

37-1 What Is Thinking?—Brains Over Brawn

Survey Question 37.1

What is the nature of thought?

Cognition (Process of thinking, gaining knowledge, and dealing with knowledge.) is the process of thinking, gaining knowledge, and dealing with knowledge. At its most basic, cognition refers to *processing a mental representation* (internal subjective expression) of a problem or situation (Sternberg, 2017). Human cognition can take many forms, from experiential daydreaming to more reflective problem solving and reasoning. Consider, for example, the relatively reflective process of planning. Picture a television interviewer who mentally tries out several lines of questioning before beginning a live interview. By *planning* her moves, she can avoid many mistakes. Imagine planning what to study for an exam, what to say at a job interview, or how to get to your spring break hotel. Better yet, in each of these cases, imagine what might happen if you didn't, or couldn't, plan at all.

Let's do some more experiential and reflective thinking while looking at **Figure 37.1**. On the left (*a*), is this face happy or sad? Chances are that you *knew* the answer just by looking at the photo. You were engaging in more or less unconscious, effortless, and automatic **experiential processing** (Thought that is passive, effortless, and automatic.). Now looking at (*b*), what is the sum of these numbers? This time, experiential processing may not have been enough; you likely had to deliberately concentrate and engage in **reflective processing** (Thought that is active, effortful, and controlled.) (Kahneman, 2011; Norman, 1994). (The difference between these two types of cognition is relevant to how well you understand and remember what you are learning; see **Module 1**.)

Figure 37.1

Experiential vs. Reflective Processing.

(a) An experiential processing task (b) a reflective processing task. See the text for an explanation.



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18
29
54
42
—

(a)

(b)

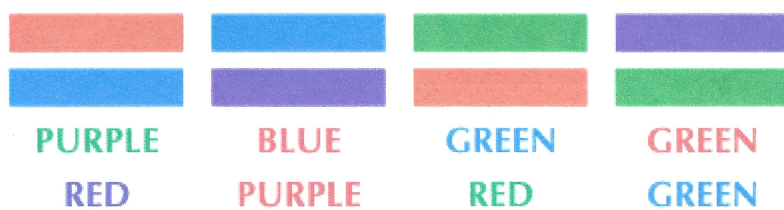
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What do you mean when you say that experiential processing is “automatic”? Try the activity shown in Figure 37.2. Fluent readers of English usually have difficulty quickly naming the color of ink used to print the words in the bottom two rows of this figure. But why? When fluent readers look at words, they normally *read* them automatically (Moors, 2016). In this case, the task is *not* to read the words; instead, it is to *name* the ink color used to print the words. But reading words is so automated that fluent readers cannot help themselves. Sooner or later, when fluent readers works through lists like these, they are likely to make some mistakes, reading out loud, for example, the word *purple* instead of naming the ink color (*green* in this example).

Figure 37.2

The Stroop Interference Task.

Test yourself by naming out loud the colors in the top two rows as quickly as you can. Then name out loud the colors of the ink used to print the words in the bottom two rows. (Do not read the words themselves.) Was it harder to name the ink colors in the bottom rows?



At the very least, fluent readers cannot speed through such lists since the *automatic* processing of word meanings is just too strong to ignore and interferes with color naming. To

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37-1a Some Basic Units of Thought

The power of being able to mentally represent problems is dramatically illustrated by chess grand master Miguel Najdorf, who once simultaneously played 45 chess games while blindfolded. How did Najdorf do it? Like most people, he used the basic units of thought: mental images, concepts, and language (or symbols). **Mental images** (Mental pictures or visual depictions used in memory and thinking.) are picturelike mental representations. A **concept** (Mental category for classifying things based on common features or properties.) is a mental category for classifying things based on common features or properties. **Language** (Words or symbols, and rules for combining them, that are used for thinking and communication.) consists of words or symbols and rules for combining them. Thinking often involves all three units. For example, blindfolded chess players rely on visual images, concepts (“Game 2 begins with a strategy called an English opening”), and the notational system, or “language,” of chess.

In a moment, we’ll delve further into imagery, concepts, and language. Be aware, however, that thinking involves attention, pattern recognition, memory, decision making, intuition, knowledge, and more (Goldstein, 2015). This module is only a sample of what cognitive psychology is about.

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Chapter 37: Cognition and Intelligence: Modes of Thought: 37-2 Mental Imagery—Does a Frog Have Lips?
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37-2 Mental Imagery—Does a Frog Have Lips?

Survey Question 37.2

In what ways are images related to thinking?

Almost everyone experiences visual and auditory images. Many of us also experience imagery for movement, touch, taste, smell, and pain. Thus, mental images are often more than just “pictures.” For example, your image of a bakery also may include its delicious aroma. Some people even have a rare form of imagery called [synesthesia \(Experiencing one sense in terms normally associated with another sense; for example, “seeing” colors when a sound is heard.\)](#) (sin-es-THEE-zyah). For these individuals, images cross normal sensory barriers (Craver-Lemley & Reeves, 2013; Marks, 2014). For one such person, spiced chicken tastes “pointy”; and for another, chocolate smells pink and stripey (Dixon, Smilek, & Merikle, 2004; Russell, Stevenson, & Rich, 2015).

Despite such variations, most of us use images to think, remember, and solve problems. For instance, we may use mental images to do the following:

- Make a decision or solve a problem (choose what clothes to wear; figure out how to arrange furniture in a room)
- Change feelings (think of pleasant images to get out of a bad mood; imagine yourself as thin to stay on a diet)
- Improve a skill or prepare for some action (use images to improve a tennis stroke; mentally rehearse how you will ask for a raise)
- Aid memory (picture Mr. Cook wearing a chef’s hat, so you can remember his name)

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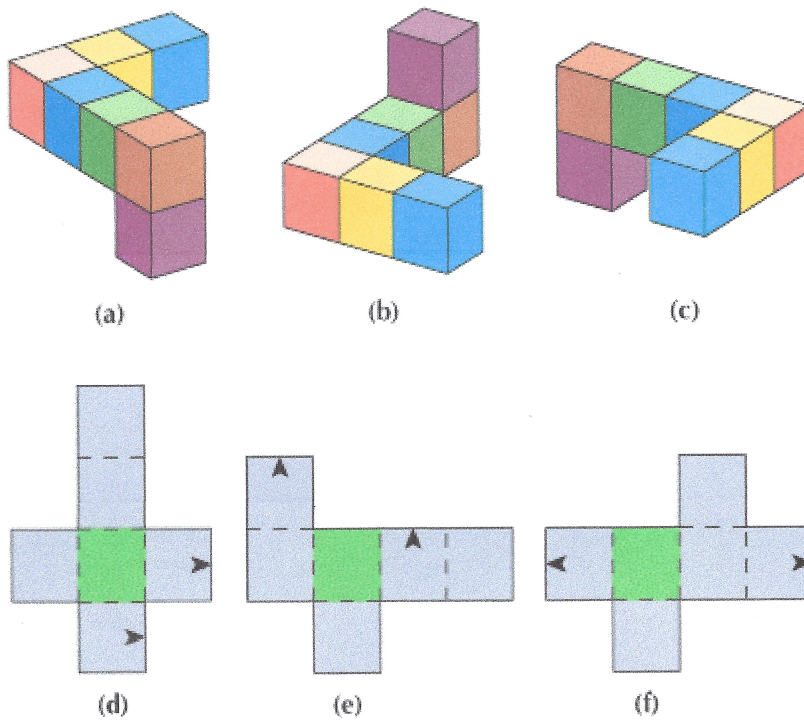
37-2a The Nature of Mental Images

Mental images are not flat, like photographs. Researcher Stephen Kosslyn showed this by asking people, "Does a frog have lips and a stubby tail?" Unless you often kiss frogs, you probably will tackle this question by using mental images. Most people picture a frog, "look" at its mouth, and then mentally "rotate" the frog in mental space to check its tail (Kosslyn, 1983). Mental rotation is partly based on imagined movements (Figure 37.3). That is, we can mentally "pick up" an object and turn it around or even fold it (Harris, Hirsh-Pasek, & Newcombe, 2013; Wraga, Boyle, & Flynn, 2010).

Figure 37.3

Imagery in Thinking.

(Top) Participants were shown a drawing similar to (a) and drawings of how (a) would look in other positions, such as (b) and (c). Participants could recognize (a) after it had been "rotated" from its original position. However, the more (a) was rotated in space, the longer it took to recognize it. This result suggests that people formed a three-dimensional image of (a) and rotated the image to see if it matched (Shepard, 1975). (Bottom) Try your ability to manipulate mental images: Picture each of these shapes as a piece of paper that can be folded to make a cube. After they have been folded, on which cubes do the arrow tips meet (Kosslyn, 1985)?



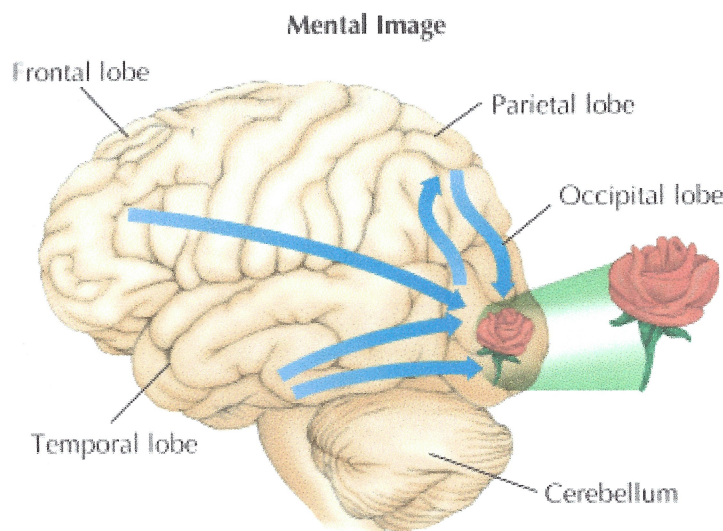
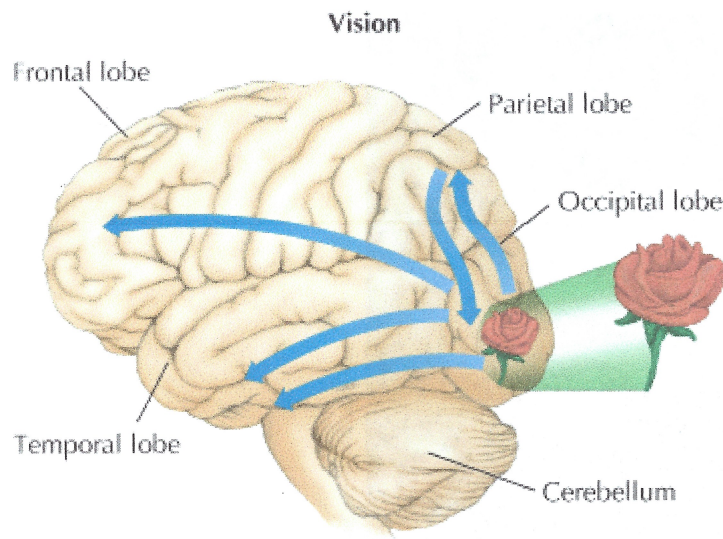
"Reverse Vision"

What happens in the brain when a person has visual images? Seeing something in your “mind’s eye” is similar to seeing real objects. Information from the eyes normally activates the brain’s primary visual area, creating an image (Figure 37.4). Other brain areas then help us recognize the image by relating it to stored knowledge. When you form a mental image, the system works in reverse. Brain areas in which memories are stored send signals back to the visual cortex, where once again an image is created (Borst & Kosslyn, 2010; Zvyagintsev et al., 2013). For example, if you visualize a friend’s face right now, the area of your brain that specializes in perceiving faces will become more active (Prochnow et al., 2013).

Figure 37.4

Imagery in The Brain.

(*Top*) When you see a flower, its image is represented by activity in the primary visual area of the cortex at the back of the brain. Information about the flower also is relayed to other brain areas. (*Bottom*) If you form a mental image of a flower, information follows a reverse path. The result, once again, is activation of the primary visual area.



Using Mental Images

How are images used to solve problems? Let's say that you are asked, "How many ways can you use an empty egg carton?" You might begin by picturing uses you have already seen, such as sorting buttons. To give more original answers, you might assemble or invent new images. Thus, an artist may completely picture a proposed sculpture before beginning work. People with good imaging abilities tend to score higher on tests of creativity, even if they are blind (Eardley & Pring, 2007; Morrison & Wallace, 2001).

Kinesthetic Imagery

In a sense, we think with our bodies as well as our brains. *Kinesthetic (motor) images* are created from muscular sensations (Grangeon, Guillot, & Collet, 2011; Olshansky et al., 2015). Such images help us think about movements and actions.

The Walt Disney Concert Hall in Los Angeles was designed by architect Frank Gehry. Could a person lacking mental imagery design such a masterpiece? Most artists, architects, designers, sculptors, and filmmakers have excellent visual imagery.



Gavriel Jecan/AGE Fotostock

Gavriel Jecan/AGE Fotostock

As you think and talk, kinesthetic sensations can guide the flow of ideas. For example, if a friend calls and asks you the combination of a lock you lent her, you may move your hands as if twirling the dial on the lock. Or, try answering this question: Which direction do you turn the hot-water handle in your kitchen to shut off the water? If you haven't memorized the words "leftie loosie" and "rightie tightie," you may "turn" the faucet in your imagination before answering. You may even make a turning motion with your hand before answering.

Kinesthetic images are especially important in movement-oriented skills such as music, sports, dance, skateboarding, and martial arts. An effective way to improve such skills is to practice by rehearsing kinesthetic images of yourself performing flawlessly (Anema & Dijkerman, 2013).

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37-3b Types of Concepts

Are there different kinds of concepts? Yes, a **conjunctive concept** (A class of objects that have two or more features in common. (For example, to qualify as an example of the concept, an object must be both red *and* triangular.)), or “and concept,” is defined by the presence of two or more features (Reed, 2013). In other words, an item must have “this feature *and* this feature *and* this feature.” For example, a *motorcycle* must have two wheels *and* an engine *and* handlebars.

A **relational concept** (A concept defined by the relationship between features of an object or between an object and its surroundings (for example, “greater than,” “lopsided”).) is based on how an object relates to something else, or how its features relate to one another. All of the following are relational concepts: *larger*, *above*, *left*, *north*, and *upside down*. Another example is *brother*, which is defined as “a male considered in his relation to another person having the same parents.”

A **disjunctive concept** (A concept defined by the presence of at least one of several possible features. (For example, to qualify, an object must be either blue *or* circular.)) has *at least one* of several possible features. These are “either/or” concepts. To belong to the category, an item must have “this feature *or* that feature *or* another feature.” For example, in baseball, a *strike* is *either* a swing and a miss *or* a pitch over the plate *or* a foul ball (unless two strikes have already been called). The either/or quality of disjunctive concepts makes them harder to learn.

Prototypes

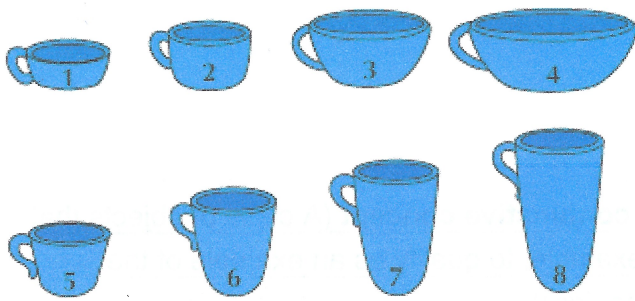
When you think of the concept *bird*, do you mentally list the features of birds? Probably not. In addition to rules and features, we might use a **prototype** (An ideal model used as a prime example of a particular concept.), or ideal model, to identify concepts (Rosch, 1977; Tunney & Fernie, 2012). A robin, for example, is a prototypical bird; an ostrich is not. In other words, some items are better examples of a concept than others are (Smith, 2013). Which of the drawings in [Figure 37.5](#) best represents a cup? At some point, as a cup grows taller or wider, it becomes a vase or a bowl. How do we know when the line is crossed? Probably, we mentally compare objects to an “ideal” cup, like number 5. That’s why it’s hard to identify concepts when we can’t come up with relevant prototypes (Minda & Smith, 2011).

Figure 37.5

Identifying Prototypes.

When does a cup become a bowl or a vase? Deciding if an object belongs to a conceptual class is aided by relating it to a prototype, or ideal example. Participants

in one experiment chose number 5 as the “best” cup.



(After Labov, 1973.)

Let's move on to explore another concept: *language*.

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37-4 Language—Say What?

Survey Question 37.4

What is language, and what role does it play in thinking?

As we have seen, thinking may occur without language. Everyone has searched for a word to express an idea that exists as a vague image or feeling. Nevertheless, most thinking relies heavily on language, because words *encode* (translate) the world into symbols that are easy to manipulate.

Wine tasting illustrates the encoding function of language. To communicate their experiences to others, wine connoisseurs must put taste sensations into words. The wine you see here is “Marked by deeply concentrated nuances of plum, blackberry, and currant, with a nice balance of tannins and acid, building to a spicy oak finish.” (Don’t try this with a soda!)

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Heinrich van den Berg/Getty Images

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37-4a Linguistic Relativity: What's North of My Fork?

Our struggle at times, to express our thoughts in words, makes it clear that our thoughts influence the words we use. But might the reverse be true? Do the words we use affect our thoughts and actions? The answer appears to be “Yes.” Cognitive psychologist Lera Boroditsky has reported that aboriginal children from Cape York, a remote part of northeastern Australia, can accurately point to any compass direction as early as age 5. In contrast, most Americans cannot do this even as adults (Boroditsky, 2011).

But why? According to Boroditsky, unlike English, Kuuk Thaayorre, the language of the Cape York Australian aboriginals, relies exclusively on *absolute* directional references. Like English, Kuuk Thaayorre has words for *north*, *south*, and so on. Unlike English, Kuuk Thaayorre lacks words for *relative* directional references, such as *left* and *right*.

For long distances, an English speaker might say, “Chicago is north of here.” But for short distances, the same speaker will shift to a relative reference and might say, “My brother is sitting to my right.” In contrast, a speaker of Kuuk Thaayorre always uses absolute directional references, saying things like “My friend is sitting southeast of me” and “The spoon is west of the cup.” If you are a young aboriginal child, you had better master your absolute directions, or most conversations will be impossible to follow.

Another interesting consequence for speakers of Kuuk Thaayorre is how they arrange time. In one study, English speakers given a set of cards depicting a series of events (for example, a person getting older or a meal being cooked and eaten) and asked to put them in order usually arranged them from left to right. Hebrew speakers usually arranged the cards from right to left, presumably because this is the direction in which Hebrew is written. In contrast, speakers of Kuuk Thaayorre arrange temporal sequences from east to west. If the sorter is facing north, the cards are arranged from right to left, but if the sorter is facing south, the cards are arranged from left to right, and so on (Boroditsky & Gaby, 2010).

Findings like these lend support to the [linguistic relativity hypothesis \(The idea that the words we use not only reflect our thoughts but can shape them as well.\)](#), the idea that the words we use not only reflect our thoughts but can shape them as well. So the next time you think that your future is “ahead” of you and your past is “behind,” think again. For speakers of Aymara, a South American language, it is the past that is “ahead” (Miles et al., 2010). So watch your back.

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38-1a Algorithmic Solutions

For routine problems, an **algorithmic solution** (A problem solution achieved by following a series of step-by-step rules.)—achieved by following a series of step-by-step rules—may be enough to solve the problem (Goldstein, 2015). A simple example of an *algorithm* is the steps that you used to add up the numbers in **Figure 37.1** (whether you did it in your head or by using a calculator). Here's another example: If you forget the combination to your bike lock, you will be able to discover it if you systematically try all the possible combinations (this could take some time, though ...).

Algorithmic thinking is **logical thought** (Drawing conclusions on the basis of formal principles of reasoning.)—proceeding from given information to new conclusions on the basis of explicit rules. To this, we can add that logical thought may be **inductive thought** (Thinking in which a general rule or principle is gathered from a series of specific examples; for instance, inferring the laws of gravity by observing many falling objects.)—going from specific facts or observations to general principles—or **deductive thought** (Thought that applies a general set of rules to specific situations; for example, using the laws of gravity to predict the behavior of a single falling object.)—going from general principles to specific situations. Becoming a problem-solving expert in any particular field involves, at a minimum, becoming familiar with the algorithms available in that field. If you have a good background in math, you may have found an algorithmic solution to the problem of the seals and the boats. (Your authors hope you didn't. There is an easier solution.)

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38-1b Solutions by Understanding

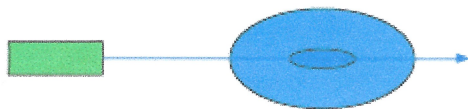
Many problems cannot be solved algorithmically. In such cases, [understanding \(A deeper comprehension of the nature of a problem.\)](#) (deeper comprehension of a problem) is necessary. Try this problem:

A person has an inoperable stomach tumor. A device is available that produces rays that at high intensity will destroy tissue (both healthy and diseased). How can the tumor be destroyed while minimizing damage to the surrounding tissue? (Also see the sketch in [Figure 38.1.](#))

Figure 38.1

The Tumor Problem.

A schematic representation of Duncker's tumor problem. The dark spot represents a tumor surrounded by healthy tissue. How can the tumor be destroyed without injuring surrounding tissue?



(Adapted from Duncker, 1945.)

What does this problem show about problem solving? German psychologist Karl Duncker gave college students this problem in a classic series of studies. Duncker asked them to think aloud as they worked. He found that successful students first had to discover the *general properties* of a correct solution. A [general solution \(A solution that correctly states the requirements for success but not in enough detail for further action.\)](#) defines the requirements for success but not in enough detail to guide further action. This phase was complete when students realized that the intensity of the rays had to be lowered on their way to the tumor. Then, in the second phase, they proposed a number of [functional solutions \(A detailed, practical, and workable solution.\)](#), or workable solutions, and selected the best one (Duncker, 1945). (One solution is to focus weak rays on the tumor from several angles. Another is to rotate the person's body to minimize exposure of healthy tissue.)

38-1c Heuristics

“You can’t get there from here,” or so it often seems when facing a problem. Solving problems often benefits from a strategy. Imagine that you are traveling to Washington, DC, and decide to look up an old FBI friend, Penelope Garcia. You search an online directory and find dozens of P. Garcias listed. Of course, you could follow an algorithm such as dialing each number in alphabetical order until you found the right one.

Alternatively, you could use a [heuristic \(Shortcut or rule of thumb for finding a solution to a problem.\)](#) (hew-RIS-tik)—a shortcut or “rule of thumb” for finding a solution to a problem. Typically, a heuristic *reduces the number of alternatives* that thinkers must consider (Benjafield, Smilek, & Kingstone, 2010). You could, for example, simplify the problem of looking up Penelope by randomly choosing just a few, plausible-looking entries. In this case, you would be using a [random search strategy \(Trying possible solutions to a problem in a more or less random order.\)](#). This is another example of trial-and-error thinking in which some possibilities are tried, more or less randomly. “Forget it,” you say to yourself. “Is there a better way I can narrow the search?” “Oh, yeah! I remember hearing that Penelope lives near work.” Then you Google a map and call only the numbers with addresses in southern Washington, nearer to Quantico.

Notice that while some algorithms may be inefficient, they are generally going to find a solution. In contrast, a heuristic may be more efficient but is less likely to find a solution. Expert problems solvers are good at knowing when best to use algorithms or move on to heuristic strategies like these:

- Try to identify how the current state of affairs differs from the desired goal. Then find steps that will reduce the difference.
- Try working backward from the desired goal to the starting point or current state.
- If you can’t reach the goal directly, try to identify an intermediate goal or subproblem that at least gets you closer.
- Represent the problem in other ways—with graphs, diagrams, or analogies, for instance.
- Generate a possible solution and test it. Doing so may eliminate many alternatives, or it may clarify what is needed for a solution.

38-1d Insightful Solutions

A thinker who *suddenly* solves a problem has experienced **insight** ([A sudden mental reorganization of a problem that makes the solution obvious.](#)) (Cushen & Wiley, 2012). Insights are usually based on reorganizing a problem. This allows us to see problems in new ways and makes their solutions seem obvious (Hélie & Sun, 2010).


Let's return now to the problem of the boats and the seals. The best way to solve it is by insight. Because the boats will cover the 10-mile distance in exactly 1 hour, and the seals swim 12 miles per hour, the seals will have swum 12 miles when the boats meet. Very little math is necessary if you have insight into this problem. [Figure 38.2](#) lists some additional insight problems that you may want to try (the answers can be found in [Table 38.1](#)).

Figure 38.2

Some insight problems.


Water lilies:

Problem: Water lilies growing in a pond double in area every 24 hours. On the first day of spring, only one lily pad is on the surface of the pond. Sixty days later, the pond is entirely covered. On what day is the pond half-covered?

 Some insight problems.


Twenty dollars

Problem: Jessica and Blair both have the same amount of money. How much must Jessica give Blair so that Blair has \$20 more than Jessica?

 Some insight problems.

How many pets?

Problem: How many pets do you have if all of them are birds except two, all of them are cats except two, and all of them are dogs except two?

 Some insight problems.

Between 2 and 3

Problem: What one mathematical symbol can you place between 2 and 3 that results in a number greater than 2 and less than 3?

Some insight problems.

One word

Problem: Rearrange the letters NEWDOOR to make one word.

Some insight problems.

Table 38.1

Solutions to Insight Problems

Water lilies: Day 59

Twenty dollars: \$10

How many pets?: Three (one bird, one cat, and one dog)

Between 2 and 3: A decimal point

One word: ONE WORD (You may object that the answer is two words, but the problem called for the answer to be "one word," and it is.)

The Nature of Insight

Psychologist Janet Davidson (2003) believes that insight involves three abilities. The first is *selective encoding*, which refers to selecting information that is relevant to a problem while ignoring distractions. For example, consider the following problem:

If you have white socks and black socks in your drawer, mixed in the ratio of 4 to 5, how many socks will you have to take out to ensure that you have a pair of the same color?

A person who recognizes that “mixed in a ratio of 4 to 5” is irrelevant will be more likely to come up with the correct answer of 3 socks.

Insight also relies on *selective combination*, or bringing together seemingly unrelated bits of useful information. Try this sample problem:


With a 7-minute hourglass and an 11-minute hourglass, what is the simplest way to time boiling an egg for 15 minutes?

The answer requires using both hourglasses in combination. First, the 7-minute and the 11-minute hourglasses are started. When the 7-minute hourglass runs out, it's time to begin boiling the egg. At this point, 4 minutes remain on the 11-minute hourglass. Thus, when it runs out, it is simply turned over. When it runs out again, 15 minutes will have passed.

A third source of insights is *selective comparison*. This is the ability to compare new problems with old information or with problems already solved. A good example is the hat rack problem, in which participants must build a structure that can support an overcoat in the middle of a room. Each person is given only two long sticks and a C-clamp to work with. The solution, shown in [Figure 38.3](#), is to clamp the two sticks together so that they are wedged between the floor and ceiling. If you were given this problem, you would be more likely to solve it if you first thought of how pole lamps are wedged between floor and ceiling

Figure 38.3

A Solution to the Hat Rack Problem.

 A Solution to the Hat Rack Problem.

Fixations

One of the most important barriers to problem solving is [fixation \(The tendency to repeat wrong solutions or faulty responses, especially as a result of becoming blind to alternatives.\)](#), the tendency to get “hung up” on wrong solutions or to become blind to alternatives (Sternberg, 2017). This usually occurs when, without giving it any thought, we place unnecessary restrictions on our thinking (McCaffrey, 2012). How, for example, could you plant four small trees so that each is an equal distance from all the others? (The answer is shown in [Figure 38.4](#).)

Figure 38.4

The Four Trees Problem.

Four trees can be placed equidistant from one another by piling dirt into a mound. Three of the trees are planted equal distances apart around the base of the mound. The fourth tree is planted on the top of the mound. If you were fixated on arrangements that involve level ground, you may have been blind to this three-dimensional solution.

The Four Trees Problem.

A prime example of restricted thinking is [functional fixedness \(Tendency to perceive an item only in terms of its most common use.\)](#), a tendency to perceive an item only in terms of its most common use (Bernstein & Lucas, 2008). If you have ever used a dime as a screwdriver, you've overcome functional fixedness.

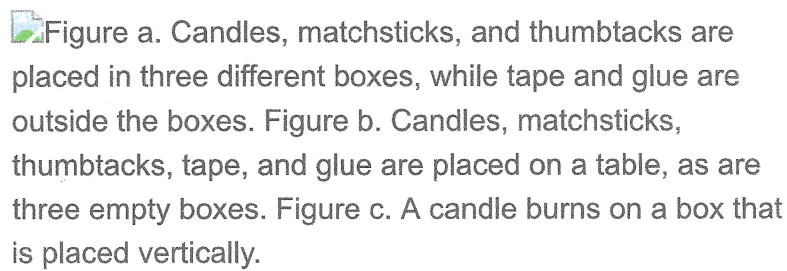
How does functional fixedness affect problem solving? Karl Duncker once asked students to mount a candle on a vertical board so that the candle could burn normally. He gave each student three candles, some matches, some cardboard boxes, some thumbtacks, and other items. Half of Duncker's participants received these items *inside* the cardboard boxes. The others were given all the items, including the boxes, spread out on a tabletop.

Duncker found that when the items were in the boxes, solving the problem was very difficult. Why? If students saw the boxes as *containers*, they didn't realize the boxes might be part of the solution (if you haven't guessed the solution, check [Figure 38.5](#)). Undoubtedly, we could avoid many fixations by being more flexible in categorizing the world (Kalyuga & Hanham, 2011; McCaffrey, 2012). For instance, creative thinking could be facilitated in the container problem by saying "This *could be* a box," instead of "This *is* a box."

Figure 38.5

The Candle Problem.

Materials for solving the candle problem were given to participants in boxes (a) or separately (b). Functional fixedness caused by condition (a) interfered with solving the problem. The solution to the problem is shown in (c).

Figure a. Candles, matchsticks, and thumbtacks are placed in three different boxes, while tape and glue are outside the boxes. Figure b. Candles, matchsticks, thumbtacks, tape, and glue are placed on a table, as are three empty boxes. Figure c. A candle burns on a box that is placed vertically.

When tested with the candle problem, 5-year-old children show no signs of functional fixedness. Apparently, this is because they have had less experience with the use of various objects. It is sometimes said that to be more creative, you should try to see the world without preconceptions, as if through the eyes of a child. In the case of functional fixedness, that may be true (German & Defeyter, 2000).

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39-1 Creative Thinking—Down Roads Less Traveled

Survey Question 39.1

What is the nature of creative thinking?

We have seen that problem solving may be based on algorithms, understanding, or insight. Routine problem solving usually requires logical **convergent thinking (Thinking directed toward discovery of a single established correct answer; conventional thinking.)**, where lines of thought converge on the answer. There is one correct answer and the problem is to find it.

What distinguishes creativity from more routine problem solving? **Creativity (Ability to combine mental elements in new and useful ways.)** is the ability to combine mental elements in new and useful ways. It is usually best achieved through **divergent thinking (Thinking that produces many ideas or alternatives; a major element in original or creative thought.)**, in which many possibilities are developed from one starting point. (See [Table 39.1](#) for some examples of convergent and divergent problems.) Furthermore, divergent thought tends to be **illogical thought (Thought that is intuitive, haphazard, or irrational.)**—intuitive, associative, or personal. Whereas problem solving is usually a consciously reflective processing activity, creativity more likely involves apparently unconscious experiential processing (Ritter, van Baaren, & Dijksterhuis, 2012).

Table 39.1

Convergent and Divergent Problems

Convergent Problems

- What is the area of a triangle that is 3 feet wide at the base and 2 feet tall?
- Erica is shorter than Zoey but taller than Carlo, and Carlo is taller than Jared. Who is the second tallest?
- If you simultaneously drop a baseball and a bowling ball from a tall building, which will hit the ground first?

Divergent Problems

- What objects can you think of that begin with the letters *BR*?
- How could discarded aluminum cans be put to use?
- Write a poem about fire and ice.

Creative thinking also involves *fluency*, *flexibility*, and *originality*. Let's say that you would like to find creative uses for the billions of plastic containers discarded each year. The creativity of your suggestions could be rated in this way: **Fluency** (In tests of creativity, *fluency* refers to the total number of solutions produced.) is defined as the total number of suggestions that you are able to make. **Flexibility** (In tests of creativity, *flexibility* is indicated by how many different types of solutions are produced.) is the number of times that you shift from one class of possible uses to another. **Originality** (In tests of creativity, *originality* refers to how novel or unusual solutions are.) refers to how novel or unusual your ideas are. By counting the number of times that you showed fluency, flexibility, and originality, we could rate your creativity, or capacity for *divergent thinking* (Runco, 2012; Runco & Acar, 2012).

It is worth noting that divergent thinking is also a characteristic of **daydreams** (A vivid waking fantasy.) (vivid waking fantasies). For most people, fantasy and daydreaming are associated with greater mental flexibility or creativity (Langens & Schmalt, 2002).

Regardless, no matter when or how it occurs, rather than repeating learned solutions, creative thinking produces new answers, ideas, or patterns (Lewis & Lovatt, 2013).

Problem finding is another characteristic of creative thinking. Many of the problems we solve are "presented" to us—by employers, teachers, circumstances, or life in general. **Problem finding** (The active discovery of problems to be solved.) involves actively seeking problems to solve. When you are thinking creatively, a spirit of discovery prevails: you are more likely to find unsolved problems and *choose* to tackle them. Thus, problem finding may be a more creative act than the convergent problem solving that typically follows it (Runco, 2015).

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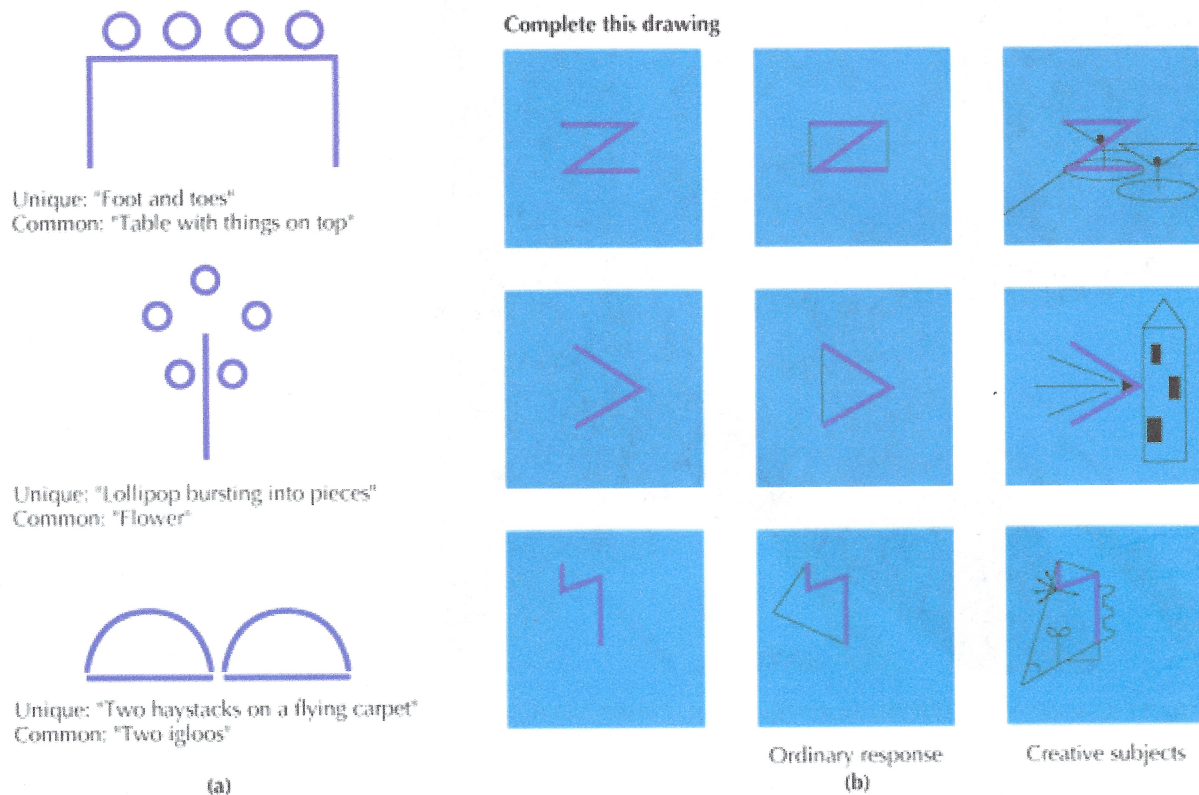
39-1a Tests of Creativity

Divergent thinking can be measured in several ways (Kaufman, 2009; Runco & Acar, 2012). In the *Unusual Uses test*, you would be asked to think of as many uses as possible for some object, such as the plastic containers mentioned previously. In the *Consequences test*, you would list the consequences that would follow a basic change in the world. For example, you might be asked, "What would happen if everyone suddenly lost their sense of balance and could no longer stay upright?" People try to list as many reactions as possible. If you were to take the *Anagrams test*, you would be given a word such as *creativity* and asked to make as many new words as possible by rearranging the letters. Each of these tests can be scored for fluency, flexibility, and originality. (For an example of other tests of divergent thinking, see [Figure 39.1](#).)

Figure 39.1

Some Tests of Divergent Thinking.

Creative responses are more original and more complex.

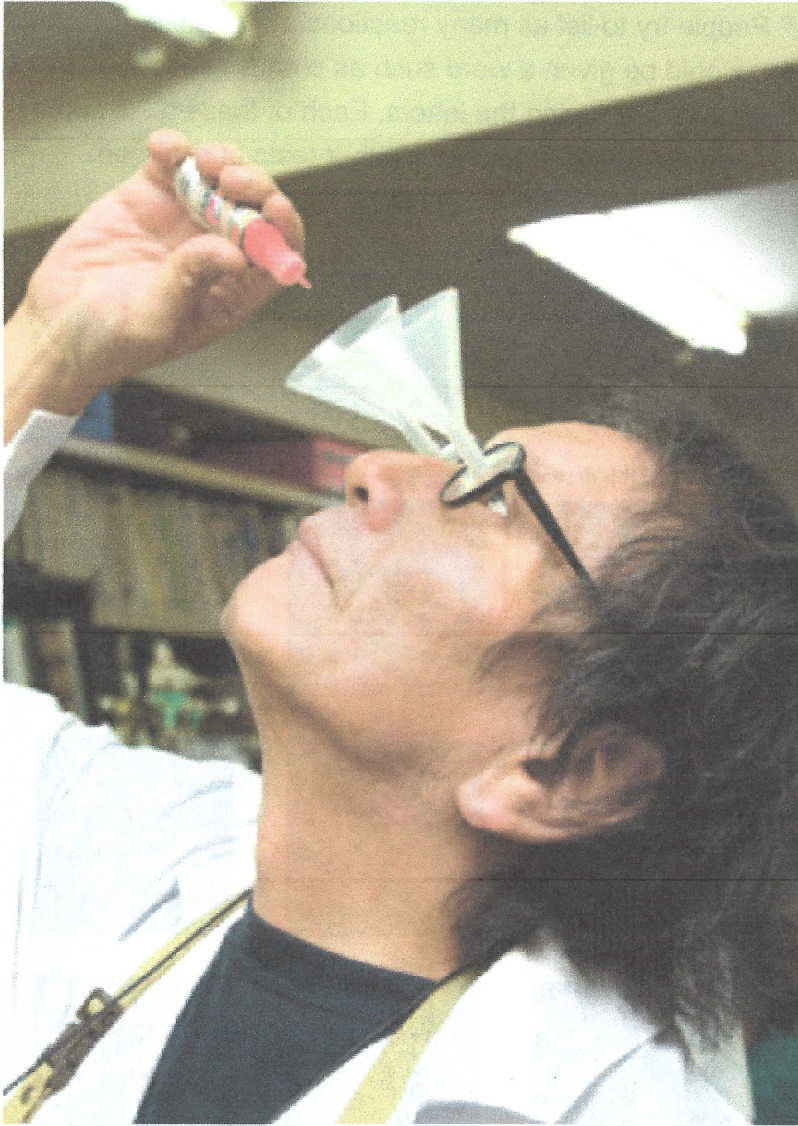


[(a) Adapted from Wallach & Kogan, 1965; (b) adapted from Barron, 1958.]

Isn't creativity more than divergent thought? What if a person comes up with a large number of useless answers to a problem? Good question. Divergent thinking is an important part of creativity, but there is more to it. To be creative, the solution to a problem must be more than

novel, unusual, or original. It also must be *high quality* and *relevant* to solving the original problem (Kaufman & Sternberg, 2010). This is the dividing line between a “harebrained scheme” and a “stroke of genius.” In other words, the creative person brings reasoning and critical thinking to bear on new ideas once they are produced (Runco, 2012).

Deliberately whimsical Japanese inventor Kenji Kawakami created these “eye drop funnel glasses” so that people with dry eyes can easily apply lubricating eye drops. In addition to being original or novel, a creative solution must be high-quality and relevant to the problem. Is this a creative solution to the “problem” of using eye drops?



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39-1b Stages of Creative Thought

Does creative thinking have a pattern? Typically, five stages occur during creative problem solving:

1. **Orientation.** As a first step, the person defines the problem and identifies its most important dimensions.
2. **Preparation.** It helps to be prepared *in general*, as an expert might be when first confronting a problem, but it also helps to become saturated with as much information about the *specific* problem as possible (Klein, 2013).
3. **Incubation.** Most major problems will have a period during which all attempted solutions are futile. At this point, problem solving may proceed on a subconscious level: although the problem seems to have been set aside, it is still “cooking” in the background.
4. **Illumination.** The incubation stage is often ended by a rapid insight or series of insights. These produce the “Aha!” experience, often depicted in cartoons as a lightbulb appearing over the thinker’s head.
5. **Verification.** The final step is to test and critically evaluate the solution obtained during the illumination stage. If the solution proves faulty, the thinker reverts to the stage of incubation.

Of course, creative thought is not always so neat. Nevertheless, the stages listed are a good summary of the most typical sequence of events.

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39-1c The Whole Human: The Creative Personality

What makes a person creative? According to the popular stereotype, highly creative people are eccentric, introverted, socially inept, unbalanced in their interests, and on the edge of madness. There may be some truth to this stereotype, at least when it comes to mood disorders (Kyaga et al., 2013; Smith et al., 2015; Young, Winner, & Cordes, 2013). Many of history's renowned artists, writers, poets, and composers, including Vincent Van Gogh, Edgar Allan Poe, Winston Churchill, and Ernest Hemingway, experienced pronounced mood swings.

In general, however, direct studies of creative individuals paint a very different picture (Hennessey & Amabile, 2010; Robinson, 2010):

1. Creativity test scores (which measure divergent thinking) and IQ test scores (which measure convergent thinking) are weakly correlated (Kim, Cramond, & VanTassel-Baska, 2010; Silvia, 2015). Highly creative people are not necessarily highly intelligent and vice versa.
2. Creative people usually have a greater-than-average range of knowledge and interests, and they are more fluent in combining ideas from various sources. They also are good at using mental images and metaphors in thinking (Riquelme, 2002).
3. Creative people are open to a wide variety of experiences. They accept irrational thoughts and are uninhibited about their feelings and fantasies. They tend to use broad categories, question assumptions, and break mental sets, and they find order in chaos. They also experience more unusual states of consciousness, such as lucid dreams and mystical experiences (Zink & Pietrowsky, 2013).
4. Creative people enjoy symbolic thought, ideas, concepts, and possibilities. They tend to be interested in truth, form, and beauty, rather than in fame or success. Their creative work is an end in itself (Robinson, 2010).
5. Creative people value their independence and prefer complexity. However, they are unconventional and nonconforming primarily in their work; otherwise, they do not have unusual, outlandish, or bizarre personalities.

Can creativity be learned? It is beginning to look as if some creative thinking skills can be learned. In particular, you can become more creative by practicing divergent thinking and by taking risks, asking unusual questions, analyzing ideas, and seeking odd connections

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39-2 Intuitive Thought—Mental Shortcut? or Dangerous Detour?

Survey Question 39.2

How accurate is intuition?

When creativity is expressed as a quick, impulsive thought, we speak of **intuition (Quick, impulsive thought that does not use formal logic or clear reasoning.)**. Sometimes rapid intuitive judgements can be as accurate as more reflective, rational consideration.

Think back to your least favorite teacher. (Not your current one, of course!) How long did it take you to figure out that he or she wasn't going to make your list of star teachers? Psychologist Nalini Ambady once asked people to watch video clips of teachers they did not know. After watching three 10-second segments, participants were asked to rate the teachers. Amazingly, their ratings correlated highly with year-end course evaluations made by actual students (Ambady & Rosenthal, 1993). Ambady obtained the same result when she presented an even thinner "slice" of teaching behavior, just three 2-second clips. A mere 6 seconds is all that participants needed to form intuitive judgments of the instructors' teaching!

Gladwell (2005) argues this is not a case of hurried irrationality. Instead, it is "thin-slicing," or quickly making sense of thin slivers of experience. Such immediate, intuitive, experiential reactions can sometimes form the basis of more carefully reasoned, reflective judgments. They are a testament to the power of the cognitive unconscious, which is a part of the brain that does automatic, unconscious processing (Bar-Anan, Wilson, & Hassin, 2010; Wilson, 2004). Far from being irrational, intuition may be an important part of how we think (Ritter, van Baaren, & Dijksterhuis, 2012).

The trick, of course, is figuring out when thin-slicing can be trusted and when it can't. After all, first impressions aren't always right. Have you ever had a teacher you came to appreciate only after the course was over? In many circumstances, quick impressions are most valuable when you take the time to verify them through more reflective observation (Tom, Tong, & Hesse, 2010).

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39-2a Errors in Intuitive Thought

Although intuition can sometimes provide accurate answers, it also can be misleading. Two noted psychologists, Daniel Kahneman and Amos Tversky (1937–1996), studied how we make decisions in the face of uncertainty. They found that human judgment is often seriously flawed (Kahneman, 2011; Kahneman, Slovic, & Tversky, 1982). Let's explore some common intuitive thinking errors, so you will be better prepared to avoid them.

Underlying Odds

One common error in intuitive judgment involves ignoring the [base rate \(The basic rate at which an event occurs over time; the basic probability of an event.\)](#), or underlying probability of an event. People in one experiment were told that they would be given descriptions of 100 people—70 lawyers and 30 engineers. Participants were then asked to guess, without knowing anything about a person, whether she or he was an engineer or a lawyer. All correctly stated the probabilities as 70 percent for lawyer and 30 percent for engineer. Participants were then given this description:

Eric is a 30-year-old man. He is married with no children. A man of high ability and high motivation, he promises to be quite successful in his field. He is well liked by his colleagues.

Notice that the description gives no new information about Eric's occupation. He could still be either an engineer or a lawyer. Therefore, the odds should again be estimated as 70–30. However, most people changed the odds to 50–50. Intuitively, it seems that Eric has an equal chance of being either an engineer or a lawyer. But this guess completely ignores the underlying odds.

Perhaps it is fortunate that we do ignore underlying odds at times. Were this not the case, how many people would get married in the face of a 50 percent divorce rate? Or how many would start high-risk businesses? On the other hand, people who smoke, drink and then drive, or skip wearing auto seatbelts ignore rather high odds of injury or illness. In many high-risk situations, ignoring base rates is the same as thinking that you are an exception to the rule.

Representativeness

Another common pitfall in intuitive judgment is illustrated by the following question: which is more probable?

- A. The New York Yankees will not be in the lead after the first half of the baseball season.

B. The New York Yankees will not be in the lead after the first half of the baseball season but will win their division.

People who follow baseball are likely to regard a statement like B as more probable than A (for those of you not in the know, the Yankees have historically been competitive in end-of-season and postseason play). However, this intuitive answer overlooks an important fact: the likelihood of two events occurring together must be lower than the probability of either one alone. For example, the probability of getting one head when flipping a coin is higher (one half, or 0.5) than the probability of getting two heads in a row (one fourth, or 0.25.) Therefore, A (the New York Yankees will not be in the lead after the first half of the baseball season) is statistically more likely than B (the New York Yankees will not be in the lead after the first half of the baseball season *but* will win their division).

According to Tversky and Kahneman (1982), such faulty conclusions are based on the [representativeness heuristic \(Mental shortcut of judging if something belongs in a given class based on similarity to other members.\)](#)—that is, we tend to give a choice greater weight if it seems to be similar to other members of a class we already know. Thus, you probably compared the information about the Yankees with your general impression of the Yankees as a highly successful team. Therefore, B might seem more likely than A, even though it isn't.

When intuitions are unknowingly based on representativeness, the results can be disastrous. In courtrooms, for example, jurors are more likely to think that a defendant is guilty if the person appears to fit the profile of a person likely to commit a crime (Davis & Follette, 2002). For example, a young, single man from a poor neighborhood would be more likely to be judged guilty of theft than a middle-aged, married father from an affluent suburb.

Framing

The most general conclusion about intuition is that the way a problem is stated, or [framed \(In thought, the terms in which a problem is stated or the way that it is structured.\)](#), affects decisions (Kahneman, 2011; Tversky & Kahneman, 1981). To gain further insight into framing, try this problem:

A couple is divorcing. Both parents seek custody of their only child, but custody can be granted to just one parent. If you had to make a decision based on the following information, to which parent would you award custody of the child?

Parent A: Average income, average health, average working hours, reasonable rapport with the child, relatively stable social life

Parent B: Above-average income, minor health problems, lots of work-related travel, very close relationship with the child, extremely active social life

Most people choose to award custody to Parent B, the parent who has some drawbacks but also several advantages (such as above-average income). That's because people tend to look for *positive qualities* that can be *awarded* to the child.

However, who would you choose if you were asked this question: which parent should be denied custody? In this case, most people choose to deny custody to Parent B. Why is Parent B a good choice one moment and a poor choice the next? It's because the second question asked who should be *denied* custody. To answer this question, people tend to look for *negative qualities* that would *disqualify* a parent. As you can see, the way a question is framed can channel us down a narrow path so that we attend to only part of the information provided, rather than reflectively weighing all the pros and cons.

Usually, the *broadest* way of framing or stating a problem produces the best decisions. However, people often state problems in increasingly narrow terms until a single, seemingly "obvious" answer emerges. For example, to select a career, it would be wise to consider pay, working conditions, job satisfaction, needed skills, future employment outlook, and many other factors. Instead, such decisions are often narrowed to thoughts such as, "I like to write, so I'll be a journalist," "I want to make good money and law pays well," or "I can be creative in photography." Framing decisions so narrowly greatly increases the risk of making a poor choice. If you would like to think more critically and analytically, it is important to pay attention to how you are defining problems before you try to solve them. Remember that shortcuts to answers often short-circuit clear thinking.

Cognition and Emotion

Another factor that bears mentioning is that "hot cognition"—thinking driven by emotions—also tends to affect good judgment (Lerner et al., 2015). Our emotional reactions to various possibilities can determine what intuitively seems to be the right answer. Emotions such as fear, hope, anxiety, liking, or disgust can eliminate possibilities from consideration or promote them to the top of the list (Kahneman, 2011). For many people, choosing which political candidate to vote for is a good example of how emotions can cloud clear thinking. Rather than comparing candidates' records and policies, it is tempting to vote for the person we like rather than the person who is most qualified for the job.

Of course, taking action in the heat of anger, passion, or stress may not be the wisest move. It may be better to cool down a bit before picking that bar fight, running off and eloping, or immediately declining that daunting job offer (Johnson, Batey, & Holdsworth, 2009). Personal rituals, such as counting to 10, meditating for a moment, and even engaging in superstitious behaviors such as crossing your fingers before moving ahead, can be calming (Damisch, Stoberock, & Mussweiler, 2010).

Cognition and Stress

"Venti, double-shot, sugar-free, peppermint, nonfat, double-cupped, extra hot, please." Overhearing the order while standing in line, the older woman remarked to her husband, "Don't you miss the days when all you could order was a coffee with cream and sugar?" Behind them, a young man whispered in his friend's ear, "Poor old people!" One stereotype of elderly people is that they have trouble coping with modern life. But are the elderly the only ones sometimes bewildered by tasks as "simple" as ordering a cup of coffee?

Isn't the freedom of having a wide variety of choices a good thing (Leotti, Iyengar, & Ochsner, 2010)? Maybe not. According to behavioral economist Dilip Soman (2010), even low-level stress can subtly influence how we think and act.

In one study, consumers were given an option to purchase jam. Half of them could choose from 6 different flavors; the other half had 24 flavors from which to choose. Although consumers with more choice expressed more interest, they were 10 times *less* likely to purchase *any* jam (Iyengar & Lepper, 2000). Similarly, restaurants with menus that feature a broader variety of choices often find that patrons are more likely to order from a smaller number of familiar choices (Soman, 2010). Apparently, businesses that increase the variety of their product offerings are not guaranteed increased sales (Greifeneder, Scheibehenne, & Kleber, 2010; Gourville & Soman, 2005).

It may be faintly amusing that people have trouble exercising choice in a coffee shop, grocery store, or restaurant. It's not that funny when more important issues are involved, such as choosing the best medicine or medical procedure. Imagine, for example, facing too many options when deciding whether to remove a seriously ill infant from life support (Botti, Orfali, & Iyengar, 2009).

Why are more complex choices so tough to make? Researchers such as Soman have identified a number of factors, such as increased stress, cognitive overload, difficulty remembering all the choices, and confusion about the possibilities (Soman, 2010). Although the growing complexity of modern life may increase our freedom, our choices may be expanding beyond our capacity to cope. It's OK to order a coffee with cream and sugar sometimes.

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