hurt in the face,” “I didn’t do it,” “Anybody isn’t here,” “Wear mitten no,” “Salt all shut,” and “Is it was a snake?”

Children seem satisfied with a rough approximation of adult language and do not attempt to perfect any single utterance before moving on to the next. If they did, they would be limited in the topics they could talk about and would never become fluent speakers of the language. Linguistic competence refers to the ability to produce and understand utterances we have never heard before. Macaulay illustrates with the following sentence: “Karl Marx was playing bridge with Abraham Lincoln, Winston Churchill, and Mary Queen of Scots when Tarzan walked in.” No listener has ever encountered this sentence before, but anyone who speaks English would immediately understand it.

Children also learn that language is both systematic and creative. Language is both rule-governed and infinitely adaptable to new situations. Macaulay illustrates each characteristic with an example.

To illustrate the systematic nature of language, he says, consider the following numbers and then try to recall them: 3, 9, 2, 7, 8, 1, 2, 4, 3, 7, 2, 9, 2, 1, 8, 7. You probably will recall only seven digits. However, if you rearrange the numbers to read 3, 9, 27, 81, 243, 729, 2187, you’ll be able to recall them all. The sequences of digits is produced by multiplying the first number by itself and then multiplying the answer by the original number, and so on. Once the rule becomes clear, it’s possible to recognize and repeat even longer sequences of digits. Similarly, we are likely to find an utterance in an unfamiliar language difficult to repeat because we do not know the rules by which it is organized. Once we learn the rules, the problem disappears.

The creative nature of language is apparent from Handout 9, the Simple Language Device (SLD). The rules are simple. Choose one word or phrase from column A and combine it with one word or phrase from columns B to F and you will automatically produce a sentence. With a total of only 54 alternatives, the SLD has the capacity to produce 531,441 sentences. Although the sentences may not be very believable, they are grammatical. The SLD has only a small number of words and one rule for combining them. Adult language has a much larger number of words and quite a few rules for combining them into acceptable utterances. This is the challenge that confronts infants as they begin the long task of becoming fluent speakers of the language spoken by those around them.


Classroom Exercise/Lecture Break: Observing Language Development
To give students a better sense of children’s language development, you might want to show video clips of children at different ages. About one week before the class meeting in which you plan to cover this topic, ask your class for a couple of volunteers who might be willing to share some videos of themselves or their children when they were very young. Ideally, the children will be younger than 3; it would be best to get two or three clips of the same child at different ages (at least a few weeks apart in age). The clips should include the child speaking for at least a few seconds. The context for the child’s speech needs to be included in the clip, and the child’s speaking must be recorded clearly enough that it will be understood when played through your classroom speakers. A good estimation of the child’s age is also necessary. You should review all videos that are submitted to you to check for appropriateness of content, length, and so on before showing them to the class. If you do not receive good candidates for presentation from your students, you might go through your own home movies, or search YouTube and other video archives on the Internet for examples.

Before showing the video clips, review the text summary of milestones in language development. Then, ask students to pretend that they are language development researchers conducting observational research on children. Have them “code” the linguistic utterances of the child being observed and write a brief summary of their findings. Remind students that they should first identify and operationally define the landmarks they will be watching for (a nice opportunity to review the features of good research design principles!). Students can work alone, or they can work together in small groups. When you have played all the videos and students have had a chance to code their observations, you can review their findings, taking advantage of the opportunity to discuss issues of interrater reliability and other important methodological issues.

Lecture/Discussion Topic: Hearing Loss
To supplement the text, ask if any of your students suffer hearing loss. Eighteen-year-olds are past the age of childhood ear infections that can adversely affect hearing but are still too young to be suffering the effects of...
aging. Assuming that 18-year-olds should have the best hearing around, researchers in the 1930s and 1950s tested them to set the standard for what the human ear can hear. By 1969, the summer of Woodstock, audiologist David Lipscomb found that one-third of the incoming freshmen tested at the University of Tennessee showed signs of hearing loss. One in eight male students had damage severe enough to interfere with communication. (A more recent study found that although many college students think their hearing is good, up to one-fourth of them may actually suffer some hearing loss. The new finding appears in the International Journal of Audiology.) Researchers suspect that loud music is the culprit, but the most recent sample was very small and the researchers feel that additional research is warranted to determine the relationship between hearing loss and sound sources. Live concerts commonly reach sound levels above 120 decibels—louder than a jackhammer or chain saw. According to standards set by the Occupational Safety and Health Administration, exposure to sound levels of 85 decibels (comparable to the sound of a food processor) eight hours a day, five days a week, will eventually cause permanent hearing loss in most people. For each five-decibel increase, the time it takes to cause lasting injury drops by half. At 120 decibels, some damage can result in a relatively short time.

One ear specialist suggests the following do-it-yourself test for hearing: Hold your hand up to your shoulder as if you’re taking a courtroom oath, then rub your thumb and forefinger together. If you don’t clearly hear a high-pitched “scratching” sound, you may have some hearing loss in that ear. Students can find out if they should consider an audiology exam by taking the hearing test provided at www.freehearingtest.com. It’s important that the test be taken in a quiet place since it involves faint tones delivered to each ear. The test is not perfect and is best at identifying hearing loss at middle and low frequencies. Students who fail the test should try again in a day or two since our ears vary in sensitivity from day to day. Nearby noise or static on the line may also interfere with the recording.

More than 36 million Americans (more than 500 people worldwide) suffer some hearing loss, making this the most common physical disability. In industrial societies, people gradually lose sensitivity to high frequencies, a condition called presbycusis. This selective, high-frequency deafness begins at a very early age. According to one survey, most 30-year-olds are unable to hear frequencies above 15,000 Hz; by age 50, hearing beyond 12,000 Hz is lost. By 70 years of age, the cutoff value falls to 6,000 Hz, a value within the range of normal speech. At every age, men exhibit a greater degree of hearing loss than do women. While some researchers believe that the cumulative effects of loud noise account for this steady hearing loss, others believe it is the result of age-related changes in the cochlea that restrict the blood supply to the delicate neural elements in the inner ear.

Contemporary sources of hearing loss range from the wars in Iraq and Afghanistan to personal listening devices. The U.S. Army estimates that battle sounds, including exploding bombs and rifle and machine gunfire, have left one in four veterans with damaged hearing. Clearly, it is one of the most common ailments that affect troops. Evidence also mounts that the popularity of MP3 players and iPods is significantly increasing the problem of hearing loss, even in children. Audio output of these personal listening devices ranges from about 60 decibels to 120 decibels. “Using earphones for hours at high volumes causes ‘shock and awe’ to delicate hairlike cells deep within the inner ear that help the brain process sound,” states Ron Eavey, director of the University of Oregon, suggests that tinnitus is the third worst thing that can happen to us, ranking only below intractable severe pain and intractable severe dizziness. In its severe forms, tinnitus is totally incapacitating, making it impossible for people to concentrate enough to complete a task. Some people gain relief by using a tinnitus masker; worn like a hearing aid, it produces a sound like a waterfall or the hiss of an FM radio tuned between stations.

Ringing in the ears, or tinnitus, affects more than 36 million Americans. Although the most common cause is exposure to loud noises, the disorder may also be produced by certain drugs, ear infections, or food allergies. Jack Vernon, director of the Kresge Hearing Research Laboratory at the University of Oregon, suggests that tinnitus is the third worst thing that can happen to us, ranking only below intractable severe pain and intractable severe dizziness. In its severe forms, tinnitus is totally incapacitating, making it impossible for people to concentrate enough to complete a task. Some people gain relief by using a tinnitus masker; worn like a hearing aid, it produces a sound like a waterfall or the hiss of an FM radio tuned between stations.


**Lecture/Discussion Topic: A Quiet World—Living With Hearing Loss**

In his book *A Quiet World*, text author David Myers gives a personal account of his mother’s and now his own personal challenge in dealing with hearing loss. It’s a book you will want to recommend to your students.

In diary fashion, Myers relates the problems at home and at work that accompany gradual hearing loss. He recounts errors tragic and humorous. Both from his personal experience and his expertise as a research psychologist, he helps readers understand the impact of the impairment on sufferers and on those closest to them. As Paul Chance observes, Myers helps his audience appreciate how the inability to hear can become the inability to connect. Myers’ later journal entries describe, for example, his encounters with new technologies and insights into the nature of hearing. An appendix provides a host of helpful resources for the hard of hearing.

Of special note is the chapter on “Aids and Advice.” Myers passes along these specific tips for friends, colleagues, and family members.

1. **Invite us to a quiet place**, for example, a room without loud music, a carpeted restaurant, a chair away from the air conditioning.
2. **Capture our attention**. If we are reading or watching television, make certain we’re looking at you.
3. **Face the light and face us**. Since we all do some lipreading, it helps to see your mouth. And don’t conclude that we are rude if we look at your mouth rather than your eyes.
4. **Rephrase**. If we don’t seem to hear it, restate it. Try using different words to express the same thought. Change “Do you want something from the store?” to “Can I get you something at Safeway?”
5. **Create a context**. Help us to know the subject. Have a printed agenda for meetings, use visual aids. Caller I.D. is a blessing for us.
6. **Speak slowly**. Don’t holler, but enunciate each word with pauses between phrases and sentences.
7. **Ask us if we have heard**. Remember, we don’t like to seem inept or to embarrass both of us by volunteering that we did not hear.


**Lecture/Discussion Topic: Talking With Our Hands**

What role do gestures play in communication? Susan Goldin-Meadow reviews important research on this interesting question.

Goldin-Meadow introduces the interesting case of a Deaf child who was obviously unable to acquire spoken language and whose hearing parents chose not to expose her to a signed language. We might imagine that such a child would be unable to communicate. However, the child did communicate. She gestured. For example, reports Goldin-Meadow, when shown a picture of a snow shovel, she produced gestures for dig, snow-falls, and pull-on boots. In addition, she pointed outside and downstairs. That is, the child conveyed several propositions about snow shovels including how, when, and where they are used, as well as where they are stored. Gestures assumed the function of language including many of its formal features such as segmentation (separate gestures to represent objects and the relations among them), combination (combining those gestures in a structured manner), and recursion (producing more than one proposition within a single gesture sentence).

Goldin-Meadow cites these additional intriguing research findings on gestures:

- Studies of profoundly deaf children who have mastered neither oral nor sign language indicate that they spontaneously use gestures to communicate. These gestures show many of the structural properties of natural language including a description of events that are not taking place in the here and now.
- Gestures that accompany speech in hearing persons do not assume a languagelike form. However, they convey information in their own right and may offer insight into a speaker’s unspoken thoughts. Listeners pay attention to these gestures and respond accordingly.
- Adults who are asked unexpectedly to communicate only with their hands display gestures with languagelike properties much like the communication of the deaf children. The appearance of these properties is intriguing in that they are not found in the gestures that speakers routinely produce when they talk.
- The gestures that children make as they learn a challenging task reflect their knowledge of the task. Some children’s gestures match or duplicate their speech; other children’s gestures express ideas that go beyond their speech. When all the children are then given further instruction in the task, those whose earlier gestures went beyond their speech seemed to profit most from the additional instruction.
• A teacher’s gestures may promote learning. For example, following a carefully prepared script, an experimenter taught children a correct strategy for solving a math problem. In some cases, no gestures accompanied the spoken instruction; in other cases, gestures provided the same information that was spoken; and in still other cases, the gestures provided information (including strategy) that went beyond the spoken words. Children who were taught with gestures that went beyond spoken language proved most successful.

• Children may imitate the gestures that a teacher produces. Those who do are more likely to succeed after instruction than are children who do not imitate.

Goldin-Meadow concludes: “Gesture offers insight into the basic capacity we have for structured communication when produced without speech and into how we think when produced with speech. The time is ripe to take advantage of our hands.”


The Brain and Language

Lecture/Discussion Topic: The Smart-Talk Syndrome

Williams syndrome can be discussed in connection with the brain and language or as part of the relationship between thought and language. Educational psychologist Eleanor Semel captured the unique challenge that faces those teaching children with Williams syndrome:

Educators are confused because the Williams syndrome child tests like the retarded child, talks like a gifted child, behaves like a disturbed child, and functions like a learning-disabled child. Each of these terms has a specific meaning in the world of special education, yet none seems to fit the characteristic peaks and valleys in Williams syndrome. The result is that children with Williams syndrome are generally not well served by schools.

This intriguing disorder is a form of mental retardation marked by the preservation of linguistic functioning in the face of severe cognitive deficits. In a sense, it could be labeled language without thought. Williams syndrome, a rare genetic disorder occurring in as many as 1 in 7500 births, seems to contradict the common assumption that certain cognitive abilities are prerequisites to language development. First identified in 1961, Williams syndrome results when a group of genes on one copy of chromosome 7 is deleted during embryonic development.

Neurophysiologist Ursula Bellugi is presently studying victims of Williams syndrome at the Salk Institute for Biological Studies in La Jolla, California. Having low IQs (in the 50s), these people are unable to read, write, dress themselves, or cross the street without help. They typically have trouble remembering the routines of daily life. They can’t copy a figure as simple as a triangle, nor have they mastered Piaget’s principle of conservation. At the same time, they can string complex vocabulary words into complex, elegant sentences. Bellugi has observed appropriate use of such infrequently used words as surrender, sáuté, nontoxic, commentator, and brochure. When asked to name all the animals he could think of, Ben, a 16-year-old with an IQ of 54, named such animals as the buffalo, saber-tooth tiger, condor, and vulture. When treated in an emergency room for a broken toe during the Special Olympics, he spontaneously asked the doctor, “Are you going to use novocaine, xylocaine, or procaine?”

Crystal, another victim of Williams syndrome, described her career plans this way: “You are looking at a professional book writer. I am going to write books, page after page, stack after stack. I’m going to start on Monday.” Putting the finishing touches on her drawing of an elephant she pointed to the mouth, trunk, and ears: “Fan ears,” she said, “ears that can blow in the wind.” However, the drawing itself is unrecognizable, having crude lines and blobs strewn over the page.

The eloquent statements do not seem to reflect deep, insightful thinking. The children may give a detailed account of how to cross a street safely and then blindly walk into busy traffic. They may correctly identify all the contexts in which the word “contagious” is used; yet, when asked to choose the most common definition—easily— they may score as poorly as children with Down syndrome. Says Bellugi, “They can tell you an enormous amount in very complex grammar without getting to the point.”

Bellugi’s studies suggest that the brain deals with elements of language, including grammar and syntax, separately from the rest of thinking. Some researchers believe that those with Williams syndrome may be able to pull themselves up by their linguistic bootstraps. For example, to boost their concentration, Orlee Udwin teaches those with Williams syndrome to rehearse verbally: “I must sit still. I must pay attention.” The technique seems to help focus the attention of the typically hyperactive children.

Bellugi initially hypothesized that Williams might damage the right hemisphere of the brain where spatial tasks are processed while leaving language in the left hemisphere intact. However, subsequent research indicated that people with Williams excel at recognizing faces, a task that utilizes the visual-spatial skills of the right hemisphere. By using functional brain imaging Bellugi also found that in those with Williams, both hemispheres carry the task of language.
Research has focused on the neocerebellum, a part of the brain that is enlarged in people with Williams. Among the brain’s newest parts, the neocerebellum appeared in human ancestors about the same time as did the enlargement of the frontal cortex. Interestingly, this same brain structure is significantly smaller in people with autism, who are generally antisocial and poor at language, just the reverse characteristics of those suffering Williams syndrome. On the other hand, researchers have found that the posterior forebrain areas (posterior parietal lobe and occipital lobe) are quite small in those with Williams syndrome, which may explain their visuospatial deficits. They have also found cellular anomalies, such as exaggerated horizontal organization of neurons, particularly in striate cortex; an increased density of cells throughout brain areas; and abnormally clustered neurons.


Language Influences Thinking (and Vice Versa)

**Lecture/Discussion Topic: The Vocabulary of Taste**

In his wonderful book *Blink*, Malcolm Gladwell describes the skills of professional food tasters Gail Vance Civille and Judy Heylmun who run a New Jersey company called Sensory Spectrum, which now also has a facility in Kannapolis, North Carolina. Before they introduce a new product, many food companies call on these two experts for their advice.

As Gladwell explains, part of the success of expert food tasters, such as Civille and Heylmun, is that they have learned a vocabulary that allows them to describe their specific reactions to foods. So mayonnaise is evaluated along 6 dimensions of appearance (color, color intensity, chroma, shine, lumpiness, and bubbles), 10 dimensions of texture (adhesiveness to lips, firmness, denseness, etc.), and 14 dimensions of flavor split among 3 subgroups—aromatics (eggy, mustardy, etc.), basic tastes (salty, sour, and sweet), and chemical-feeling flavors (burning, pungent, astringent). Each factor is evaluated on a 15-point scale. Or take cookies. Heylmun explains, “We just did Oreos and we broke them down into 90 attributes of appearance, flavor, and texture.” Re-creating in her mind what an Oreo feels like, she concluded, “It turns out there are 11 attributes that are probably critical.”

This points to the importance of a specific vocabulary to describe our opinions or reactions. Without the right words, we can’t make ourselves clearly understood. For example, ask your students, “Can you describe the difference between Coke and Pepsi?” It’s very difficult. Expert food tasters like Civille and Heylmun use what they call a DOD (degree-of-difference) scale that goes from 0 to 10 to compare products in the same category. Two things that are totally different are assigned a 10, whereas a 1 might describe the difference between two batches of the same product. Coke and Pepsi are only a 4. In fact, the difference is even less if the colas have aged or lost some of their carbonation.

What this means is that if we are asked to give our thoughts about Coke and Pepsi, typically our responses are not very useful. At most we make some vague and general comments about sweetness or level of carbonation. Only an expert taster will pick up on the subtle nuances that distinguish these soft drinks.

This can be demonstrated quite remarkably with a simple test (you might try it in the classroom or assign it as an out-of-class student project). Although people may be able to detect the difference between Coke and Pepsi (in fact, even correctly identifying each product) with Coke in one glass and Pepsi in another, they perform at chance when there are three glasses, two filled with one of the colas and the third with the other. As Gladwell explains, in the beverage business, this is called the triangle test. For this test, the person does not have to identify which is Pepsi and which is Coke but simply has to tell which of the three drinks is not like the other two. Just over one-third of nonexperts can identify the odd glass, which is little better than chance.

The explanation for the difference between the two-versus-three-beverage test is that with two colas, one only has to compare two first impressions. With three colas, one has to be able to describe and hold in memory the taste of the first and second in comparing them with the third. That requires knowledge and understanding of the vocabulary of taste. In contrast to nonexperts, Heylmun and Civille have no problem passing the triangle test.


**Lecture/Discussion Topic: Think Before You Speak**

Sometimes, language seems to interfere with thought. Although we are often advised to “talk through” a problem, Jonathan Schooler and his colleagues reported that verbalization can interfere with insight problem solving. Present the following insight problem suggested by Schooler to your class:

A giant inverted steel pyramid is perfectly balanced on its point. Any movement of the pyramid will cause it to topple over. Underneath the pyramid is a $100 bill. How...
would you remove the bill without disturbing the pyramid? (p. 183) (The insight is that the bill can be removed by destroying it, that is, by tearing it, burning it, etc. The obstacle is that we think only in terms of preserving the bill.)

Ask your students to think about the problem for a few minutes, then write down in detail everything they can remember about how they tried to solve the problem—from strategy to any solutions they considered.

When research participants were asked by Schooler and his colleagues to do this in solving a series of insight problems, they actually solved 30 percent fewer problems than those who were not asked to explain themselves. The investigators speculate that the verbalization may cause nonreportable aspects of a task to become overshadowed by those that are more readily reported. Solutions to insight problems occur suddenly, suggesting that the critical steps leading to the solution are unavailable for conscious inspection. “It’s the same kind of paralysis through analysis that you find in sports contexts,” suggests Schooler. “When you start becoming reflective about the process, it undermines your ability. You lose the flow. There are certain kinds of fluid, intuitive, nonverbal experiences that are vulnerable to this process.”

In contrast, verbalization would not be expected to interfere with noninsight problems because they involve a series of incremental steps, each of which is separately reportable. In fact, verbalization may facilitate our solving such problems.


Lecture/Discussion Topic: The Impact of Language on Thought

Beth Azar reviewed research that shows how language influences how people think about and approach the world. In contrast to the Romance languages, English and German languages have many different “manner” words, that is, words that describe the manner in which people and objects move. She reported that Dan Slobin found that one result of this language difference is that English and German speakers pay much more attention to the manner in which people and objects move—for example, wriggling, jogging, or bounding—than do people who speak French or Spanish.

A language’s structure also seems to influence children’s cognitive development. Alison Gopnik and Soonja Choi studied groups of American and Korean children as they learned their first words. Korean emphasizes verbs much more than does English, and this is reflected in how mothers speak to their babies. One result is that English-speaking children learn more nouns as their first words and Korean children learn more verbs. To assess how this difference in language development might affect cognitive development, Gopnik and Choi compared and contrasted children’s understanding of tool use (involving more verbs) and object categorization (involving more nouns), two skills that develop at the same time that children are developing language. Results showed that children in the two language groups had opposite patterns of development. The Korean children consistently solved tool-use problems before the English-speaking children did, and the English-speaking children consistently solved object-categorization problems before the Korean children.

“It wasn’t that the English speakers were better than the Korean speakers, or vice versa,” said Gopnik. “There was something specific about the particular areas of development which seemed to be linked to the particular languages the children were exposed to.” Children’s ability to solve the cognitive problems was linked in time to their word acquisition. They learned to solve a tool-use problem a couple of weeks after learning a word relevant to tool use. Similarly, children began to sort objects a couple of weeks after a huge increase in the number of nouns they knew. The pattern was the same for both groups: Which one came first depended on the language they learned. Gopnik concluded, “The kinds of language the children were using seemed to be influencing the kinds of cognitive tasks they were solving and when they were solving them.”


Lecture/Discussion Topic: New Words

Although language influences our thinking, thinking also affects our language. New words provide an excellent example. As the text notes, new words and new combinations of old words express new ideas. In *The Stuff of Thought*, Steven Pinker suggests that we need merely examine the jargon of a given specialty, from photography to skateboarding, to appreciate that “lexical suppliers will step up to meet a demand.” Even casual computer users have a vocabulary unknown to most people a generation ago: modem, reboot, RAM, upload, browser, and so on.

Alan Metcalfe, a past president of the American Dialect Society, uses the acronym FUDGE, to explain how new words make it into the language: Frequency, unobtrusiveness, diversity of users and situations, generation of other forms and meanings, and endurance of the concept help us to understand why some new words
make it while others fall by the wayside. The more a word is used by many people in a variety of situations, the tendency of the word to generate new forms, and the endurance of the concept that the word represents increase the probability it will find a permanent place in our language.

Still, Pinker notes, many gaps in our language simply refuse to be filled. He observes that we have no word for the first decade of the twenty-first century or for unmarried homosexual partners. We have had enormous difficulty finding a gender-neutral third-person pronoun to replace he or she despite no shortage of suggestions (e.g., na, shehe, thon, herm). Yet none has made an inroad. We have no term for one’s adult children nor a collective term for one’s nephews and nieces. There’s no word for the parents of a child’s spouse (as in the Yiddish machetunim). We should have a word for disgusting lumps of brown snow that accumulate behind a car wheel and fall onto the garage floor, as well as for the early-morning insomnia in which our bladder is too full to fall back to sleep while we are too tired to get up to empty it.

Pinker notes that an entire genre of humor has developed to fill the gaps in our language. Comedian Rich Hall uses the word sniglet for a word that should exist but does not. See if your students identify with a few of his examples. How about elbonics for the actions of two people maneuvering for one armrest in a movie theater, or peppier for the waiter in a fancy restaurant whose sole purpose is to ask diners if they want ground pepper? Could we use furbling to refer to wandering through a maze of ropes at an airport or bank even when you are the only one in line? Finally, we might use phonesia to refer to the experience of dialing a phone number and suddenly forgetting whom you were calling just as the person answers.

More simply, the Washington Post Style Invitational Column asks readers to fill a word gap by changing one letter in an existing word. Here are a few to share with your students:

Sarcasm: the gulf between the author of sarcastic wit and the person who does not get it

Hipatitis: terminal coolness

Dopeler effect: the tendency of stupid ideas to seem smarter when they come at you rapidly

Beelzebug: Satan in the form of a mosquito that gets into your bedroom at three in the morning and cannot be cast out


Classroom Exercise: Doublespeak

William Lutz’s national bestseller Doublespeak provides an excellent extension of the text discussion of linguistic influences on thinking. Doublespeak, writes Lutz, is language designed to alter our perception of reality and to corrupt our thinking. Handout 10 gives students practice at translating doublespeak (the items vary in difficulty, and you may want to have students work in groups). The answers are: 1. tax increase; 2. lies; 3. greeting cards; 4. acid rain; 5. newspaper carrier; 6. toothbrush; 7. death; 8. elevator operators; 9. recession; 10. neutron bomb; 11. car mechanic; 12. first strike, or invasion; 13. school desk; 14. cemetery plot; 15. thermometer.

Although doublespeak is sometimes humorous and relatively harmless—for example, labeling a car mechanic an automotive internist—at other times it is used to avoid responsibility, to make the bad seem good, the negative positive, the unpleasant attractive. Lutz suggests that doublespeak has four different forms.

The first is the euphemism, an inoffensive or positive word or phrase used to avoid a harsh, unpleasant, or distasteful reality. Thus, a tax increase becomes revenue enhancement, lies become inoperative statements, and neutron bombs become radiation enhancement devices.

Jargon is a second kind of doublespeak. It is the specialized language of a trade or a profession, such as medicine, law, engineering, education, or auto mechanics. Although jargon can provide a kind of verbal shorthand that allows group members to communicate efficiently, it can also be pretentious and obscure to those outside the group. The act of smelling becomes “organoleptic analysis,” glass becomes “fused silicate,” and a crack in a metal support beam becomes a “discontinuity.”

Gobbledygook or bureaucratese is a third form of doublespeak. This is simply a matter of piling on words, or overwhelming the audience with long sentences. Sometimes it is merely the product of carelessness or sloppiness. Other times it is carefully designed and constructed to appear to communicate when in fact it doesn’t. As a vice-presidential candidate, Dan Quayle explained the need for a “strategic defense initiative” by saying, “Why wouldn’t an enhanced deterrent, a more stable peace, provide a better prospect to denying the ones who enter conflict in the first place to have a reduction of offensive systems and an introduction to defensive capability? I believe this is the route the country will eventually go.”

The fourth kind of doublespeak is inflated language that attempts to make the ordinary seem extraordinary,
to make everyday things seem impressive, to make the simple complex. A toothbrush becomes an oral hygiene appliance and a thermometer becomes a digital fever computer. Elevator operators become the vertical transportation corps and gravediggers become internment excavators.

Since Doublespeak was published, Lutz has gone on to write The New Doublespeak (1996) and other related books, which your students may be interested in reading.


Classroom Exercise/Critical Thinking Break: Verbal Information Can “Overshadow” Memory

This exercise was recommended in the Memory unit of these resources in relation to the effect of verbal information on memory. Research has found that in certain circumstances giving detailed verbal descriptions of certain types of objects and visual events can actually impair our ability to remember them accurately. This phenomenon is known as verbal overshadowing. If you did not use this material earlier, you may want to do so now as you discuss language.

Thinking Without Language

Podcasts: Thought With(out) Language?

Part 1:
Radiolab is a biweekly radio program produced by WNYC and heard across the country on public broadcasting stations. The episodes, hosted by Jad Abumrad and Robert Krulwich, are witty, insightful, and focused on understanding and informing the public about interesting (even intriguing) scientific issues and phenomena.

Radiolab produces podcasts from the weekly episodes. The podcasts are available as free downloads from iTunes as well as directly from their website (www.radiolab.org); they vary in length from about 6 minutes to more than an hour (depending on the topic and purpose of the episode). They are produced with high production value (lots of sound effects, music, suspense); you and your students will enjoy listening to them as well as learning from them.

One Radiolab episode, “Words” (1:00:07 hours, aired August 9, 2010), explores the concept of life without words. The hosts and guests discuss various topics, such as signing by Deaf people, loss of language after a stroke, and a new language that emerged among Deaf children in Nicaragua when they were grouped together for the first time to attend school in 1978. A short “bonus video” (length: 3:05) was produced to complement this episode; a link to it is posted on the Radiolab website at www.radiolab.org/blogs/radiolab-blog/2010/aug/09/bonus-video-words.

You might want to recommend that students read an interesting story titled The Writer Who Couldn’t Read (June 21, 2010, www.npr.org/templates/story/story.php?storyId=127745750), Robert Krulwich describes the experience of Howard Engle, a Canadian novelist, who woke up one morning to discover he had lost the ability to read (a disorder called alexia) as the result of an undetected stroke. The article is short and engaging, and it includes two multimedia demonstrations: (1) a brief video describing what it was like for Engle to lose his reading ability (3:06 min.), and (2) a short audio clip of Engle “reading” with his tongue (6:56 min.).

Also, Oliver Sacks, the world-famous neurologist and author of many books, has published a new book, The Mind’s Eye (Knopf, 2010), detailing the lives of several individuals who have adapted to the loss of certain abilities and cognitive functions that many of us take for granted. All of these cases share the feature that their losses create paradoxes and perplexities in social communication and interaction. A few cases in this new book involve language, communication, and/or thinking. Students might enjoy reading this book; Sacks keeps the reader interested.

Part 2:
Another program relevant to the topic of language is a “Shorts” piece titled “Voices in Your Head” (14:05 min., aired September 7, 2010). In this episode, the host interviews developmental psychologist and researcher Charles Fernyhough about the relationship between thinking and language, and, in particular, the hypothesis (based on the work of Russian theorist Lev Vygotsky) that children may not be able to think until they have learned to “internalize” the voices of the adults who guide and teach them.

Fernyhough’s blog (hosted by Psychology Today) includes several postings related to this topic called “The Child in Time” (www.psychologytoday.com/blog/the-child-in-time). Two very relevant posts are “What do we mean by ‘thinking’?” (August 15, 2010) and “‘Accents’ in the womb? A brief note” (November 7, 2009).

Consistent with Vygotskian theory, several lines of developmental research present converging evidence that maternal speech patterns play a significant role in children’s linguistic development. Richer, more “elaborative” maternal speaking styles are predictive of more complex vocabulary and syntax, more dynamic and detailed reminiscing about past events, and better understanding of time in the future.


**Classroom Exercise: Introducing Imagery Research**

W. Burt Thompson suggests an excellent classroom activity for introducing imagery research. Not only does it illustrate how we often think in images, but it also quickly and reliably replicates the *symbolic distance effect*. That is, when people must decide which of two imagined objects is bigger, their decision time increases as the size difference between the two objects decreases. Handout 11a is a list of animal pairs in which the size difference is large. Handout 11b is a list of animal pairs in which the size difference is small. Randomly distribute copies of the handouts (face down) to your students. Tell them not to turn over their copy until you give the signal.

Explain that you are going to measure how quickly they can decide which of two objects is larger. For example, write car-house, penny-dime on the chalkboard. Tell your students that they will have 25 seconds to complete as many as possible. In each case, they should circle the larger item in each pair, working quickly and accurately.

After giving them 25 seconds to work, have them tabulate and report their results, using separate columns on the chalkboard for Handouts 11a and 11b. A visual inspection of the data will convince your class that the small-difference decisions take longer than the large-difference decisions.

Before discussing the exercise with the entire class, you may wish to have students work in small groups to generate possible explanations or theories about how people make size comparisons. Many, but perhaps not all, may claim that we use imagery. If a proposed theory includes the generation of images, ask the class how supporting evidence might be obtained, that is, how researchers might show that imagery is involved. As Thompson explains, the discussion naturally leads to consideration of how information is represented in the mind.


**Classroom Exercise: Mental Imagery**

Steven Pinker (1997) observes that “mental imagery is the engine that drives our thinking about objects in space.” Pose the following questions to your students:

How many windows are in your living room? What’s darker, a Christmas tree or a frozen pea? What’s larger, a guinea pig or a gerbil? When a person stands straight up, is her navel above her waist? If the letter D is turned on its back and put on top of a J, what does the combination remind you of? Most students will tell you that they answer these questions using a mental picture.

Peter Van Sommers suggests that often we are not as good as we think we are at mental imagery. Distribute a copy of Handout 12 (two pages) to all students, instructing them to keep it face down. Tell the class that you are going to test them on how well they can re-create something based on a mental picture. Have them turn the page over and look at the knot for 10 seconds. Then instruct them to cover it with one hand and form a picture of it in their mind. Ask, “How many crossings are there?” (Most people say two when actually there are three.) Instruct them to attempt to draw the knot in the space below. Van Sommers reports that in his experience, very few can draw the knot correctly.

Have students look at the Star of David for 10 seconds and again turn over the page. Ask, “Does the figure contain a parallelogram?” If people store mental images that correspond to the physical objects they have seen, they should be able to reproduce the image and find the parallelogram. Stephen Reed found, however, that an overwhelming majority of respondents did not. This suggests, argues Reed, that people do not store mental pictures but rather verbal descriptions—in this case, of two triangles (one pointing upward and the other pointing downward) on top of each other. Searching their verbal description, people found only triangles, not a parallelogram.

However, support for mental images being depictions and not merely descriptions comes from an experiment reported by Steven Pinker. He and his colleagues had people reinterpret images from verbal descriptions that were read while their eyes were closed. Ask your students to close their eyes and then write down what they were read while their eyes were closed. Ask your students to then write down what they were reading. Tell your students that they will have 25 seconds to work. After giving them 25 seconds to work, have them tabulate and report their results, using separate columns on the chalkboard for Handouts 11a and 11b. A visual inspection of the data will convince your class that the small-difference decisions take longer than the large-difference decisions.

**Classroom Exercise: Mental Imagery**

Imagine the letter D. Rotate it 90 degrees to the right. Put the number 4 above it. Now remove the horizontal segment of the 4 to the right of the vertical line.
Imagine the letter B. Rotate it 90 degrees to the left. Put a triangle directly below it having the same width and pointing down. Remove the horizontal line.

Imagine the letter K. Place a square next to it on the left side. Put a circle inside the square. Now rotate the figure 90 degrees to the left.

Pinker reported that most people had no trouble reporting the sailboat, the valentine, and the television set that are implicit in the verbiage.

Another example of our difficulty with mental imagery is the proverbially familiar back of the hand. When we draw our hands, we tend to ignore the fact that our thumb does not emerge from the base of our index finger but from a little above the wrist.

In his book *Experiences in Visual Thinking*, Robert McKim suggests that two aspects of visual imagery are important. The first is clarity—the sharpness of our mental pictures. The second is control, the degree to which we can manipulate our images. James Adams provides exercises that help illustrate and evaluate each aspect.

To demonstrate clarity, have students imagine the items below. Instruct them to number from 1 to 10 on a sheet of paper and write “c” for clear, “v” for vague, or “n” for nothing, consistent with how sharp and detailed the image appears in their mind.

1. The face of a close relative
2. Your bedroom
3. The grille on the front of your car
4. A camellia blossom
5. A running cow
6. The earth from orbit
7. Sarah Palin
8. Your first bicycle
9. Two fried eggs
10. Hillary Clinton

Adams suggests that clarity depends on a number of factors. Most obviously, it depends on seeing. If you’ve never seen a running cow, your mental image will probably not be too sharp. In addition, clarity depends on motivation (the camellia is clearer for camellia lovers), the visual character of the object (Hillary Clinton is probably clear because she appears so often in political cartoons, as well as elsewhere in the media), and timing (your first bicycle may have grown dim by now).

Have students evaluate their ability to control or manipulate their mental pictures by visualizing the following.

1. A pot of water coming to a boil and boiling over
2. The running cow changing slowly into a galloping racehorse
3. An elderly person you know, perhaps a grandparent, changing back into a teenager
4. A speeding motorcycle colliding with a giant feather pillow
5. The picture in “4” in reverse

McKim believes that the ability to control visual images can be developed with practice. By engaging in a wide range of imaginative activities, people presumably become more confident in their use of visual imagery for conceptualization.


**Student Project: Cognitive Maps**

Cognitive maps provide a good basis for introducing thought without language. Cognitive maps are mental representations of the spatial environment. (The image learning program in PsychSim, described in the Learning unit, also introduces students to cognitive maps.) They represent the world as we believe it to exist. If students are asked to think of the layout of the house in which they grew up, or are asked the shortest route from class to the library, they think in terms of images, not words. Sometimes our cognitive maps are very detailed and accurate; in other cases, they may be sketchy and bear little correspondence to reality.

You might have students draw from memory a map of the college campus as an out-of-class project and then bring it to class to compare with the maps of other students. They are likely to find wide individual differences. Previous research has shown that people tend to expand the size and detail of the buildings most important to them. You might sort maps by majors and show how this holds. Also compare the maps of new students with those of students who have been on campus for some time.

In *The Image of the City*, Kevin Lynch introduced the use of sketch maps to assess people’s representation of the environment. He was especially interested in identifying the architectural and geographical characteristics that make some places more “imageable,” and thus easier to remember. He found that this depends on “legibility,” or the ease with which specific parts can
be recognized and organized into a coherent pattern. Legibility in turn depends on the form and arrangement of five physical elements. These include "paths" along which the observer moves; "edges," or boundaries such as walls, shores, and railroad tracks; "districts" that the observer mentally enters "inside of"; "nodes," or strategic points to and from which the observer travels; and finally, "landmarks," or clearly defined physical objects such as buildings, signs, or statues.


**Classroom Exercise: Creating a Mental Model**

Margaret Matlin notes that when we hear a description of a place, we actively create a mental model that represents the important features of the scene. Research suggests that those who have been asked to draw maps of environments they have merely read about are just as accurate as those who have studied a map. To illustrate this process, tell students you are going to read the description of a place. They are to listen carefully because you will ask questions about it when you are finished. Then slowly read the following account that Matlin adapted from Barbara Tversky's research.

You are at the Jefferson Plaza Hotel, where you have just taken the escalator from the first to the second floor. You will be meeting someone for dinner in a few minutes. You now stand next to the top of the escalator, where you have a view of the first floor as well as the second floor. You first look directly to your left, where you see a shimmering indoor fountain about 10 yards beyond a carpeted walkway. Though you cannot see beyond the low, stone wall that surrounds it, you suppose that its bottom is littered with nickels and pennies that hotel guests have tossed in. The view down onto the first floor allows you to see that directly below you is a darkened, candle-lit tavern. It looks very plush, and every table you see seems to be filled with well-dressed patrons. Looking directly behind you, you see through the window of the hotel's barbershop. You can see an older gentleman, whose chest is covered by a white sheet, being shaved by a much younger man. You next look straight ahead of you, where you see a quaint little gift shop just on the other side of the escalator. You're a sucker for little ceramic statues, and you squint your eyes to try to read the hours of operation posted on the store's entrance. Hinging from the high ceiling directly above you, you see a giant banner welcoming the Elks convention to the hotel. It is made from white lettering sewn onto a blue background, and it looks to you to be about 25 feet long. (Based on Tversky, 1991b, p. 133, from p. 205 of M. Matlin [1992] *Cognitive Psychology*, 4e, New York: West Publishing.)

After you have finished, ask the students to imagine that they have turned to face the barber shop. Then have them write down answers to the following questions.

1. What is above your head?
2. What is below your feet?
3. What is ahead of you?
4. What is behind you?
5. What is to your right?

When Nancy Franklin and Barbara Tversky had participants read descriptions such as this one, they found that all had constructed images of the environment as they were reading. Most also said they had constructed imagery from the observer’s point of view. Franklin and Tversky were especially interested in knowing whether response time varied with the location of the object being tested. It did. The shortest reaction times were for those objects above and below them, followed by objects ahead of and behind them; the longest reaction times were for objects to the right and left of them.

Franklin and Tversky compared three models that could explain how people might explore their mental models. The *equiavailability model* states that people can make decisions equally rapidly about all directions because all are equally available to the observer. Clearly, the different reaction times are inconsistent with this model.

According to the *mental transformation model*, reaction times should depend upon the amount of mental movement needed to inspect each location. For example, you should respond more quickly to objects in front of you because they require no mental movement. Objects behind you should take the longest because you have to turn completely around. Those objects on the left and right should require intermediate times. Again the data do not fit this claim.

According to the *spatial framework model*, our mental images do not mirror our perceptions. Some spatial directions are more prominent than others. When we are in an upright position (as opposed to reclining), we distinguish between one vertical (above-below) and two horizontal spatial directions (front-back and left-right).

Of these three directions, the above-below dimension is most prominent because it remains constant regardless of our body position. It is also readily accessible because of its association with gravity—that is, objects only fall downward, not upward. Thus, judgment times for the above-below dimension should be fastest. In contrast, objects in the two vertical spatial dimensions (what is in the front-back or left-right
dimension) changes with our body position. Because we can more readily attend to and move toward the front than toward the back, the front-back dimension has more accessibility and prominence than the right-left dimension. Thus, judgment times for front-back should be intermediate and those for left-right should be slowest.

Need for Cognition Scale

Rate each of the following statements in terms of how well it characterizes you. There are no “right” or “wrong” answers, and your responses will remain anonymous. Write a number in the blank from “1” indicating “extremely uncharacteristic of me” to “5” indicating “extremely characteristic of me.”

1. I would prefer complex to simple problems.
2. I like to have the responsibility of handling a situation that requires a lot of thinking.
3. Thinking is not my idea of fun.
4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.
5. I try to anticipate and avoid situations in which I may have to think in depth about something.
6. I find satisfaction in deliberating hard and for long hours.
7. I only think as hard as I have to.
8. I prefer to think about small, daily projects to long-term ones.
9. I like tasks that require little thought once I’ve learned them.
10. The idea of relying on thought to make my way to the top appeals to me.
11. I really enjoy a task that involves coming up with new solutions to problems.
12. Learning new ways to think doesn’t excite me very much.
13. I prefer my life to be filled with puzzles that I must solve.
14. The notion of thinking abstractly is appealing to me.
15. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.
16. I feel relief rather than satisfaction after completing a task that required a lot of mental effort.
17. It’s enough for me that something gets the job done; I don’t care how or why it works.
18. I usually end up deliberating about issues even when they do not affect me personally.

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Problem Solving

1. Husbands and Wives Problem

Three men—Fred, Ed, and Ted—are married to Joan, Sally, and Vickie, but not necessarily in that order. Joan, who is Ed’s sister, lives in Detroit. Fred dislikes animals. Ed weighs more than the man who is married to Vickie. The man married to Sally breeds Siamese cats as a hobby. Fred commutes over 200 hours a year from his home in Ann Arbor to his job in Detroit. Match up the men with the women they married.


2. The Buddhist Monk Problem

Exactly at sunrise one morning, a Buddhist monk set out to climb a tall mountain. The narrow path was not more than a foot or two wide, and it wound around the mountain to a beautiful, glittering temple at the mountain peak.

The monk climbed the path at varying rates of speed. He stopped many times along the way to rest and to eat the fruit he carried with him. He reached the temple just before sunset. At the temple, he fasted and meditated for several days. Then he began his journey back along the same path, starting at sunrise and walking, as before, at variable speeds with many stops along the way. However, his average speed going down the hill was greater than his average climbing speed.

Prove that there must be a spot along the path that the monk will pass on both trips at exactly the same time of day.


3. The Hobbits-and-Orcs Problem

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


4. Truthtellers and Liars Problem

You are visiting a strange country in which there are just two kinds of people—truthtellers and liars. Truthtellers always tell the truth and liars always lie. You hail the first two people you meet and say, “Are you truthtellers or liars?” The first person mumbles something you can’t hear. The second says, “He says he is a truthteller. He is a truthteller and so am I.” Can you trust the directions that these two may give you?

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### The Water Jug Problem

Imagine that you have three water jugs of varying capacities (quart sizes noted below) and an unlimited water supply. How would you use the jugs to end up with the desired amount of water indicated for each problem?

<table>
<thead>
<tr>
<th>Problem</th>
<th>Jug A</th>
<th>Jug B</th>
<th>Jug C</th>
<th>Desired Quarts of Water</th>
<th>Solution??</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29</td>
<td>3</td>
<td></td>
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<td>2</td>
<td>21</td>
<td>127</td>
<td>3</td>
<td>100</td>
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</tr>
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<td>3</td>
<td>14</td>
<td>163</td>
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</tr>
<tr>
<td>9</td>
<td>28</td>
<td>76</td>
<td>3</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

HANDOUT 4

Which of the following are the more frequent causes of death in the United States?

1. All accidents or strokes?
   I am ____ % certain of my answer. *

2. Suicide or blood poisoning?
   I am ____ % certain of my answer.

3. Homicide or diabetes?
   I am ____ % certain of my answer.

4. Motor vehicle (car, truck, bus) accident or colorectal cancer?
   I am ____ % certain of my answer.

5. Drowning or leukemia?
   I am ____ % certain of my answer.

Which country has the largest population?

6. Morocco or Saudi Arabia?
   I am ____ % certain of my answer.

7. Australia or Myanmar?
   I am ____ % certain of my answer.

8. South Africa or Vietnam?
   I am ____ % certain of my answer.

9. Libya or Sri Lanka?
   I am ____ % certain of my answer.

10. Iraq or Tanzania?
    I am ____ % certain of my answer.
Which city has the higher crime rate?

11. Chicago, IL or Kansas City, MO
   I am ____ % certain of my answer.

12. Las Vegas, NV or Stockton, CA
   I am ____ % certain of my answer.

13. Miami, FL or Phoenix, AZ
   I am ____ % certain of my answer.

14. Honolulu, HI or Raleigh, NC
   I am ____ % certain of my answer.

15. New York, NY or Aurora, CA
   I am ____ % certain of my answer.

*Estimates can range from 50 percent (I’m just guessing) to 100 percent (I’m absolutely certain).

For each of the following questions, answer in terms of a range within which you expect the correct answer will almost certainly fall. Given a 98 percent confidence level, if you give answers between 100 and 200, for example, this would mean you think there is only a 2 percent chance that the real answer is either less than 100 or more than 200.

1. I feel 98 percent certain that the area of the United States is more than _____ square miles but less than _____ square miles.

2. I feel 98 percent certain that in 2008 the population of Afghanistan was more than _____ but less than _____.

3. I feel 98 percent certain that in 2007 General Motors spent more than $_____ but less than $_____ on advertising.

4. I feel 98 percent certain that the number of American battle deaths in the Spanish-American War was more than _____ but less than _____.

5. I feel 98 percent certain that in 2007 the number of female commissioned officers in the United States Army was more than _____ but less than _____.

6. I feel 98 percent certain that in 2008 the number of operating nuclear plants in the world was more than _____ but less than _____.

7. I feel 98 percent certain that the number of suicides in the United States in 2006 was more than _____ but less than _____.

8. I feel 98 percent certain that in 2001 the number of cars imported into the United States from France was more than _____ but less than _____.

9. I feel 98 percent certain that in 2007 the production of oats in the United States was more than _____ bushels but less than _____ bushels.

10. I feel 98 percent certain that the number of medals Germany won in the 2006 Winter Olympics was more than _____ but less than _____.

HANDOUT 6

<table>
<thead>
<tr>
<th>Question</th>
<th>Guess: Did the speaker tell the truth or a lie?</th>
<th>I am % confident that my guess is correct.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Something that happened to me during grade school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. My favorite meal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. My earliest memory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. My favorite vacation trip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. A high point of my high school days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. The most influential person in my life</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. My favorite professor outside the psych department</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. The part of the country in which I’d most like to live</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. A surprising talent that I have</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Something interesting about a member of my family</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Estimates can range from 50 percent (I’m just guessing) to 100 percent (I’m absolutely certain).
In each case, circle either “a” or “b.”

1. Threatened by a superior enemy force, the general faces a dilemma. His intelligence officers say his soldiers will be caught in an ambush in which 600 of them will die unless he leads them to safety by one of two available routes. If he takes the first route, 200 soldiers will be saved. If he takes the second, there’s a one-third chance that 600 soldiers will be saved and a two-thirds chance that none will be saved. Which route should he take?
   a. Route 1
   b. Route 2

2. Choose between:
   a. a sure gain of $3000
   b. an 80 percent chance of winning $4000 and a 20 percent chance of winning nothing

Thinking Styles

Instructions: Use the following key to indicate your response to each of the following statements. Place the appropriate number in the space before each statement.

1 = completely false
2 = somewhat false
3 = neither false nor true
4 = somewhat true
5 = completely true

_____ 1. I don’t like to have to do a lot of thinking.
_____ 2. I try to avoid situations that require thinking in depth about something.
_____ 3. I prefer to do something that challenges my thinking abilities rather than something that requires little thought.
_____ 4. I prefer complex to simple problems.
_____ 5. Thinking hard and for a long time about something gives me little satisfaction.
_____ 6. I trust my initial feelings about people.
_____ 7. I believe in trusting my hunches.
_____ 8. My initial impressions of people are almost always right.
_____ 9. When it comes to trusting people, I can usually rely on my “gut feelings.”
_____ 10. I can usually feel when a person is right or wrong even if I can’t explain how I know.

### Simple Language Device

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suddenly</td>
<td>several</td>
<td>naked</td>
<td>giraffes</td>
<td>ran</td>
<td>into the room</td>
</tr>
<tr>
<td>Slowly</td>
<td>six</td>
<td>hairy</td>
<td>Martians</td>
<td>jumped</td>
<td>out of the box</td>
</tr>
<tr>
<td>Without warning</td>
<td>those</td>
<td>bloody</td>
<td>students</td>
<td>slipped</td>
<td>between the houses</td>
</tr>
<tr>
<td>Amazingly</td>
<td>some</td>
<td>blue-blooded</td>
<td>dalmatians</td>
<td>fled</td>
<td>from behind the trees</td>
</tr>
<tr>
<td>Reluctantly</td>
<td>the</td>
<td>laughing</td>
<td>duchesses</td>
<td>skipped</td>
<td>down the road</td>
</tr>
<tr>
<td>Carefully</td>
<td>a few</td>
<td>dark</td>
<td>boys</td>
<td>crawled</td>
<td>over the hill</td>
</tr>
<tr>
<td>Fortunately</td>
<td>a great many</td>
<td>bald</td>
<td>lawyers</td>
<td>darted</td>
<td>through the tunnel</td>
</tr>
<tr>
<td>Cunningly</td>
<td>twenty-two</td>
<td>unscrupulous</td>
<td>octogenarians</td>
<td>danced</td>
<td>across the bridge</td>
</tr>
<tr>
<td>In due course</td>
<td>innumerable</td>
<td>dirty</td>
<td>feminists</td>
<td>limped</td>
<td>up the street</td>
</tr>
</tbody>
</table>

HANDOUT 10

Doublespeak

How good are you at understanding doublespeak? Translate each of the following with a word or term in the blank provided.

1. revenue enhancement =
2. inoperative statements =
3. social expression products =
4. poorly buffered precipitation =
5. media courier =
6. oral hygiene appliance =
7. negative patient care outcome =
8. vertical transportation corps =
9. period of accelerated negative growth =
10. radiation enhancement device =
11. automotive internist =
12. pre-emptive counterattacks =
13. pupil station =
14. underground condominium =
15. digital fever computer =

HANDOUT 11a

cow-rat
bear-flea
ant-elic
horse-quail
moth-wolf
roach-horse
mouse-lamb
moose-frog
rat-horse
bear-quail
bee-hog
roach-whale
hog-ant
fox-worm
bear-rat
quail-cow
horse-fox
quail-whale
cat-moose
whale-dog
flea-wolf
rat-elk
duck-flea
bear-frog

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flea-bee
ant-moth
deer-cow
horse-sheep
moth-flea
pig-fox
flea-roach
duck-dove
ant-roach
hog-cow
wolf-bear
cow-sheep
cat-rat
wolf-cow
ant-bee
moth-flea
rat-duck
frog-moth
bear-hog
flea-roach
frog-rat
hog-cat
roach-ant

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