**Resources:** Ch. 4, 10, 13, 14, & 15 of : Thinking. An Interdisciplinary Approach to Critical and Creative Thought, Fourth Edition, Pearson Education; the Problem Solving and Action Example and Template

 **Choose**a real world problem from the news in the last few weeks.

 **Prepare** a 10- to 15-slide Microsoft® PowerPoint® presentation with speaker notes according to the following criteria:

* A description of the problem situation
* A problem-solving technique
	+ Identification of the technique
	+ Explanation of why the chosen technique works best for the problem
* Offer a solution to the problem.
* Reconstruct the decision-making process you used to come up with the solution.
	+ What criteria were used to make the decision?
	+ Is the decision emotional, logical, or both? Explain your answer.
	+ Identify the factors used in the decision-making process.
* Evaluate your decision.
* Was the decision logical? Why or why not?
* Did the decision solve the problem? Why or why not?
* Is there a way to evaluate the effects of the decision over time? Why or why not?
* Provide detailed speaker notes in the presentation file or in a separate document.

**Include**photos, illustrations, graphs, diagrams, animations, videos, or audio clips, as appropriate. Document the source of each media item you include.

**Format**your references consistent with APA guidelines. Include citations and references on a References slide.

**Chapter 4 The Mystery**

Our brain. It lies behind the creativity within the Sistine Chapel and the formulas of Einstein. It has taken humankind to the moon and will someday reach the stars. Perhaps only the universe itself can equal its marvel, yet we know so little of it. How can this physical organ create a private mental world that has no mass and no spatial location? Where are our thoughts? How are they generated by our brain? How has our identity become intricately enmeshed within it? These questions we cannot yet answer, and we leave them to the philosophers and neuro-scientists of the future. Here we take a brief, pragmatic look at what we do know about the brain, particularly how it affects our thinking, for though the brain is still a great mystery, we have begun to learn its secrets.

We have also begun to learn the secrets of memory—but only begun. This mystery within a mystery is the bedrock of thinking itself. It, too, has its points of wonder. How is it, for example, that a physical process in the brain can give rise to the memory of your grandfather? If you could take a journey inside your brain, where would he be found? While we can’t answer this question, it is worthwhile to think about it, for the activity of thinking enhances thought, just as the activity of memorizing enhances memory.

In what follows we look at the brain, its universe of neurons, the influences on the brain that affect our thinking, and ways to move our brain toward better thinking. We then explore memory, its impermanence, the reasons why we forget, and how we can remember better. With this understanding of our brain and memory, we can lay a stronger foundation for critical and creative thinking.

**Thinking and Our Brain**

As you read these words your brain is at work. Relying on earlier learning which associated certain line patterns with letters of the alphabet, your brain checks its own database for familiar combinations of these letter patterns and then recognizes the words or word phrases as individual units. Unfamiliar words, like “phacoemulsification” are flagged and processed with greater attention to each letter or syllable. As all of this is taking place your brain is simultaneously placing these words and word phrases in a context that gives them meaning; the words make sense. Your brain may then continue on to yet another step as you think about the meaning of the sentences themselves. For example, you might wonder about the complexity of this process, the fact that you have little control over it (try not to see the letters as words, for example), or whether there can be any kind of thinking without the brain (as in speculations about an afterlife). As you continue to process these words, you might also judge the value of this information, compare it with other information you already have, or wonder about the point the authors are making. You might even think about whether a machine could ever be developed that can do what you are doing now. All this wondering, valuing, and organizing is done with your brain. Alter the brain or destroy it and the character of this process changes or ceases altogether.

The brain is incredibly complex and has the potential to handle huge thinking demands. It contains more than one trillion cells, about a hundred billion of which are neurons. These neurons are the single-cell messengers that carry out the responses that comprise our thinking and movement activities. It would take you about 4,731 years to count them all if you counted one number per second every minute of your waking life! But that’s just the beginning, for each of these 100 billion neurons has 1,000 to more than 200,000 contacts with other neurons, each neuron sending and receiving messages up to 1,000 times a second. With this incredible, dynamic interconnectedness, the number of different pathways in the brain is unimaginable!

What we consider to be critical thinking ability is located in the outer part of the brain, that wrinkled skin called the *cortex*. The cortex is about one-tenth of an inch thick and is convoluted, which explains how its one and two-thirds square feet of surface area can fit within the confines of the human skull. The cortex alone contains more than ten billion neurons. In one square inch of this cortex there are about ten thousand miles of nerve cell connections! In the entire cortex, if we layed these connections out end to end, they would stretch to the moon and back to earth—and then to the moon again! (Davis, 1984). It is here, in this incredibly expansive cortex, that all the higher intellectual processes take place. The rest of the brain is responsible for lower functions, such as emotions, hunger, and basic life-sustaining processes, although even these are influenced by input from the cortex.

We are still in our infancy in understanding how our brain’s universe of neurons interact to create thinking, but we have made some significant progress. We know, for example, that brain neurons do not touch; they communicate by sending tiny amounts of chemical substances called *neurotransmitters*across a *synapse,* the microscopic space between “adjacent” neurons. Fifty-three different types of neurotransmitters have been identified so far (Ratey, 2001), with perhaps hundreds waiting to be discovered. The balance between these neurotransmitters is rather delicate. A glass of wine, a strong cup of coffee, a poor night’s sleep, a candy bar, or a common cold pill can affect it. Even falling in love can change the chemistry of the brain. When this chemistry changes, the way we perceive and think about reality changes too. Below we briefly address some of the variables that can impact the brain in a way that affects our critical thinking abilities.

**Thinking Activity****4.1. An Exercise in Mental Discipline**

Do you agree with the Eastern analogy of the mind that thoughts jump hither and thither like monkeys jump from tree branch to tree branch? To check out this “monkey mind” analogy, try a simple meditation exercise for ten minutes. Sit in a comfortable chair in a quiet room and try to keep your attention on only one thing, like a mental image of a candle flame, the sound “ah nam” silently repeated to yourself, or a blue vase. When you find yourself thinking about something else, bring your attention back to your object of meditation. After doing this exercise, what do you think about the extent to which you consciously control your thinking?

**Food and Drugs**

*O God! that men should put an enemy in their mouths to steal away their brains.*

SHAKESPEARE, *OTHELLO*

Clearly the brain needs food. Like the rest of our body, it requires energy, specifically glucose, which it gets from the body’s conversion of starches and sugars. Like the rest of the body, the brain also needs protein and vitamins for proper functioning. Without adequate nutrients, intellectual impairment results:

In an intensive study of the children of North American Indians, Dr. Ernesto Pollitt, of the Massachusetts Institute of Technology, demonstrated a 50 percent decrease in behavioral performance in severely malnourished children. Memory, abstract reasoning, thinking, and verbal ability were most affected. (Restak, 1979, pp. 107–8)

But we do not have to be malnourished to notice the effects of nutritional deficiency on our thinking. Simply trying to go through the day with too few calories impairs our ability to concentrate, as any student knows who has tried to concentrate on a lecture on an empty stomach.

Of particular importance to thinking are the B vitamins. Vitamin B deficiency has been linked to problems in memory, concentration, and depression. In acute cases of vitamin B deficiency, particularly thiamine, Korsakoff’s syndrome may develop. This is a chronic disorder that, even after the vitamin deficiency is corrected, creates gross deficits in recent memories. This syndrome primarily affects alcoholics, for alcohol rapidly depletes the body of essential B vitamins.

Besides depleting the body of vitamin B, alcohol also impairs our thinking, particularly judgment and decision making, through its intoxicating effects. Heavy, prolonged drinking changes brain tissue and may permanently retard intellectual abilities. Specifically, it can retard problem solving, impair learning and perception, and reduce attention. These effects are due to the underlying brain damage inflicted by chronic alcohol abuse. This damage occurs because alcohol interferes with neurotransmitters, kills brain cells, causes neuron atrophy and incorrect growth, and shrinks the brain (Oscar-Berman et al., 1998;Barinaga, 2000). Areas that are targeted include the limbic system, responsible for memories, and the cerebral cortex, where our higher-thinking activities occur (Oscar-Berman et al., 1998). Though not everyone responds to alcohol in the same way, the more alcohol one drinks, the more likely these pernicious effects will occur.

Besides alcohol, another legal and very popular drug in the United States is nicotine, most commonly absorbed through cigarette smoking. Studies on the effects of smoking on memory and learning are mixed. Some have found that smoking enhances learning and memory, especially short-term recall; others have found it to have a deleterious effect. Reviews of some of these studies (Adler, 1993a;Bower, 1993) suggest that the positive effects of smoking on learning and memory seem to pertain only to simple memory tasks, and these positive effects may benefit only those who are already addicted to nicotine. Regarding more complex memory and learning tasks, however, nicotine has been found to be detrimental, decreasing logical reasoning abilities, impairing performance on complex memory tasks, reducing problem-solving ability, and adversely affecting recall of critical information in essays. Similar effects are experienced during nicotine withdrawal and may linger for one to two months afterward (Adler, 1993b). A later study found a relationship between heavy smokers (greater than twenty cigarettes per day) and cognitive decline during middle age (Richards et al., 2003). While researchers are continuing to explore the possible learning and memory enhancements of nicotine, they seem to agree that cigarette smoking’s potential for harm far outweighs any memory and learning enhancement so far discovered. If the above is not enough reason to stop smoking, consider the effects of smoking on the developing fetus’s brain. Smoking increases the risk that the newborn will be mentally retarded by 50 percent and raises the risk of attention deficit disorder by threefold (Ratey, 2001, p. 26).

**Think About It**

*It is common knowledge that women who drink while pregnant may cause their baby to be born with fetal alcohol syndrome, a group of birth defects that includes mental retardation and facial and limb abnormalities. Yet, according to a 1996 report (cited in Barinaga, 2000), 20 percent of women who drink alcohol continue to drink while they are pregnant. Does this show the power of addiction over sound thinking? Or is there another explanation? What do you think?*

Marijuana is the most popular illicit drug in the United States. One animal study found that chronic exposure to moderate levels of THC, the main active ingredient in marijuana, accelerated brain-cell death in the hippocampus, a critical brain structure for long-term memory formation (Landfield, Cadwallader, and Vinsant, 1988). Human studies have also found detrimental effects of marijuana on the memory system (e.g. Lane et al., 2005). These studies also show attention deficits among marijuana smokers (e.g., Pope and Yurgelun-Todd, 1996). And more than one study has found that the effects on memory of long-term users of marijuana endure beyond the period of intoxication and worsen as marijuana use continues (e.g., Solowij et al., 2002; Bolla et al., 2002). This is compatible with earlier research that has found attention deficits and decreased motivation among regular marijuana users. Even occasional use of marijuana harms thinking, but as marijuana use becomes heavier and longer, the cognitive deficits increase. In addition to these deficits in attention and memory, other neurological deficits have been found, such as the relationship between marijuana smoking in adolescence and the increased risk of developing a mental illness later in life (Ferdinand et al., 2005). The mechanism behind these neurological deficits is not yet known, but it might involve the reduced blood flow to the brain that occurs among marijuana smokers—and lasts beyond the cessation of the drug (Fackelmann, 2005). In short, marijuana correlates with an increased risk of later mental illness, reduces blood flow to the brain, and retards learning by negatively affecting the attention and memory systems. Because of the deficits in attention and memory, students who study while smoking marijuana are wasting a lot of their time. And though marijuana smokers believe it enhances their creativity, one study found that in fact it does not (Tinklenberg et al., 1978).

Another drug that can affect thinking is cocaine, a stimulant that, taken daily in large doses, can produce irritability and disturbed concentration. With chronic, heavy use it can lead to paranoid thinking and perceptual disturbances (Grinspoon and Bakalar, 1985). Even those who never ingested cocaine may suffer its effects if they were exposed to it in the womb. Research with humans and animals have found that prenatal exposure to cocaine has subtle but significant effects after birth, such as concentration difficulties and greater susceptibility to distractions. Animal research suggests that these effects are due, at least in part, to abnormal growth of brain neurons (Vogel, 1997). Brain abnormality of those prenatally exposed to cocaine is also suggested by research that has found a difference in EEG measures in infants who were prenatally exposed (Scher, Richardson, and Day, 2000). Research in this area is challenging and not all conclusions are consistent (e.g. Hurt and Malmud, 1997), but apparently cocaine is not a brain-friendly drug.

Other commonly abused drugs, also in the stimulant class, are the amphetamines. These drugs are commonly used to maintain wakefulness and alertness or to increase metabolism and suppress appetite. Although they do have these effects, in heavy use over several days they can cause paranoid delusions, hallucinations, irritability, and insomnia—and distortions in thinking and social functioning that result from these effects. A drug user’s “irritability and paranoia may cause fights and unprovoked violence and drive their friends away; their preoccupation with the drug has a disastrous effect on their family relationships and work” (Grinspoon and Bakalar, 1985). When discontinued after prolonged use, they can lead to depression and even suicide.

Ecstasy (MDMA), a drug with amphetamine and hallucinogenic properties, became a popular “club drug” in the early 1990s and continues to be popular. Studies are finding that this drug may cause memory problems and other cognitive impairments, such as mental processing speed. The memory effects can last at least a year after the drug has been discontinued (“Study: Ecstasy may cause,” 2001; “Study links cognitive deficit,” 2004).

All of these drugs interact with the brain at the synapse, increasing or decreasing the brain’s natural chemical activity. Even though their pharmaceutic effects are different, they all have in common the ability to disrupt our cognitive abilities—and in some cases the deficits seem to last after the drug is discontinued, leaving open the possibility of permanent cognitive damage.

**Think About It**

*Many people considered to be very brilliant, some to the point of genius, developed ideas and theories that conflicted with those of other very brilliant persons. For every brilliant determinist we can find an equally brilliant proponent of free will; for every empiricist, a rationalist; for every pessimist, an optimist; and for every theist, an atheist. In one sense almost all of them are mostly or entirely wrong, assuming there can be only one correct view. That being the case, what is our basis for considering these people to be extraordinarily brilliant?*

**Sleep**

We need sleep to think; perhaps that is why we spend one-third of our lives sleeping. The important stage of sleep for critical thinking is the rapid eye movement (REM) stage, during which dreaming occurs. When people are more intellectually active during the day, they dream more (Smith and Lapp, 1991), and when they are deprived of dream sleep, they have cognitive impairments, such as reduced memory capabilities (Li et al., 1991; Drummond et al., 2000) and impaired concentration (Horne, 1985). These studies and others (e.g., Louie and Wilson, 2001) suggest that dreams are crucial for solidifying learning that takes place during the day and that our daily sleep is necessary for optimal cognitive functioning.

So how much sleep should we get each night? There is still no consensus among experts, but one study of college students found that only those who slept at least six hours improved on a learning task, and those sleeping eight hours improved the most (Blakeslee, 2000). A later study supported these findings. People who slept only six hours or less produced cognitive deficits equal to two nights of total sleep deprivation (Van Dogen et al., 2003). Although sleep needs vary, most people will need much more than six hours for optimum cognitive functioning. Some researchers are now recommending between nine and ten hours, which is closer to our ape cousins (Brownlee, 1999a; Coren, 1996). This recommendation seems particularly relevant for teenagers and young college students who are going through biological maturation and straining their cognitive resources with brains not yet fully developed. Sleep deprivation for this group correlates with poor academic performance (Wolfson and Carskadon, 2003). And though we may “get by” with less sleep and be unaware of the effects of our sleep loss, we will still suffer the consequences of sleep deprivation. Sleep debt can negatively affect mood, motivation, memory, decision making, concentration, problem solving, and logical thinking (Coren, 1996). One sleep expert estimates that for teenagers those consequences translate to a loss of one IQ point per day for each hour short of eight hours of sleep—accumulating throughout the week (Brunet, 1997). Fortunately, he also believes the loss can be recovered by sleeping on weekends. Time for a nap?

**Think About It**

*The lowered reasoning ability of people with a sleep debt has been taken advantage of by professional negotiators who intentionally keep their parties up very late at night and continue the meeting early the next morning. One negotiator admitted to keeping the caffeinated coffee available all night to further reduce their sleep. In the end, an agreement is more easily reached because participants get sloppy, forget details, and lose their motivation to fight over anything but the major issues (Coren, 1996). Is this ethical?*

**Thinking Activity****4.2. Critical Reading Before We Sleep**

To illustrate how mental fatigue can hinder critical thinking and concentration abilities, read the following passage on the unconscious by C. G. Jung and the poem by Emily Dickinson just before you fall asleep, or during some other period when you are mentally fatigued. (Don’t do it now!) Then, shortly after you awake, read them again. Granted, you are reading them for the second time and may understand them better because of that, but you should also notice the difference between your ability to concentrate the first time as opposed to the second. How does your first reading compare with your second?

The Passage from Carl Jung:

We cannot overlook the fact that, just as consciousness arises from the unconscious, the ego-centre, too, crystallizes out of a dark depth in which it was somehow contained in potentia. Just as a human mother can only produce a human child, whose deepest nature lay hidden during its potential existence within her, so we are practically compelled to believe that the unconscious cannot be an entirely chaotic accumulation of instincts and images. There must be something to hold it together and give expression to the whole. Its centre cannot possibly be the ego, since the ego was born out of it into consciousness and turns its back on the unconscious, seeking to shut it out as much as possible. Or can it be that the unconscious loses its centre with the birth of the ego? In that case we would expect the ego to be far superior to the unconscious in influence and importance. The unconscious would then follow meekly in the footsteps of the conscious, and that would be just what we wish. (Jung, 1983, p. 218)

Now read this untitled poem by Emily Dickinson (1924, pp. 223–24).

* I heard a fly buzz when I died;
* The stillness round my form
* Was like the stillness in the air
* Between the heaves of storm.
* The eyes beside had wrung them dry,
* And breaths were gathering sure
* For that last onset, when the king
* Be witnessed in his power.
* I willed my keepsakes, Signed away
* What portion of me I
* Could make assignable,—and then
* There interposed a fly,
* With blue, uncertain, stumbling buzz,
* Between the light and me;
* And then the windows failed, and then
* I could not see to see.

**Our Thinking Potential**

If we avoid the substances and practices that can dull our thinking, and work positively on the suggestions in this book to sharpen our cognitive skills, we can begin to fulfill our own unique potential to think. Our brain can be moved toward greater thinking.

For our thinking to grow, our brain must grow. Like a muscle, it must be worked to reach its maximum capabilities. Without intellectual work and stimulation, our minds will not develop to their potential. Ideally, this stimulation should begin during the first three years of life. Talking to infants might be the best kind of stimulation they can receive at that young age. But stimulation shouldn’t stop there. New research is finding that the human brain grows dramatically through the first fifteen years, and then slows just as dramatically after that. From ages three to six, parts of the brain involved in planning and organizing new actions and in maintaining attention develop most rapidly. From ages six to puberty accelerated growth shifts to the areas involved in language and spatial relations (Thompson et al., 2000). The brain does not complete its basic hardwiring until the early twenties! (Brownlee, 1999b). Enjoying a robust environment during these formative years will help the brain reach its thinking potential.

Many studies have shown the effects of environmental stimuli on intellectual development. Some of these studies involved orphans and other children who were raised in a sterile, impoverished environment. Other studies used rats in an experimental design in which some were raised in a rich, complex environment and others in a sterile one. What these studies find is that a rich, stimulating environment is necessary for the actualization of the brain’s intellectual capacity. Raise an organism in an intellectually unchallenging environment and its intelligence becomes stunted.

While it is best to nourish the brain when young, the good news is that even as adults we can improve our brain. One study found that even aged rats who had lived all their lives in a sterile world could benefit from a stimulating environment (Greenough, 1988). Put in a world with mazes, bridges, and spinning wheels, these rats developed an average of 2,000 new synapses *per neuron*. It would be unethical to perform such a study with human beings, of course, but the implication of this research is that it may never be too late for us to start growing toward our potential. And if that isn’t enough to motivate us to use our mind, consider this: studies (e.g., Gagnon et al., 1990) have found that the longer we stay intellectually active, the less chance we have of developing dementia, a brain disease that insidiously degrades intellectual functioning. Do you feel like taking up a foreign language about now?

If we get our sleep, avoid drugs (including alcohol), eat right, and stimulate our brain with intellectual activity, we may expand the potential of our brain. But does the nature of our brain limit our understanding of the world? It probably does, although it is difficult to know the extent to which it does. The situation is something like a blind man trying to know a world of colors and light, which he cannot experience.

If we reflect for a moment on our experience, we can see that we have only five senses that feed our brain the information we use to think. It is possible that there are six, seven, or more than a hundred ways to experience the world. We have no reason to suppose that we possess all the senses necessary for a complete understanding of the universe. Even the experiences we are given with our senses may not represent the true reality. Is your pen really blue? Or is that blueness just the relationship between your pen, your sense organs, and the way your brain processes the sensory data? Does the colorblind man see it wrongly or just differently? Do we have sufficient justification for believing that our brain and sense organs bring the “real” world to us? Could it be that our brain structures reality as much as it discovers it? The philosopher Immanuel Kant believed that causation, space, and time are structures imposed upon the world by our brain. The Oxford mathematician Roger Penrose (1989) takes a similar view:

The “time” of physical descriptions does not really “flow” at all; we just have a static-looking fixed “space-time” in which the events of our universe are laid out! Yet, according to our perceptions, time does flow. My guess is that there is something illusory here too, and the time of our perceptions does not “really” flow in quite the linear forward-moving way that we perceive it to flow (whatever that might mean!). The temporal ordering that we “appear” to perceive is, I am claiming, something that we impose upon our perceptions in order to make sense of them in relation to the uniform forward time-progression of an external physical reality. (p. 444)

In sum, our brain, as healthily as we might maintain it, probably limits our ability to perceive and think about the world. It is likely that if our neurons fired faster, if they were organized differently, or if our brains were slightly larger, our experience of reality would be quite different than it is today. Thus, our thinking may not be perfect thinking yielding absolute truths about reality, just the best sound thinking we can do with the brain instrument we are given.

**Think About It**

*We know that drugs can alter our perception of reality and distort our thinking. Yet the brain is also a drug machine in its normal state. Does the normal “drugged” state of the brain limit and distort our thinking too? What state of the brain gives us a “true” picture of reality?*

**Brain and Mind**

One of the most important philosophical problems concerns the relationship between the brain and the mind, Known as the *mind-body problem,* it involves two fundamental (and related) questions: (1) are the brain and mind separate entities? (2) in what way are brain and mind related? The brain is rather simply defined as the physical organ or mass of nervous system tissue enclosed by the skull. Most people know to what we refer when we speak of the brain. There is less agreement, however, about the definition of mind. It is not the physical organ under our skull that we refer to when we speak of our mind. Rather, mind is normally defined as the organized structure of our mental processes, including remembering, thinking, perceiving, and experiencing. Sometimes it is seen as synonymous with consciousness, but then what of the unconscious? Is that not part of the mind? One might say that the neuron is of the brain, but our memories of first grade are of our mind, part of our mental world. But what is that mental world? Is it merely a property of the brain? Is it generated by the brain? Or does the brain simply receive mind and interpret mind, much like a radio station receives radio signals? Does the mind drive the brain? Or does the brain drive the mind? Can mind exist at all without the brain? If so, what is its nature without a brain, and how do we account for the apparent connection between the two such that a change in brain tissue seems causally related to a change in mental experience?

Interestingly, the brain and the mind seem to have different properties. The brain has mass, is public (it can be seen during an autopsy), and is located in space. Our mental world, however, is private (no one knows what you’re thinking), has no mass, and is not located anywhere in space (so far as it appears). When we refer to our memory of our grandfather, we don’t equate it with the sequence of neuron firings that occur during our recollection. So how can a brain, which has properties that our mental life does not, and does not seem to be the same as our mental life, give rise to mind? Or vice versa? Are brain and mind two aspects of something else? Is matter an illusion? (It does seem to disappear as our exploration of it deepens.) Or is mind somehow a form of matter?

Finding the answers to these questions will help to solve other important philosophical problems like determinism versus free will and the possibility of survival after death. There are good arguments on many sides of this mind-body issue, but none has provided a definitive conclusion—and perhaps no argument ever will, for as one philosopher puts it, “there is room for the possibility that the nature of mind and matter might not be accessible to human thought:”

I do not believe that any current theory makes a significant dent in the mind-body problem. I thus hold that the relation between the mind and the body is a deep mystery. More than that. . . . I take it to be a *permanent* mystery. (McGinn, 1997, p. 6–7)

In this chapter we have made statements such as “Our brain can be moved toward greater thinking” and “For our thinking to grow, our brains must grow.” Obviously these statements could be challenged, depending on one’s point of view on the mind-brain relationship. It is difficult to satisfy all theoretical points of view on this issue, and we do not mean to support any particular theory of mind.

**Thinking and Memory**

*The past is what you remember, imagine you remember, convince yourself you remember, or pretend to remember.*

HAROLD PINTER, PLAYWRIGHT

Without at least some brief memory, we could not think. For even adding the numbers 6 and 3 requires memory of 6 as we add to it 3. Without memory there could be no thinking based upon experience and there would be no continuity to our world. We would be fully immersed in the present and have no future to imagine, no past to consider. We wouldn’t know who we were or where we were going. Being conscious in this perpetual present seems conceivable to some, but thinking in it seems unimaginable.

Thinking and memory are inseparable. What we think depends both on our ability to remember and on the content of that remembering. A poor memory or a distorted memory makes it difficult for us to think successfully. Even a good memory, however, is not perfect. In spite of how certain we may be about prior events, we can be wrong. Therefore, we must listen to the recollections of others and be open to the possibility that their stories offer a more accurate version of what we experienced. We must also back up our memory with hard data and write down events that we know we will be expected to recollect later, and we must work actively to encode information through meaningfulness, practice, and the use of mnemonics. Below we look briefly at how memory can deceive our thinking, why we forget, and how we can improve our memory.

**The Changing Nature of Memory**

When memories are laid down in the brain, the neurons related to those memories undergo physical changes. Neurons branch out to make more connections, and they become able to fire more efficiently, needing less neurotransmitter stimulation. But exactly how these and other physical changes can lay down memories in the brain is still quite a mystery. What we do know, however, is that memories, no matter what their physical underpinnings, are subject to change. Before reading further about memory, take time to complete the thinking activity below.

**Thinking Activity****4.3. Memories of Childhood**

Take a moment to recollect the first time you learned to ride a bicycle or, if that’s too difficult, one of the first times you rode a bicycle. Remember this in as much detail as you can before reading the next paragraph.

If your memory is an exact copy of what you experienced, then you have recalled no more than the front of your bicycle, your arms and hands on the bicycle handlebars, the sidewalk or road ahead, and some houses or trees on the side depending on where your experience occurred. If you remembered more than that and have visualized your head (which you did not see), your grandfather pushing you (whom you did not see), the rear wheel of the bicycle (which you did not see), and so on, you are adding to your actual visual experience. Almost everyone adds information to these experiences. These additions are often consistent with the meaning of what happened but are not perfect reproductions of the actual event.

From the above exercise it becomes clear that we actually reconstruct our memories as opposed to retrieving an exact copy of our experience. This reconstruction often, but not always, moves in the direction of the meaning of the experience. That is, although these memories are not necessarily accurate in their details, they may nonetheless be consistent with the meaning that we gave the experience. One of the earliest experiments to demonstrate this (Carmichael, Hogan, and Walter, 1932) found that if we show subjects a picture of something that looks like a very thick letter C or a very thin quarter-moon and tell them it’s the letter C, they will tend to remember it later as looking thinner, much more like the letter C than a quarter-moon. And when other subjects are shown the same stimulus but are told it is a quarter-moon, they later remember it as much thicker than it was, looking more like a quarter-moon. In other words, people’s memories are distorted in the direction of the meaning of the stimulus, in this case the letter C or the quarter-moon.

The importance of meaning to our recollections of events cannot be dismissed lightly, because throughout our daily lives we continuously give meaning to the great and small experiences we endure. A dog bite might be experienced at the time as a minor nuisance but remembered as even more trivial than it was. On the other hand, if a dog bite was originally perceived as an awful ordeal, then perhaps with time our recollections of it will make it much worse than it was. The dog becomes larger, the bite more severe, the duration of battle lengthens, and the dog’s owner becomes more indifferent, or even sadistic. Indeed, it appears our lives are but true tales embedded in fiction.

The memories that are most subject to change are episodic memories, those memories of biographical events in our lives. Other kinds of memory, such as perceptual-motor memory (memory for how to perform skills like riding a bicycle and operating heavy machinery) and semantic memory (memory of our own language, of what a dog is, and how to add numbers) are less vulnerable to distortion. But what about episodic memories of emotional events that seem to freeze time? Examples of such events are the bombing of Pearl Harbor, John F. Kennedy’s assassination, the explosion of the space shuttle Challenger, and the events of September 11. Many Americans can recall in vivid detail where they were and what they were doing when they heard or saw the news of these events. But as we explore these memories, we find that these, too, vivid as they are, may be erroneous; in fact, most of our memories are quite subject to change. Some, in fact, are complete fabrications, stories that appear to come from nowhere with no grounding in facts whatsoever, yet believed to be true by the people holding them.

**Think About It**

*Have you ever told a story and embellished it to add more excitement to it, and then one day, as you were telling it for the tenth time, you caught yourself starting to believe the embellishments? How often do you suppose you’ve told such stories, failed to catch yourself slipping over the edge, and ended up believing your own created fiction?*

Experimental research has found differences among people in their tendency toward false recollections, which could be due to innate differences or variances in personal histories (e.g., Clancy et al., 2000). Despite these differences, most people are especially prone to recalling distorted or fabricated memories while under hypnosis. Leading questions by the hypnotist or expectations of the subject under hypnosis can lead to fabricated memories. In spite of what most people think, if people undergo hypnosis to retrieve lost memories, the memories they retrieve are likely to be confabulations (false memories) instead of accurate recollections, and the confabulations revolve around the expectations of the hypnotist or the subject. Such confabulations might describe recollections of past lives and have been used to explain some false memories of incest abuse (Goldstein, 1992; Wassil-Grimm, 1995).

The following anecdote is a good example, albeit extreme, of the constructive nature and unreliability of memory. The anecdote seems to describe a reconstructed memory that is not consistent with actual events, yet the rememberer considers it to be true.

The vet had come to this psychologist complaining that he suffered from constant nightmares from his years in Vietnam. He would awaken sweating, heart pounding, surrounded by images of his wounded buddies, visions of blood and gore everywhere. Unable to turn off the state of constant readiness that served him well in the foxhole, he startled at the slightest sound, reflexively reaching for his knife. During sessions the vet would cry about the buddies he’d seen murdered or would scream out in horror at a combat memory. The experienced psychologist treating him would reassure him that the war was over and he was now safe at home.

Nonetheless, the vet could not be saved, and he committed suicide by inhaling carbon monoxide. Following his death, his widow attempted to get his name put on the Vietnam Memorial in Washington, D.C., since she felt he was justifiably a “casualty of the war.” An extensive search of the man’s military record showed that he had never set foot in Vietnam. (Wassil-Grimm, 1995, p. 93)

**Forgetting**

Not only do memories change and impair our thinking, but we can forget them entirely. Some memories actually seem meant for forgetting, like a telephone number that we will never use again. These short-term memories last only about twenty to thirty seconds without rehearsal. Once they fulfill their purpose, they are forgotten and are probably not retrievable.

The memories most important for most of our thinking are our long-term memories. These are the memories that we need to perform well on exams, discuss the philosophy of Plato, and think critically about the world around us. Contrary to what most people believe, most of our long-term forgetting occurs shortly after learning; the rate of forgetting tapers off with time. For example, most of what we remember one year after a college course we will remember two years later, but much of what we remember from our reading today will be forgotten in a few weeks.

**Recall Versus Recognition**

It is much easier to recognize information than to recall it. In one study that dramatically illustrates the power of recognition (Haber, 1970), subjects were shown 2,560 photographic slides at the rate of one every ten seconds. One hour after the last picture was shown, each subject was then presented with 280 pairs of pictures. One picture in each pair was from the set of 2,560 pictures; the other was from a similar set. Each subject was asked to identify the picture that was also in the set of 2,560. What do you suppose the accuracy rate was? One might expect an accuracy rate on a recall task of this sort to be no greater than 10 percent. In this recognition experiment, however, accuracy rates were between 85 and 95 percent! This is one good reason why police departments use mug shots to help victims identify criminals. Unfortunately, we often do not have a choice about how we are to recall information. But whenever we do, the recognition option is usually more successful.

**Why We Forget**

Sometimes we forget because to remember would be painful. This theory of forgetting, called*repression,* suggests that we forget more of the unpleasant events in our lives than the good. This idea has found some empirical support through numerous case studies. Unfortunately, all of us can remember some bad events; no one knows why some negative experiences are repressed and others are not.

Another reason we forget is because other information, especially similar information, interferes with what we are trying to remember. This interference theory of forgetting explains the problems and frustrations of cramming. At the beginning of the cram session we may accurately associate names with events and theories, but as the information builds so does interference, and we often find ourselves associating names and events incorrectly. Cramming does increase learning, but because it requires more study time to overcome the interference problems, we would do better to space our study out over time.

**Think About It**

*The interference theory suggests that we not study two foreign languages simultaneously. What other subjects may pose interference problems if studied concurrently?*

A third reason why we forget is because we can’t find the right cues. Cues can be names of categories (tools), the location in which an experience occurred (Washington Park), certain smells (plum trees), and so on. Even our emotional state might serve as a cue. When we are sad, we can remember sad things more easily than happy events, and vice versa (Baddeley, 1990). Why we can’t retrieve the right cues is unknown, but often it may be that strong, distinct cues were never associated with the information initially.

Stress is also detrimental to memory. Studies are finding that certain hormones that are increased during physical and emotional stress can impair recall. The culprits are corticotropin-releasing hormones (CRH) produced by the hypothalamus, and glucocorticoids produced by the adrenal gland: corticosterone, cortisone, and cortisol. High levels of CRH produced under stress can interfere with memory and learning by damaging the neurons in learning and memory areas of the brain, particularly the hippocampus. Damage done in stressful early years, such as that occurring during child abuse, may even affect memory in adulthood (Karten, Olariu, and Cameron, 2005). With respect to the glucocorticoids, one interesting study with rats found that stress in the form of electric shock interfered with the recall of memories through the effects of corticosterone (De Quervain et al., 1998). A later study with humans supported these results. Subjects were asked to memorize sixty verbs and were then given cortisone an hour before being tested. The results: scores from the cortisone group dropped by 35 percent (De Quervain et al., 2000). These findings might explain some of the memory problems that coincide with depression and old age, two conditions that correlate with higher cortisol levels. These studies may also explain memory problems of court witnesses who are under duress, or other human memory errors that occur under stressful conditions—such as failing memory due to test anxiety. Those most likely to succumb to the pressures of test anxiety are the students who would have performed better than their peers had there been no such pressure. In other words, the best without pressure succumb the most with it (“Tests and Stress,” 2005).

**Think About It**

*Why is it that some students who know the material for a test cannot remember the material when they take the exam? The studies above suggest that the stress before and during the exam could interfere with a student’s recall. If so, what implications does this information have for testing students?*

**How to Improve Memory**

The basic strategy for enhancing memory is to lay the information down well initially because our ability to remember is proportional to the degree to which our memories were originally stored. We must not write our memories with mere chalk; we should engrave them like a chisel on stone. We can accomplish this by making the information more meaningful, by associating information with what we already know well, by using mnemonic techniques, and by repetition and practice.

**Make Information Meaningful**

Experiences that are exciting are easy to retrieve because they are particularly meaningful; their memories are laid down effortlessly. Meaningful information is less likely to be forgotten than meaningless information. And though we may not find the world always exciting, we can make it meaningful in other ways. For instance, finding the relevance of the information we are trying to learn and how it can relate to our lives increases its meaning and makes it more memorable. We can also try to understand how the information is organized or, better yet, organize the information ourselves. This provides a meaningful structure that facilitates recollection.

Information can also be made more meaningful by associating the information with what we already know well. The license number KLB100, for example, may be the initials of our name and the age we would like to live to. Noticing this relationship may make retrieval of this number effortless for months or years.

**Use Mnemonic Techniques**

Mnemonic techniques are strategies for encoding information so that recall is easier. One strategy uses pictures, rhymes, and associations, another uses a linking technique, and still another uses the familiarity we have with our home environment. Entertainers who impress their audience with their excellent memory usually use these and other mnemonics.

**Think About It**

*The fact that we can usually retrieve memories at will suggests that our memories are organized. Estimate how long it would take you to retrieve the memory of the color of your first bicycle if your memories were not organized and were retrieved at random.*

**Thinking Activity****4.4. Using Mnemonics**

The following mnemonic techniques will help you to facilitate recall by laying down memories in an organized, meaningful manner.

**Rhyme-Association Method**

This is a good technique to learn if you want to impress your friends. It allows you to remember lists forwards and backwards and to identify any object associated with any of the numbers. This step first requires memorizing rhymes for each number one through ten such as the following:

|  |  |
| --- | --- |
| One-Bun | Six-Fix |
| Two-Stew | Seven-Heaven |
| Three-Bee | Eight-Bait |
| Four-Floor | Nine-Dine |
| Five-Dive | Ten-Dog pen |

Once you have these rhymes memorized, you associate the idea or thing you are trying to remember with the rhyming word. To enhance recall, these associations should be as ridiculous and lively as you can make them. For example, if you want to remember “alligator,” you can imagine biting into a bun, expecting a juicy hamburger, and finding a baby alligator instead—who, much to your surprise cries, “Ouch! What do you think you’re doing!” If the eighth word you are trying to remember is “rocking chair,” you can imagine fishing with a rocking chair as bait.

For the numbers eleven through twenty, you can develop associations for each rhyming word in a particular setting, such as on an airplane. For eleven, you might think of biting into the bun as you hit an air pocket, for example.

Try remembering the following words with the above technique:

|  |  |
| --- | --- |
| dust mask | stapler |
| calculator | lamp |
| sock | quarter |
| battery | address book |
| book | screwdriver |

**Method of Location**

This mnemonic technique is similar to the one above; the main difference is that you do not have to memorize rhymes first. Instead, you use what you already know, such as the arrangement of your living room furniture. As you try to remember a list, mentally walk through your living room and associate each word with a living room object. In the above example, you might imagine an alligator in your houseplant playing love ballads on his guitar in an attempt to win the affection of the shark lying on your sofa.

Practice using this technique with the ten items above.

**The Linking Technique**

Sometimes the information we are trying to remember is difficult to picture using the above techniques. The state of Wisconsin, for example, is hard to imagine lying on the living room sofa. The linking technique may be better in such cases. In this technique, all the items to remember are connected to each other. Each item can be pictured as it is, or something else associated with or sounding like the object can take its place. For example, if you want to remember the states of Minnesota, California, New York, and Florida, you can imagine a Viking (Minnesota) standing next to the Statue of Liberty (New York) wearing a Mickey Mouse hat (Florida) as an earthquake (California) rocks the statue and the Viking back and forth.

Practice using this technique with the first thirteen states below. They are given in the order in which they became part of the United States of America.

1. Delaware
2. Pennsylvania
3. New Jersey
4. Georgia
5. Connecticut
6. Massachusetts
7. Maryland
8. South Carolina
9. New Hampshire
10. Virginia
11. New York
12. North Carolina
13. Rhode Island

**Repeat**

The more we repeat new information and ideas, the easier it is to remember them. College professors who have taught a course numerous times can often teach an entire semester from memory alone. But simply repeating something over and over, without attending to its meaning—i.e., without thinking about it—does not usually work well to lay down strong memories. People repeatedly see pennies throughout their lives, perhaps over a 100,000 of them, but relatively few can draw the front and back of a penny and place all the words, numbers, and pictures in their proper place. From this illustration it becomes clear that we could read a chapter in a college text repeatedly, but if we did not make it meaningful, organize it, or make associations with it, we would learn and remember very little. There is a place, however, for mere repetition. Poetry, for example, is learned by repetition because we are trying to recall exact words, not just the meaning. But if the poetry is not made meaningful, the words we learn are empty.

**Practice**

Memory can be likened to a muscle: If it is exercised, it grows; if it is not, it weakens. Putting our memory to work increases our ability to remember. As the saying goes, “Use it or lose it.”

**Memory Pills**

We can see that laying down memories can take some serious effort. Wouldn’t it be nice if we could just take a pill? Successful experiments using a “memory protein” have already been conducted with animals (Weed, 2000), and human trials are now underway (Jacoby, 2005). The idea that college students of the future will be picking up their memory pills along with their textbooks is thus not that farfetched. As one researcher put it, “It’s a matter of when, not if, memory drugs are going to reach the market (Jacoby, 2005). But how much memory is too much? Do we really want to remember the details of every bad argument, every embarrassing event, or every boring movie? What price are you willing to pay to ace that exam?

**Summary**

Our brain is a thinking instrument made up of billions of neurons in a complex connectedness that is unimaginable. In order for our brain to function properly and for us to reach our potential for thinking, our brain must receive adequate nourishment and sufficient sleep. It must also remain free of drugs, alcohol, marijuana, cocaine, and other substances that can affect the delicate neurotransmitter balance in the brain and lead to distorted thinking. But our brain needs more than sound nutrition and freedom from pernicious drugs; it needs stimulation. A rich, challenging environment will build our brain into a stronger thinking organ, and it will help to forestall the dementias of old age. Our brain may not solve all the mysteries that concern us—and may actually create as much of the world as it discovers—but it will give us new glimpses and new insights into our unfolding personal universe.

Hidden within our brain is our memory. We have explored some of its nature and mystery and have learned that we must listen to others who disagree with our recollections, for our long-term memory is in constant movement; it may not only revise our past, it may even create it. We’ve also looked at some reasons why we forget—repression, interference, loss of cues, stress, and failure to lay down memories well in the first place—and we’ve explored ways to enhance memory through meaning, mnemonics, repetition, and practice.

Through this greater awareness of the nature of memory, we have abandoned our absolute trust in what it presents to us. But we have also learned to improve it and move on to become better thinkers.

**Brain and Memory Challenges**

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| --- | --- |
| 1. | This chapter suggests that we can do a lot to maximize our brain’s potential. List some of the ways to improve the working of your brain. Then decide which ones you are going to pursue. |

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| --- | --- |
| 2. | We know that the brain is fairly sensitive to coffee, sleep, drugs, and food. What are the implications of this sensitivity for our behavior? |

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| 3. | We have seen that old people who stay active develop fewer cases of some brain diseases. Do you know any older people who are very mentally alert? What are their mental activities—reading, hobbies, talking with people, and so forth? |

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| --- | --- |
| 4. | Do you know any young people who do not show much intellectual interest or activity? Do you find any areas in your own life in which you are intellectually lazy? Reading a challenging book is food for the mind. What else could you do to give your mind regular workouts? |

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| 5. | Look again at the quotation from Shakespeare’s *Othello* (p.69). What do you think is the “enemy” that can steal away our brains? |

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| --- | --- |
| 6. | Using your own experience or the experience of others you know, identify instances in which the drugs mentioned in this chapter clouded thinking and judgment. What were the consequences of the person’s reduced ability to think critically? |

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| --- | --- |
| 7. | How is it that a physical brain can give rise to a mental world that has properties that the physical world does not? Are there other situations in which physical matter generates something that has nonphysical properties? |

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| --- | --- |
| 8. | We mentioned that the brain is fed by our five senses. Can you imagine any other sense that could exist? Or is this impossible to imagine? |

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| --- | --- |
| 9. | How might your brain be filtering, creating, and structuring reality? Is it possible to know something without the instrument of our knowing (the brain and senses) affecting and distorting what we know? What does it mean to say that we know something as it really is? |

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| --- | --- |
| 10. | Do you will the brain to action, or does the brain will you to action? Are you something that exists apart from the brain, or are you something that is manufactured by the brain? |

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| --- | --- |
| 11. | Have you ever gone without sleep for several days? How did it affect your thinking and concentration? |

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| --- | --- |
| 12. | Your ability to think is related in part to the stimulation in your environment. In light of this, how would you assess your environment? |

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| --- | --- |
| 13. | Can you think of other mnemonic techniques besides those mentioned in this chapter? |

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| --- | --- |
| 14. | If we can’t think without memory, then it is obviously very important to us. In what ways can you enhance your memory? |

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| --- | --- |
| 15. | Although memory is vitally important, it is also fallible. Can you recall times when you were certain about some past event and then found out that you recalled wrongly? Can you identify what it was that caused your poor recall? |

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| --- | --- |
| 16. | Try the penny challenge, if you haven’t already done so in Chapter 3: Draw the front and back of a penny and place the following in the right positions: Lincoln’s face (facing forward? facing right? facing left?), the date the mint mark, “In God We Trust,” “Liberty,” “One Cent,” and “E Pluribus Unum.” Finally, a simple question: What image is on the back? Now find a penny and check your memory. Did repeatedly seeing a penny result in a perfect memory? |

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| 17. | Interference can hamper memory. Develop a study schedule that gives you the least amount of interference. Remember, do not overload by cramming, and do not place similar subjects back to back. |

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| 18. | Do you suffer from test anxiety? If so, what can you do to reduce it so that your memory will serve you better on your next test? |

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| 19. | Firmly laying down a memory is fundamental to recalling it later. What can you do to lay down strong memories so you can recall them when you want them? |

## Chapter 10 Scientific Thinking

*Science is a way of thinking much more than it is a body of knowledge.*

CARL SAGAN, *BROCA’S BRAIN*

Science. It is almost a second language as well as a method of inquiry. Rarely a day goes by when we don’t hear about some new discovery in fields such as medicine, psychology, and physics. To think more critically about such discoveries, such as a cure for cancer, new treatments for depression, evidence for life on other planets, or an advertisement for a new “wonder drug,” we need to know the language and methods of science.

In this chapter we explore the nature of science, beginning with the basic steps of the scientific method. We identify some of the assumptions and requirements of this method and contrast it with other ways of knowing. We look at the empirical nature of science and its limitations, and we briefly consider the problem of proof. We also explore some research designs, their drawbacks, and the experimenter biases of the scientists themselves. Our goal is not to become scientists but to learn about the basis of research in order to become intelligent consumers of scientific information.

## The Scientific Method

The worldwide technical and scientific literature was over 60 million pages a year by 1970 (Toffler, 1970). If scientific information comes close to doubling every twelve years as some suggest (Marien, 1998), it may now easily exceed 400 million pages. This explosion in knowledge began with an increased reliance on the scientific method as the tool for understanding our material and psychosocial universe. This method, which has so radically transformed our world, is a type of inductive thinking that moves through four major steps:

1. Observation
2. Hypothesis formulation
3. Experimentation
4. Verification

These same four steps were used by Galileo when he studied the effects of gravity on falling objects. Galileo observed bodies appearing to fall faster the longer they fell. He then formed a hypothesis that falling bodies increase their speed at a steady rate. He experimented by rolling balls down an inclined plane and measuring their speed at different points. He then attempted to verify his hypothesis by analyzing the experimental results, which showed that the balls increased their speed at a constant velocity of 32 feet/second every second, in agreement with his hypothesis. To further verify his results, Galileo and others ran his experiment again.

### Observation

The scientific method begins with *observation.* Observation is the food for our wondering about the world. We might observe a phenomena that needs explaining, such as the rising sun or a comet tail. Or we might observe a possible relationship between two events that needs to be tested, such as our grand-mother’s vegetarianism and her longevity, or the bite of a skunk and the disease of rabies. Observations lead us to wonder about the causes and effects of what we observe, about its character and constitution, and how we might intervene to create desirable change. For example, as we observe that many human beings are stricken with cancer, we may begin wondering about the cause of cancer, the processes that maintain or strengthen cancer cells, and about ways to prevent it or remove it. This kind of wondering about cause-and-effect relationships can be called scientific thinking and takes us to the second step of the scientific method.

### Hypothesis

A *hypothesis* is a tentative statement about the relationship between two variables, usually in the form of a prediction: “If A, then B.” For example, if (1) we had observed that people dying of cancer are usually heavy cola drinkers, (2) we were aware that cancer rates were lower before cola was invented, and (3) there was considerable scientific debate about the safety of cola additives, then our thinking and observation might lead us to suspect that the cause of cancer is excessive cola drinking. We could express the hypothesis in an if-then statement, such as “If people drink large amounts of cola, then they are more likely to develop cancer.” This if-then hypothesis could be simplified into a single statement: “The cause of cancer is drinking too much cola.” No matter how the hypothesis is formulated, it must be tested for its truthfulness because the casual observations alone are not enough to support it.

### Experimentation

*Experimentation,* the third step of the scientific method, tests the hypothesis through any of various research methods, including the formal experiment. There are many ways to conduct these studies, each with its own advantages and disadvantages, as we discuss later. For instance, in our cola example, we could feed large quantities of cola to chimpanzees and after a while compare their cancer rates with those of a group of chimpanzees that did not receive cola. Or we could find human beings with a history of excessive cola consumption and compare their cancer incidence with that of humans who avoid such consumption. Once the experiment or data collection is complete, we move on to the last step of the scientific method, verification.

### Verification

*Verification* is the analysis of data to see if that data support or dispute the hypothesis. In our example, we would analyze the results of our experiment to see if the excessive cola drinkers did indeed have a higher incidence of cancer. If they did, then our hypothesis would be supported (but not proven). If there was no difference between the groups, then we would have to go back to our first step to look for new observations or begin thinking about other cause-and-effect relationships that might explain our observations. This last step of the scientific method can be fortified through replication, which means running the study again, or some variation of it, to ensure that the results are reliable. It is especially helpful if other researchers replicate the results. Verification can also be fortified through prediction, which is the ability to use our study’s conclusions to reliably predict other outcomes.

These are the basics of the scientific method, a model of inquiry that is sometimes supplemented with hunches, intuitions, good luck, and creative play:

“To our knowledge, no one has ever been able to grow neurons from the brain, probably from any animal, much less a human,” said Dr. Solomon Snyder. . . . “We didn’t expect it to work. We can’t tell you why it did work. . . . We did it by diddling around, by being at the right place at the right time.” (Bor, 1990)

**Think About It**

*While creating technological marvels and producing vast amounts of worthwhile information, the products of the scientific method have also created an ecological nightmare, extended humankind’s ability to kill a thousandfold, and raised ethical issues that seem to transcend our capacity to answer them.*

### Science and Other Ways of Knowing

The scientific method can be further understood by distinguishing it from other ways of knowing, such as philosophy and appeal to authority. Like science, philosophy has systems for investigating the world, and the questions philosophers address may be inspired by a set of observations. However, philosophy differs from science in its greater emphasis on reason for solving problems as opposed to observation. The two also differ in the objects of their investigations. The domain of science is the world of observation, also known as the empirical world. Philosophy, on the other hand, often makes its inquiry outside the empirical world, investigating values, meaning, the nature of God, and so on.

The scientific method can also be distinguished from appeal to authority. Many people seek knowledge by appealing to an authority figure. This figure may be a well-respected doctor, teacher, or religious book. The scientific method, however, is at great odds with this way of knowing. When we appeal to authority, we believe something is true because an authoritative figure said so, and we do not require a set of systematic observations to support it. During the Middle Ages, for example, the Catholic Church taught that all the heavenly bodies revolved around the earth. Most people accepted this teaching because it came from the Church’s interpretation of an authoritative source, the Bible, and casual observation supported it: the heavenly bodies did appear to go around the earth. But from the scientific point of view this observation led only to a hypothesis, which was not tested scientifically. There were, as we know now, other explanations that would just as well have supported the observation that planets and stars appear to go around the earth. These explanations were not tested scientifically because the hypothesis was assumed to be true since it came from an authoritative source. When the Church’s teachings were eventually challenged by Copernicus and Galileo, they were deemed heretical, not because they were at odds with observation, but because they were at odds with authority!

**Think about it**

*Is science at the end of its useful life? Will it ever find another physical law? Will it ever discover the roots of consciousness? Will it ever find out what happened before the big bang? Will it ever answer the big questions? Or will it just give us technical trivia about esoteric matters that will have no real impact on our lives?*

**Copernicus and Galileo**

In the sixteenth century, Copernicus argued that the earth moved around the sun. His idea was contrary to the teachings of the Catholic Church, which believed that the celestial bodies revolved around the earth. Needless to say, Copernicus’s teachings inflamed many Christians, including Martin Luther who considered him a fool who wanted “to turn the whole of astronomy upside down” (Crowther, 1969, p. 48). In 1616, sixty years after Copernicus’s death, the Catholic Church, fearing a great scandal and dissent if Copernicus’s views were taken seriously, put his text outlining a heliocentric (sun-centered) theory of the solar system on the *Index of Prohibited Books*.

Although Copernicus is credited with introducing the heliocentric solar system, it was Galileo who was prosecuted for supporting such a view. Relying on scientific observation of the sun, planets, and stars, instead of on religious doctrine, Galileo found strong empirical support for Copernicus’s theory and was unafraid to go public with his views. Even though forbidden by the church, Galileo published a book in 1632 supporting Copernicus’s ideas and was consequently forced to stand trial for heresy. Found guilty, he was ordered to recant his views and was sentenced to house arrest, which remained in effect until he died eight years later. Such was the price of science. Only in 1992 did the Pope finally recant and admit that Galileo was right.

This story shows that appealing to authority is not always going to yield a valid picture of reality, and it shows the power of our worldviews to inhibit our consideration of opposing beliefs, no matter what the evidence. In this case, Christians had a worldview that placed earth and human beings at the center of the universe. This view prevented them from thinking objectively about alternate views, even when the scientific evidence was substantial. This story also shows us the necessity for courage in our critical thinking, courage to abandon beliefs that make us feel safe and secure, and to stand up for an unorthodox view that may make us vulnerable to criticism from others. Without such courage, thinking cannot take the creative leaps often necessary for a breakthrough in knowledge.

## The Empirical Nature of Science

The world of science is the empirical world, the world of observation. In order to apply the scientific method, scientists must be able to make observations and measurements. Therefore, all variables under study in science must be defined in observable, measurable terms. By giving *operational definitions* to variables in this way, we make it clear to others what those variables are and what observations or measurements will indicate their presence. Physicists must decide what physical traces from an atom collision will indicate or define certain atomic particles. Astronomers must define a black hole in a way that they can recognize it when it is present in their observations of deep space. And psychologists must define variables such as love, frustration, and stress in such a way that they can be observed and measured.

An example of a *nonoperational definition* is Webster’s definition of *love* as “strong affection” and “warm attachment” toward another. Although this definition conveys to others the meaning of the term love, it does not indicate to others what observations or measurements are necessary to indicate the presence of love. With only Webster’s definition in mind, with no observational measures to indicate its presence, imagine trying to ascertain the percentage of passersby who are in love. But if we define love as walking hand in hand with someone for at least sixty seconds, then we are defining love operationally and we would be able to observe and count the number of people passing by who are in love. But have we, in this case, defined love accurately?

### Erroneous Operational Definitions

When variables are defined operationally, they are sometimes defined incorrectly. When this happens, the conclusions of the research may be in error. In medical research, for example, an operational definition of low-fat eaters has been based on a person’s response to a questionnaire designed to determine how much fat a respondent eats now—not in the past, not in the future. That information is then used in studies twenty years later to see if low-fat eaters had, for example, more or less cancer than the high-fat eaters over the twenty-year period. Since people’s eating habits do change, one can certainly question whether twenty years of low-fat eating can be adequately defined by only one questionnaire twenty years ago.

As another example, consider a 1991 survey by the National Centers for Disease Control (“Good News,” 1991). According to the survey, 45 to 75 percent of Americans have “sedentary lifestyles,” sedentary being defined as “fewer than three 20-minute sessions of exercise each week.” One can imagine the reactions of millions of parents whose days are completely filled by employment, childcare, and housekeeping responsibilities that include miles of walking, hundreds of flights of stairs, and lifting babies and heavy bags of groceries, with no time left over for a regular exercise program. We could hardly call these people sedentary! We can see that, despite the good intentions of scientists, sometimes the concept under study is one thing, whereas the operational definition of that concept is another.

**Think about it**

*In the above operational definition of love, the meaning of love may have been lost by defining it as handholding for sixty seconds. When we count handholding, are we really counting love? Are we missing anyone? A better definition might be to define love as a “yes” response to the question “Are you in love?” Can you think of a better operational definition?*

### Operational Debates

Operational definitions that are acceptable to everyone are sometimes very difficult to achieve. Such difficulty often leads to debate. One area of debate in psychology, for instance, is whether or not the hypnotized state is an alternate state of consciousness. First, researchers have to define in nonoperational terms what they mean by an alternate state of consciousness, and then they have to define this state in observable, measurable terms. Those who believe that hypnosis does not lead to an*alternate state* typically define alternate state operationally as a pattern of brain waves different from those of the waking state. They then point out that such brain wave change does not occur during hypnosis, and therefore hypnosis is not an alternate state of consciousness. Supporters of the alternate state theory might respond by challenging this operational definition. They might argue that it is possible for a person to be experiencing an alternate state of consciousness even though their brain waves indicate nothing more than normal waking consciousness. Given that possibility, critics of the alternate state theory of hypnosis could be relying on an invalid operational definition!

### The Limits of Science

Without an operational definition, the scientific method cannot be employed. Science cannot, for example, tell us whether or not a biblical heaven or hell exists. Such metaphysical concepts are generally not reducible to operational terms. They lie outside the realm of observation and are best left to the areas of religion and philosophy.

Besides metaphysical questions, questions of values and ethics also lie outside the domain of science. Consider the issue of abortion. Is abortion right, or is it wrong? The answer cannot be found through observation. Scientists cannot find an answer to this question by looking through microscopes, observing biological changes in laboratory dishes, or observing how human beings respond to the abortion issue. The question of abortion is one of values, and although science can give us information that can be useful in answering such a question—for example, ascertaining when the heart starts beating in a fetus—it cannot by itself evaluate ethical statements. Value questions lie within the realm of religion and philosophy and outside the realm of science.

Consider the value statement “It is wrong to kill human beings for any reason but self-defense.” Can you imagine any scientific way to support or refute such a statement? Where would we look for the answer? Perhaps, you might say, in our emotions, for most human beings find killing emotionally repulsive. But how do you determine that human emotion should be the criterion for determining values? Is that a scientific fact or a philosophical statement? No kind of scientific observation could possibly tell us that human emotion is the criterion for determining values. Once again we are back to the realm of philosophy and have left the domain of science.

In short, scientific investigation is a magnificent procedure for unlocking many secrets of our world, but it does have limitations and may never, as Schopenhauer put it, “reach a final goal or give an entirely satisfactory explanation” of our world (Schopenhauer 1859/1958a, p. 28). Carl Jung echoed this sentiment in an interview on his eightieth birthday: “True reality can only be approached and surmised spiritually” (Jung, 1957/1977). In the words of Wittgenstein, “We feel that even when all possible scientific questions have been answered, the problems of life remain completely untouched” (Wittgenstein, 1961, *Tractatus Logico-Philosophicus,* 6.52).

**Thinking Activity****10.1. Creating Operational Definitions**

If you were proposing to study the following variables, which ones could you operationally define? Which ones could not be so defined? The key to determining your success is to ask, “What could I observe that would indicate the presence of the variable?” and “Could my definition be defining another variable instead?” Try your definitions out on others to see if there is agreement that your definition indeed defines the term without losing its meaning.

1. Frustration
2. Obesity
3. Aggression
4. Soul
5. Scientist
6. Depression
7. Thumb sucking
8. Migraine headache
9. Multiple
10. Nothing
11. Black hole
12. Gravity
13. Telepathy
14. Evolution
15. Pain
16. God
17. Immoral behavior
18. Prejudice
19. Meditation personality
20. Hypnotized subject
21. Psychological stress
22. Altruistic behavior
23. Happiness
24. Life
25. Consciousness
26. Thinking
27. Death
28. Beginning of human life
29. Intelligence
30. Heaven

**Thinking Activity****10.2. The Domain of Science**

For which of the following questions would science be the appropriate method of investigation? Indicate your answer by putting “S” to the left of those questions.

|  |  |  |
| --- | --- | --- |
| \_\_\_\_\_\_\_\_ | **1.** | Do human beings have free will? |
| \_\_\_\_\_\_\_\_ | **2.** | How can we reduce pollution in the environment? |
| \_\_\_\_\_\_\_\_ | **3.** | Is there life on other planets? |
| \_\_\_\_\_\_\_\_ | **4.** | Considering the physical and psychological changes that occur, is a person the same person from birth through old age? If so, why? |
| \_\_\_\_\_\_\_\_ | **5.** | Does God exist? |
| \_\_\_\_\_\_\_\_ | **6.** | At what point in fetal development do brain waves occur? |
| \_\_\_\_\_\_\_\_ | **7.** | When does human life start? |
| \_\_\_\_\_\_\_\_ | **8.** | What is life? |
| \_\_\_\_\_\_\_\_ | **9.** | What principles should guide a person’s behavior toward others? |
| \_\_\_\_\_\_\_\_ | **10.** | What is the origin of the human race? |
| \_\_\_\_\_\_\_\_ | **11.** | How can we increase our longevity? |
| \_\_\_\_\_\_\_\_ | **12.** | What was Shakespeare’s purpose in writing *Romeo* and *Juliet?* |
| \_\_\_\_\_\_\_\_ | **13.** | What is the human mind? |
| \_\_\_\_\_\_\_\_ | **14.** | Should human beings be punished for evil deeds? |
| \_\_\_\_\_\_\_\_ | **15.** | Are human beings basically good, or are they basically evil? |
| \_\_\_\_\_\_\_\_ | **16.** | What is beauty? |
| \_\_\_\_\_\_\_\_ | **17.** | Does stress cause most cases of depression? |
| \_\_\_\_\_\_\_\_ | **18.** | Does wearing a seat belt decrease the incidence of highway fatalities? |
| \_\_\_\_\_\_\_\_ | **19.** | Does drinking milk before bedtime aid sleeping? |
| \_\_\_\_\_\_\_\_ | **20.** | Is there life after death? |
| \_\_\_\_\_\_\_\_ | **21.** | What is intelligence? |

## Science and the Understanding of Human Nature

*A scientific conception of human behavior dictates one practice, a philosophy of personal freedom another.*

B. F. SKINNER, *SCIENCE AND HUMAN BEHAVIOR*

Because of the remarkable success of the scientific method in understanding the material universe, psychologists and sociologists have applied scientific thinking to the understanding of the psychological and sociological dimensions of human beings. From a philosophical viewpoint, this scientific thinking rests upon a foundation of determinism, which leads to some interesting problems when applied to the study of human beings. Below we explore some of these problems through a discussion of determinism.

### Determinism as Foundation

Scientists seek not only to discover phenomena but to discover the order underlying various phenomena—that is, the cause-and-effect relationships between things. The psychologists’ lengthy surveys, the biologists’ dish cultures, and the physicists’ atomic accelerators are all designed to discover the components of nature and the laws that govern the actions of these components, whether those components are human beings, tsetse flies, or atomic matter. Most scientists assume that the world is orderly, predictable, and operating through complex mechanisms of cause and effect. In other words, they assume a deterministic universe. If the world were not determined, but completely chaotic, scientific investigation could not lead to the discovery of natural laws.

There is considerable debate among philosophers and scientists about the extent of determinism, but most agree that for the macrocosmic physical universe determinism is a valid description of events. The debate centers on the role of determinism in the microcosmic world of particle physics and in the behavior of human beings. We will concern ourselves with the latter.

### Human Beings and Determinism

Social scientists are concerned with the understanding and control of human behavior in order to promote optimal social and psychological functioning. The assumption behind this concern, in whole or in part, is determinism: Social scientists assume that genetic, psychological, and social forces in each person’s history govern the character and behavior of each individual. Although not all psychologists adhere to a deterministic view of human nature, their dominant tendency to look for explanations of human behavior by examining past events seems to assume such a view, especially when the general goal is to discover laws or principles that may govern human behavior. Here is an example:

|  |  |
| --- | --- |
| **STUDENT:** | Why did Mark become a psychopath? |
| **PROFESSOR:** | Well, our answer lies in the genetic, social, and psychological forces that shaped Mark through his early development. Interestingly, Mark’s father was also a psychopath and might have passed on some “psychopathic genes” to him. Moreover, being a psychopath, Mark’s father did not teach him a healthy value system and actually served as a negative role model for Mark. Mark’s mother, of course, had to work ten hours a day, six days a week, because Mark’s father was often unemployed and was not a reliable source of income. Consequently, Mark’s mother was not around to help shape Mark’s values either and never really formed a strong bond with him. She often neglected Mark and physically abused him when she was under stress, which was more often than not. Sadly, there was never any sign of affection expressed toward him at all. And that’s why Mark became a psychopath! |

If Mark’s behavior is shaped by his genetic constitution and his psychological and social environment, can he be held responsible for anything that he does? Hard determinists must answer “no,” for they believe that every element of Mark’s behavior, including the choices, judgments, and assessments underlying that behavior, are nothing but the result of a complicated chain of cause-and-effect relationships:

In the mind there is no absolute or free will; but the mind is determined to wish this or that by a cause, which has also been determined by another cause, and this last by another cause, and so on to infinity. (Spinoza, *Ethics*, Part II, Prop. XLVIII)

Hard determinists argue that if all the variables about Mark were known, they would be able to predict his behavior with perfect precision. The reason they cannot ever predict perfectly what someone will do is not because people are free, but because they never know all of the variables bearing on that behavior. Thus, they talk about probabilities. They say that, given a certain kind of parenting style and a certain social environment, the chances are good that someone will become a psychopath. But rarely, if ever, can they be certain.

Opposed to determinism are the indeterminists, who believe that even though much of our life is shaped by genetic and psychosocial forces, there is still an element of free will behind our behavior. We are free in the sense that we could have done otherwise, but we chose not to, and thus we are accountable for our actions.

If the indeterminists are right about our freedom, can scientists ever understand and predict our behavior? Some philosophers argue that prediction and freedom are not incompatible. For example, you may know your friend well enough to know how he would choose to behave in a given situation. Thus, even though he is acting freely, you can predict his behavior. Then again, maybe you can’t:

I have observed instances of a person deliberately upsetting the predictions simply to reaffirm his unpredictability and therefore autonomy and self-governance. For instance, a ten-year-old girl, known for being always a good citizen, law-abiding and dutiful, unexpectedly disrupted classroom discipline by passing out French fried potatoes instead of notebooks simply because, as she later said, everyone just took her good behavior for granted. A young man who heard his fiancée say of him that he was so methodical that she always knew what to expect of him, deliberately did what was not expected of him. Somehow he felt her statement to be insulting. (Maslow, 1966, p. 42)

Would any scientist have been able to predict that the ten-year-old girl would hand out french fries? The determinist, of course, would argue that an inability to predict the girl’s behavior only reflects the complexity and enormity of the variables behind that behavior and in no way undermines determinism. Nonetheless, most of us would agree that a strong sense of freedom is evident in the example above. So strong is that sense of freedom in our lives that it may be more the burden of the determinists to show that we are *not* free than it is of the indeterminists to show that we are.

The point is that social scientists generally act under the assumption of determinism when they look for the causes of human behaviors and thoughts, even though their subjects feel free and are held responsible for their acts by others. For example, when Mark the psychopath murders, we react with outrage, not against a psychosocial system that made Mark what he is, but against Mark himself as though he is responsible for what he did, as though he could have chosen otherwise. Thus we have a contradiction between the deterministic assumption of social scientists which absolves Mark from responsibility and the reaction of the world in general which presupposes Mark’s responsibility and freedom. B. F. Skinner, a prominent determinist, explained the contradiction this way:

All of this suggests that we are in transition. We have not wholly abandoned the traditional philosophy of human nature [that we are free]; at the same time we are far from adopting a scientific point of view that our behavior is determined without reservation. We have accepted the assumption of determinism in part; yet we allow our sympathies, our first allegiances, and our personal aspirations to rise to the defense of the traditional view [of human freedom]. (Skinner, 1953, p. 9)

**Think about it**

*In his statement below B. F. Skinner explains the contradiction between the deterministic assumption of social science and our general assumption of free will as due to an inability to fully embrace determinism because of our loyalty and attraction to the idea of free will. Do you agree? Is our “love” of free will and its implications getting in the way of straight thinking about it? Or are there solid reasons for defending free will?*

Although we have not determined the extent of human free will, we can say with some confidence that the precision of social science may be limited by the extent of it: the greater our freedom, the less the rule of cause and effect applies and the more difficult human behavior is to predict and control. And if human freedom exists at all, then perhaps the goal of social scientists ought to be to encourage it. As Maslow (1966) wrote, “If humanistic science may be said to have any goals beyond sheer fascination with the human mystery and enjoyment of it, these would be to release the person from external controls and to make him less predictable to the observer” (p. 40).

**Determinism and Probability**

Although determinism underlies the scientific work of the physical and social scientists, many scientists work more with the concept of probability than with the concept of determinism. Probability is concerned with the likelihood of a particular event occurring in a particular situation. In quantum mechanics, for example, physicists work with Werner Heisenberg’s uncertainty principle. This principle states that, because atomic particles are so small, the methods we use to observe and measure those particles change them. Therefore, physicists can observe and measure the exact momentum of a particle, but they cannot simultaneously determine its exact velocity because that would have been changed by the act of observing momentum, and vice versa. If physicists want to know both momentum and velocity, they can only make statements about the probability that a particle will fall within a particular range of values; for a given probability, the smaller the range for one value, the larger the range for the other.

Social scientists also deal with probability. Much of their research is done with groups of people as they compare the average value of one group with that of another. If, for example, they find that a group of people exposed to noisy working conditions have poorer marital relations than a similar group that is exposed to quiet working conditions, they might conclude that exposure to a noisy work environment leads to poor marital relations. However, not everyone in the noisy conditions is necessarily going to be affected that way. There are usually exceptions in every group. Thus, for a given individual who is exposed, we can talk about probable effects on marital relations, not certain effects.

Do these probability theories undermine determinism? Not necessarily. Einstein, for example, thought that the uncertainty principle reflected the limitation of our ability to measure atomic particles, not an inherent indeterminism of atomic elements. Similarly, the work of social scientists with probability may only reflect their limitation in assessing all of the important characteristics of each individual; for although a group may have similar people, they do not have identical people. Those unmeasured differences foil our ability to predict behavior with certainty.

## Proving a Theory

*We cannot pretend to offer proofs. Proof is an idol before whom the pure mathematician tortures himself: In physics, we are generally content to sacrifice before the lesser shrine of plausibility.*

A. EDDINGTON, “DEFENSE OF MYSTICISM”

Imagine being a traveling nurse who cares for leukemia patients in a large city. After several months and hundreds of patient visits, you notice that many of your patients live very close to high-voltage power lines. You at once suspect that the magnetic fields from those power lines may be the cause of leukemia in your patients. At this point you have formed a hypothesis, a tentative statement of the relationship between events generally based on casual observation. Now you proceed scientifically. You look up the addresses of all your patients and find that 85 percent of them live within 1,000 feet of high-voltage wires or an electrical transformer, both of which generate a strong magnetic field. You then go to the city health department and collect addresses of all leukemia victims in the last ten years and find that most of them lived in urban areas, which is where high-voltage lines are more common. Furthermore, you find that as distance from high-voltage lines decreases, leukemia rates drop. You then write an article and state your theory that strong magnetic fields cause cancer in children at rates directly related to the strength of the magnetic field.

Have you proven your case? No! There are other possible explanations for the results. For example, the fact that most of the cases come from urban areas may be nothing more than a reflection of the distribution of the population in the United States: Most cancers are in urban areas because that is where most people live. The higher rate of leukemia near power lines can also be explained in other ways: it could be that the majority of high-voltage lines run through the more industrial parts of the city, and the industrial pollutants could be responsible for the leukemia. Or if high-voltage power lines are more common in urban areas, then it could be the stress of urban life, and not power lines, that is responsible for the disease—and so on.

**Think about it**

*Can you think of other explanations for the leukemia results that are not connected to high-voltage lines?*

Suppose you continue your research, this time using laboratory rats, and you find that the rats exposed to high voltages develop leukemia. And suppose your research is so good that we just cannot think of any explanation for your results except the theory that you have formulated. Have you then proven your theory? You may have a strong case, for you would certainly have corroborating evidence, but you would not want to say that you have proven your theory. Scientists generally do not like to use the words *proven* and *proof* (despite how often you hear them in commercials), for even though no other explanation for one’s results is available, there might still be one. As the Viennese philosopher Karl Popper (1965) put it, “The demand for scientific objectivity makes it inevitable that every scientific statement must remain tentative for ever” (p. 280).

Ultimately, proof must remain subjective, for the amount of data necessary to convince one person of the validity of a theory may be insufficient to convince another. How do we determine, to everyone’s satisfaction, how much and what kind of data are necessary to prove a particular theory? Certainly if someone proposed a theory that challenged our worldview, we would want more data than if that person proposed a theory that did not usurp conventional beliefs. As we saw in Chapter 2, people are very resistant to changing their worldviews; a great deal of data would be required to do so. But how much?

One scientist who challenged our worldview was Albert Einstein. His theory of the universe confronted basic beliefs about space and time. His idea, for example, that time is relative, that two individuals traveling at different speeds through the universe age at different rates, or that a person at the base of a mountain ages at a different rate from a person living at the top, seriously disturbs the common-sense view of time held by most people even today. Nonetheless, his theory has been supported by numerous experiments throughout the last several decades. Has his theory been proven? It certainly is convincing to many physicists and mathematicians; however, because proof is subjective, with each individual requiring more or less data or different kinds of data, some people probably won’t accept relativity as proven until they actually travel through the universe at different speeds.

In the rest of this chapter we explore some of the ways that science, particularly the social and medical sciences, can make progress toward “proof,” and we illustrate in more detail why it is important for researchers and consumers to be cautious about jumping to hasty conclusions.

**Think about it**

*Relatively few people fully understand Einstein’s theories of relativity. How can a layperson become convinced of the validity of his theories?*

## Controlled Experiments

A *controlled experiment,* also called *experimental design* or *true experiment,* is any research design that allows the experimenter to control the variables in an experiment so that the results of the experiment can better establish a cause-and-effect relationship. A controlled experiment requires at least one control group and one experimental group. The control group is the comparison group; the experimental group, also called the treatment group, is the group that receives the treatment. Theoretically, the two groups are identical except for the treatment. For example, if a chemist wants to find out if a new chemical added to ordinary detergent will improve its cleaning efficiency, one group of clothes will be washed with the new chemical (experimental group), while the other will not (control group). Both groups must have the same kinds and amount of clothing, with the same amount and type of stain, and must be washed in the same amount of water, at the same temperature, in the same kind of machine, and so on. Except for the added chemical, the washing conditions must be identical. If this identity has been achieved, we have a well-controlled experiment, and if the experimental group comes out cleaner, the chemist shall have reason to be excited about the cleaning power of his chemical.

To illustrate the importance of having control over all the variables, consider a fictitious study that is not well controlled: Farmer Smith wants to find out if a special additive that he has developed will increase the number of eggs his chickens will lay. To begin, he randomly separates his 500 chickens into two groups. He does this randomly because he has learned, correctly, that randomization is usually the best procedure for dividing groups when one has a large number of subjects. If he divides his chickens by size, or age, or activity level, he will have two groups that are not identical. His randomization reasonably ensures that his two groups of chickens have about the same number of active and passive chickens, average age, average size, and so on. In fact, his randomization reasonably assures him that his two groups are the same on variables he hasn’t even thought about, such as diseases, appetites, genetics, and so forth. Any slight differences between his two groups should not be statistically significant.

So far Farmer Smith is proceeding okay. He now puts one group of chickens in a hen shack near the farmhouse, and the other in an existing hen shack about 500 feet away. The chickens near the farmhouse become his experimental group and the chickens in the other shack become the control group. Farmer Smith then puts one cup of his secret ingredient in each five-gallon bucket that he uses to supply water for the chickens in the experimental group. For the chickens in the other hen shack he uses regular water.

During the three months that Farmer Smith conducts his experiment, he keeps careful records of how many eggs each coop delivers each day. When his study is complete, he finds that the experimental group laid 25 percent more eggs on the average than the other group. Absolutely delighted, he finally shares his secret study with his wife and son at the dinner table one evening. Smug and proud as he finishes his story, he sits back waiting for the praise. His son looks puzzled and queries his father. “Dad, maybe the chickens in the distant hen shack didn’t lay as many eggs because they were stressed out by that fox. He doesn’t come up near the house much, but you know he tries to get at the chickens in the other shack near the road.” “Or maybe it was the noise,” said his wife, “That distant coop sets pretty close to the highway you know. All those trucks screaming by all day and night have to have some effect on those chickens, don’t you think?” “Or the sun,” said his son. “That one coop sits out there with no protection from the heat, while the one by the house is shaded most of the time. Maybe chickens that are cool and comfortable lay more eggs.” “Just a thought,” added his son. “Yea, just a thought,” said his wife. Farmer Smith, looking dejected, excuses himself as he slowly gets up from his chair to find a quiet room to plan his secret ingredient research—again.

We now know that Farmer Smith didn’t control enough variables to be confident that the differences between his groups were due to his secret ingredient and not the noise, fox, or heat conditions that also differed between his two groups. Much to the embarrassment of researchers, such as Farmer Smith, someone often develops a competing explanation for their results. The experiment must then be run again, this time controlling for the variables that slipped by last time. And so it goes.

So next time you hear a commercial claim that says something like “Rinsing with our mouthwash before bedtime kills twice as many odor-causing germs as brushing alone,” think! What other variables could explain the results? The researchers compared their product to brushing without rinsing, but did they compare their product to brushing and rinsing with water before bedtime? Perhaps it is rinsing with a fluid that’s important in the removal of germs and not the expensive product’s “special ingredients.”

## Quasi-Experimental Design

In Farmer Smith’s study, he correctly divided his subjects into two groups randomly. This is not always possible, however. For example, if we want to introduce a new teaching strategy for learning math, we might find that some schools are cooperative and others want nothing to do with our new technique. Thus, our experimental group becomes a sample of convenience instead of a randomly chosen group from the community. Whenever we select our two groups through nonrandom means we have a *quasi-experimental design,* as long as the researcher is still the one who makes the groups different by “treating” one group and not the other. Quasi-experimental designs, lacking randomness, are a little more vulnerable to the possibility that the two groups were not equal at the outset of the study. The class receiving the new teaching style, for example, might be different from the control class at the outset because it came from a different school environment, a different neighborhood, and perhaps a different socioeconomic class. These differences might explain any outcome differences.

## Nonexperimental Designs

The experimental and quasi-experimental designs are not always appropriate or practical. Thankfully, there are many other research designs available. These other designs are often referred to as nonexperimental designs. These include, but are not limited to, the *expost facto design,* the *correlational design,* the *survey method,* and the *case study.*

### Ex Post Facto Design

For reasons we will soon explain, researchers sometimes use an ex post facto design. In fact, it may very well be the most common design underlying the science news we receive from the popular media. In the *ex post facto design* researchers *find* the groups that have differences. In other words, the researcher walks onto the scene *after* the treatment conditions have been created, thus the name “ex post facto” or “after the fact.” For example, using the ex post facto design in order to discover the effects of meditation, we would *find* meditators and nonmeditators. After finding the two groups, we would measure them on another variable such as emotional stability. If the meditation group is found to be more emotionally stable than the nonmeditation group, we might conclude that meditation increases emotional stability. The problem with this method, however, is that groups that are *found* generally have other differences between them besides the variable being studied, and those differences may be the real explanation for any outcome differences. In the example above, meditation may not be the only difference between the two groups. If it is not, how are we to know if it is meditation that causes emotional stability or if it is one of the other differences?

What other differences might there be? Perhaps people who meditate are more educated than people who do not. Or maybe people who meditate also tend to be vegetarians. Or maybe people who choose to meditate have more leisure time and less stress. Or maybe they are spiritually inclined, which leads them to take up meditation. Who knows? The point is, any one of these other variables, called *hidden variables,* could explain the outcome differences between the two groups. In other words, education, vegetarianism, leisure time, or spiritual inclination could have been responsible for the increased stability of the meditation group and not the meditation itself.

Whenever we find differences between groups instead of creating differences, we run into the problem of hidden variables. Scientists attempt to control for the variables that may obviously explain the differences by, for instance, making sure that the meditators and nonmeditators both eat meat, have the same level of education, and so forth. But what about intelligence, drug abuse history, or early family experiences? Research cannot always identify and control all the potentially important variables. Therefore, one or more of these uncontrolled variables might be the real reason for the outcome differences.

Suppose you hear about an ex post facto study that compared vegetarians with nonvegetarians and found that vegetarians live longer. Most people uninformed about ex post facto designs would quickly conclude that adopting a vegetarian diet will increase longevity. But *the cause-and-effect relationship is not obvious in ex post facto designs.* For example, it could be that vegetarians happen to be the kind of people who care about their health more than the typical nonvegetarian, and they not only avoid meat but also avoid alcohol and tobacco more than nonvegetarians, and they tend to see their doctor more frequently for regular check-ups. So is it vegetarianism that leads to longevity or the other good health habits that tend to accompany vegetarianism?

Another problem with ex post facto designs is determining the *direction* of cause and effect. To illustrate, let’s consider a study that tries to find out if people who are satisfied with their marriage have higher work motivation than people who are not. Obviously, we would have to *find* our subjects as it would be quite “challenging” to make one group satisfied with their marriage and another dissatisfied. Suppose we find that the group of subjects that was satisfied had higher work motivation than the other group. Does this mean that marital satisfaction somehow leads to more positive work attitudes, or is it that industrious people tend to put more energy into their marriages, consequently creating more marital satisfaction? In this case, aside from any hidden variable problems, the direction of cause and effect is not clear. But sometimes we can weed out a cause-and-effect direction. For example, an ex post facto design comparing youth and elderly on their differences in bone density, or atheists and Catholics on their longevity, will enable us to weed out one direction of cause and effect: Changing bone density will not make a person elderly, and living long will not make one Catholic! Nonetheless, hidden variables may still confound our interpretation and make it difficult to know precisely what cause-and-effect relationships exist to explain our results.

So why use ex post facto designs instead of the more controlled experimental designs when the latter is better at determining cause and effect? Sometimes it is simply impractical to use the experimental design. Would you want to be assigned to an experimental group and asked to eat no meat for the next 25 years? Other times the experimental design does not represent the real-world situation adequately. Having children watch an hour of violent television in a laboratory might not represent the hours and hours of television viewing they experience in their real life. Lastly, the ethical problems of running controlled experiments are often grave. To study the effects of child abuse using the experimental approach would require the researcher to abuse the children in the experimental group. Finding abused kids and studying them is the only moral choice.

Arguably, ethical problems are avoided by using animal subjects instead of humans. Granted, we cannot use animals to study child abuse, but a controlled experimental design looking for the possible cancer-causing effects of a particular drug could be conducted with animal subjects. However, there is the problem of generalization when using animal subjects instead of human ones. Generalization is the assumption that what is true of the sample is true of the larger population under study. To assume that a drug that causes cancer in laboratory mice also causes cancer in humans is to make a statement of generalization. Given the differences between human beings and animals, there is room for skepticism about such generalizations.

**Think about it**

*Disregarding the problems of generalization and ethics, can you think of any topics for social science research in which we could not use animals?*

### Correlational Design

Most of us have heard of the relationship between crime and unemployment, and between vegetable consumption and lowered risk of cancer. We’ve all been warned about the relationship between stress and health problems, and we might have heard that the more male children a mother has, the greater the chance is that the next child will be homosexual (Purcell, Blanchard, and Zucker, 2000). Much of this information comes from correlational research.

The correlational research method is very similar to the ex post facto design. In both designs the investigator *finds* the variable under investigation; the researcher does not create it. However, unlike the ex post facto design, the correlational design looks for the degree of relationship between two or more variables, instead of examining differences between groups. The kinds of variables that can be studied are innumerable: from human stress and happiness, to solar magnetic fields and the earth’s temperature. If a relationship exists between two variables, then as one variable moves the other will also. For example, we could collect data from a large group of people about how much meat they typically eat in one week. At the same time, we could administer a test to assess the level of iron in their blood. If people who ate more meat tended to have higher blood iron levels, then we have established a positive correlation. If we found that people who ate more meat had lower blood iron levels, then we have established a negative correlation. But the question we must always ask is, “How *strong* is the relationship between the two variables?” If a correlation exists, it can range from very weak to very strong. If there was only a very weak positive relationship between meat eating and iron levels, there would be little basis for altering one’s eating habits. On the other hand, if the relationship was strong, it might be well-advised to eat more meat if one wanted to raise one’s blood iron levels.

If there is no correlation between two variables, we can be certain that there is no cause-and-effect relationship between them, for all cause-and-effect relationships are correlational ones. But if a correlation is found, there will generally still be questions, as in the ex post facto design, about the direction of cause and effect, or even if a cause-and-effect relationship exists, because *correlational designs are not meant to determine cause and effect!* For example, if we find a strong correlation between aggressiveness and viewing violent television, does that mean that watching violent **TV** causes aggressive behavior? Or is it that aggressive personalities choose to watch more violent television? Or both? Or neither? We could have a good correlation with any of these possibilities. Perhaps more abusive parents, for example, let their children watch violent television more than less abusive parents, and it is the abuse that causes aggressiveness, not television. From this simple example, we can see how correlational studies can demonstrate a relationship between variables but can determine little about any cause-and-effect interactions. On the topic of violent television, the body of research over several decades, *using a variety of research designs,* indicates that there is a cause-and-effect relationship between viewing violent television and aggressive behavior, and the direction of cause and effect goes *both* ways.

Sometimes common sense and advanced statistical methods can help to clarify the directional problem. In one of the examples above, we could probably rule out the possibility that blood iron levels cause meat eating. Could we then conclude that meat eating raises iron levels if we have found a positive correlation between meat eating and iron levels? Not necessarily, for as we have just seen in the ex post facto design, a third variable might explain the relationship. If for some reason meat consumption correlates with potato consumption, physical activity, smoking, or alcohol consumption, it could be one of those variables and not meat eating that is responsible for changes in iron levels.

Given all these problems of correlational designs, why do we have these kinds of studies at all? One reason is that correlational designs yield statistics about the degree to which two variables are related—that is, the degree to which they correlate. The higher the degree of correlation, the more precisely we can predict one of the variables if we know the other—and we can do this without knowing anything about cause and effect. Life insurance companies, for instance, use correlations when they assess the gender and health habits of new subscribers to determine death potential and insurance risk. And college admissions committees use ACT and SAT scores because they correlate somewhat with academic success. Another reason for using correlational designs is the same as for using ex post facto: It avoids the ethical and practical problems of using experimental approaches.

**Think about it**

*Could a controlled experiment be used to determine if meat eating raises blood iron levels?*

**Thinking Activity****10.3. Determining the Research Design**

The following are titles of real news articles. Place an “E” before those articles in which you think the researcher used an experimental or quasi-experimental study and a “C” before those in which you think the researcher used the ex post facto or correlational design. In those cases in which you think either approach might have been used, you may indicate both “E” and “C.” To help you with your thinking, ask yourself if an experimental approach to these topics, in which the researcher creates the treatment differences between groups, would be unethical or extremely impractical.

|  |  |  |
| --- | --- | --- |
| \_\_\_\_\_\_\_\_ | **1.** | Lead Exposure, Laziness Linked to Alzheimer’s |
| \_\_\_\_\_\_\_\_ | **2.** | More Evidence That Smoking Moms Have Smoking Kids |
| \_\_\_\_\_\_\_\_ | **3.** | Vegetables Lower Prostate Cancer Risk |
| \_\_\_\_\_\_\_\_ | **4.** | Vitamin E May Help Ease Menstrual Cramps |
| \_\_\_\_\_\_\_\_ | **5.** | Acupuncture Helps Relieve Depression |
| \_\_\_\_\_\_\_\_ | **6.** | Hormones in Womb Linked to Sexual Orientation |
| \_\_\_\_\_\_\_\_ | **7.** | Women with Breast Implants Have Higher Suicide Risk |
| \_\_\_\_\_\_\_\_ | **8.** | Brain Pattern Differs in Boys with ADHD |
| \_\_\_\_\_\_\_\_ | **9.** | Loss of Parent Tied to Mental Illness |
| \_\_\_\_\_\_\_\_ | **10.** | Special Glue Assists Nerve Repair |
| \_\_\_\_\_\_\_\_ | **11.** | Moderate Drinking Tied to Arterial Disease |
| \_\_\_\_\_\_\_\_ | **12.** | Smoking During Pregnancy Linked to Child Psychiatric Disorders |
| \_\_\_\_\_\_\_\_ | **13.** | Fish Oil Found to Ease Manic Depression |
| \_\_\_\_\_\_\_\_ | **14.** | Overwork Only One Cause of Job Burnout |
| \_\_\_\_\_\_\_\_ | **15.** | Poor Parenting May Create Disruptive Children |

### The Survey Method

One of the most convenient and relatively inexpensive ways to gather data for research is through a survey. A survey is simply an instrument with questions designed to assess our attitudes and opinions about various issues. This instrument can be given to a subject through an oral or written medium. We have probably all experienced the oral method when we were approached in a shopping mall by someone who wanted to ask us a few questions about a new product, or when we answered a phone call from an independent research firm with questions about our leanings in an upcoming election.

Without the survey method it would be difficult or impossible to acquire information about people’s beliefs, attitudes, and opinions. We might be able to infer some attitudes and beliefs by observing someone’s behavior, but much of a person’s subjective life cannot be reliably measured by this method. However, with the survey method a person’s political affiliation could be operationally defined as a “yes” response to the question “Are you a Republican?” The survey technique transfers a political view, which we cannot see and measure, into an oral or written response, which we can observe and measure. Some information would otherwise be nearly impossible to accurately define operationally, such as people’s daydreams, their conception of God, their attitude toward gun control, their sexual behavior, or their worst regrets.

Surveys are a very popular method for accumulating data on large numbers of people, principally because of their relatively low costs, ease of administration, and ability to assess personal information and private experiences. However, surveys must meet four conditions for them to be efficient research tools: (1) They must be administered to people in a way that encourages honesty; (2) the questions must be clearly stated, and asked objectively—that is, without bias in one direction or another; (3) they must reach a representative sample of the population being studied; and (4) they must be returned in an unbiased manner. If any of these conditions is not met, the survey results become invalid.

The best way to encourage honesty in survey responses is to assure the person that his or her answers will remain anonymous. This is especially important when dealing with sensitive topics like sexual behavior, childhood sexual abuse, and problems of addiction. A face-to-face interview by a stranger about sexual habits does not provide the anonymity required for honest answers.

Anonymity alone, however, does not ensure valid results if the questions are asked in a biased manner—that is, by pressuring, intimidating, or otherwise indicating how they are to be answered. One “State of the Nation” survey violated the rules of anonymity and unbiased questioning when it instructed respondents to return the survey with their name on it and prefaced the survey with a four-page letter on how to vote. Part of the letter appears below:

May God strengthen you as you continue to speak out against abortion, homosexuality, communism, pornography, anti-Christian TV programming and secularism in government. . . . There are more well-funded liberal activists than ever at work on Capitol Hill. They smell victory in the making because it appears on the surface that the Christian agenda has been defeated. . . . You and I must show them they are wrong. . . . Radical feminist groups, the American Civil Liberties Union, and People for the American Way would like nothing more than to see ministries like Coral Ridge silenced.

A few years later the Democratic National Committee mailed a seven-page survey with sensitive political questions as part of its Democratic Party membership acceptance form. At the top of each page of the survey was printed the respondent’s name!

One would think that academic institutions would be one place where good surveys would be found, since this is where survey design is taught. But even in these institutions bad surveys are generated. It is not uncommon for college administrators to send surveys to faculty with questions about the respondent’s age, sex, race, department, and highest degree. Obviously, in small departments such information is devastating to anonymity.

Survey bias can also be found in academic arenas. One college survey on the topic of student retention asked respondents to rate the potential of various programs to improve retention from “low potential” to “high potential.” Following each variable name, such as “advising” or “admissions selectivity,” a paragraph explained the value of such a program. For example:

*Academic Advising*. The importance of academic advising as a retention strategy is well documented in the literature. Advising provides the most significant mechanism by which students can clarify their educational/career goals and relate these goals to academic offerings.

The above paragraph certainly steers respondents away from “low potential” and “moderate potential” ratings. Oftentimes administrators, managers, church leaders, and others have good intentions, but they are not well prepared in survey design.

Even if a survey guarantees anonymity and objectivity, it is not necessarily going to generate useful data if no one returns it or if only a certain kind of person returns it. Probably the most difficult challenge in using the survey technique is selecting a representative sample and ensuring an unbiased return. An unbiased return occurs when everyone in the sample returns the survey or when the surveys are returned by a representative sample of people from the sample itself. But even an unbiased return is not going to yield valid results if the sample receiving the survey is not representative of the larger population being studied. For example, if we want to find out what men’s attitudes are about a female candidate for the U.S. presidency, we need to solicit the views of men who are rich as well as poor, Protestants as well as Catholics, young as well as old, educated as well as uneducated, and so on.

A popular survey among the American public in the 1980s was the Ann Landers survey that asked women if they would “be content to be held close and treated tenderly” and forget about the sex act (Landers, 1984, Nov. 4, and 1985, Jan. 14 and 15). This question generated the second-largest response in the history of her column and, to the amazement of many, men in particular, the results came back overwhelmingly in support of being held instead of having sex. But the manner in which the survey was conducted gives us little confidence in the validity of the results. One might argue that Ann Landers surveys did not reach a cross section, or representative sample, of American women. It might be that women who read Ann Landers were disproportionately a certain type of woman compared with women in general in the United States. If this was true, then the results need to be qualified: *Among women who read Ann Landers,* a certain percentage of them would rather be held than have sex.

But even this conclusion may not be justified. There might also have been a problem of return bias in the Ann Landers survey. Because there was no motivation to fill out the survey other than the desire to do so, we might wonder why some women desired to fill it out and send it in, whereas others did not. Clearly not every woman who read the survey sent it in. Was there something special about the women who did respond?

Psychologists have shown that people who have strong negative feelings about an issue are more likely to express themselves on that issue than people who have strong positive feelings. With this knowledge in mind, we might suspect that women who were dissatisfied with their sex lives and were emotionally unfulfilled might have been more inclined to send in the survey. If this was true, then Ann Landers received a biased return; that is, she did not get responses from a representative sample of her readers, but instead she received a disproportionate number of survey returns from readers in emotionally unfulfilling relationships. All that we can conclude from her survey is that some women prefer to be held rather than have sex. We can conclude nothing about American women in general, nor can we even make general statements about Ann Landers readers.

Unscientific surveys, such as the Ann Landers survey, magazine surveys, Internet surveys, and so forth, are abundant in American media. Even evening news programs are using them when they solicit their viewers’ opinions by asking them to dial a telephone number to express their view on a certain issue or when they request a response to their Web site questionnaire. These unscientific surveys may elicit responses from only certain kinds of people, who may not be typical of the larger population. Internet questionnaires, for example, are only going to be available to those who have a computer with an Internet connection. And though most people have a telephone, telephones can also be used unscientifically. When a news program asks its viewers to dial a telephone number to record a vote on a political issue, it is likely that those who have the strongest feelings and greater wealth (because there is a charge for these calls) will be more inclined to respond. People on tight budgets with moderate feelings about the issue are less likely to be reached by such a method, yet they may constitute the majority of the public. One is reminded of the telephone survey conducted during the Dewey versus Truman presidential campaign. A phone survey was conducted to find out which candidate was likely to win the election. The phone survey showed such a lead for the Republican candidate Dewey that the*Chicago Daily Tribune* did not wait for election results and announced his win in the morning paper the day after the election. It turned out that Truman had won. The mistake? The phone interviews reached only the wealthy, for at that time only wealthier people could afford the luxury of a phone. And since wealthy people tend to vote Republican, the survey amounted to nothing more than asking Republicans who they were going to vote for!

**Opinion Versus Fact**

Surveys about people’s opinions on a topic are sometimes misconstrued as fact about a topic. The only fact that an opinion survey can claim is the fact about people’s opinions. Surveys that ask nonexperts for opinions on the cause of homosexuality, the theory of evolution, or whether life exists on other planets can be taken only as statements of people’s opinions. They cannot be used as facts about homosexuality, evolution, or extraterrestrial life. If a majority of people believe that homosexuality is a matter of free choice, that widespread opinion cannot be used as evidence to support a theory of free choice. Similarly, the argument for evolution cannot be weakened by the general public’s opinions about it.

Evidence and strong argument lead to facts; inexpert opinions do not. Unfortunately, many people’s opinions about matters of science and philosophy do not come from scientific evidence or philosophical study but from enculturation forces. Over many millennia those forces were responsible for teaching people to believe in witches, human sacrifice, a flat earth, a geocentric cosmological system, and the inferiority of virtually every minority and religious group on the planet. So much for people’s opinions.

### The Case Study

We have seen that in order to generalize from a sample of people to a larger population we need to have a representative sample, which requires an adequate and unbiased return. Without representativeness we cannot make meaningful statements about a larger population of people. This problem of generalization is especially acute in case-study methods of investigation. The case-study method involves studying one person thoroughly as opposed to studying a large sample of people. It was the principal research method used by such famous psychologists as Sigmund Freud and Carl Jung. But because only one person is being studied, statements of generalization cannot be made from a case study. Yet people make them all the time:

|  |  |
| --- | --- |
| **PROFESSOR SMITH:** | According to a well-conducted study on the principle of reciprocity, we are more likely to succeed in attracting others by expressing a positive interest in those people whom we find attractive, as opposed to using the strategy of “playing hard to get.” |
| **STUDENT:** | I don’t think that’s right at all. |
| **PROFESSOR:** | And why is that? |
| **STUDENT:** | Well, I got my husband by playing hard to get, so I think playing hard to get works just fine. I recommend it to everyone. It sure worked for me. |

In the above example, the student is using herself as a case study and then generalizing to others. Such reasoning is not valid. No one should question the student’s honesty about her experience; what ought to be questioned, however, is the generalizability of the student’s experience to everyone else’s experience, particularly when the student’s experience contradicts the results of a well-conducted study.

Technically speaking, case studies can be conducted within the physical sciences as well. But in the physical sciences it is legitimate to discover certain principles about a single physical event or object and then assume that those principles apply to all other events or objects identical with the one studied. If one discovered, for example, that adding two atoms of hydrogen to one atom of oxygen produced water, we could assume that that would be the case for all hydrogen and oxygen atoms. Studying human beings, however, is a different matter entirely because no two human beings are identical in their histories or constitutions. Finding out that Joan developed a multiple-personality disorder because she was severely abused as a child does not allow us to assume that everyone severely abused as a child will develop a multiple-personality disorder, or that everyone with a multiple-personality disorder was abused as a child (though, in fact, most of them were). Maybe Joan’s manner of developing a multiple personality was atypical, which is conceivable given each person’s unique genetics, family history, peer relations, and interpretation of life events.

If we cannot generalize from case studies in the social sciences, of what value are they? Case studies are valuable for clinical work with patients, and they can give us hints about what might be transpiring in similar cases. (When comparing human beings, there are never *identical* cases.) These hints can then be tested using a larger sample of people.

## The Role of Chance

It is possible that the results we get from a study are due to chance and cannot be attributed to the variables being studied. This statement does not imply that the world is chaotic or that some miracle occurred to cause our results. Chance, as we use the term here, means that the results of our study were due to random influences. For example, in a controlled experiment the researcher takes all precautions to make sure that the control and experimental groups are equal before the experimental variable, such as a new drug, is introduced. If they are equal and the group that gets the treatment is affected differently than the control group, then we can attribute that difference to the treatment—maybe. There is always the chance that the two groups were not identical before the treatment was delivered. If so, that inequality, whatever it is, might be responsible for the outcome and not the treatment. In a drug study, for instance, it could be that when the researcher selects the experimental group, by chance that group, in spite of all precautions taken to assure equality with the control group, is a hardier bunch than the control group before the drug is even administered. In this case, a higher cure rate in the experimental group might have occurred had the researcher fed the treatment group peanut butter, or given them nothing at all!

Other research designs can also be bedeviled by chance factors. In correlational research, for example, it is possible that the correlation we discover is simply bogus! We know there is no correlation between the number of nickels you have in your pocket and the number of trees in your backyard. Yet, if we randomly selected 200 people would it not be possible, albeit not likely, that those with more nickels happened to have more trees? Certainly! Such a correlation would be due to sampling error caused by chance.

It may be evident by now that the larger our sample size, the less likely these errors are going to occur. But even with 500,000 people in each sample the possibility of sampling error still exists, however remote. That chance, called the *significance level,* is statistically calculated based on the size of the samples, the amount of variability within those samples, the size of the difference in outcome between the two groups, and the strength of a correlation.

Obviously, when the odds of our results occurring by chance are one out of a million, we have great confidence that our results reflect a real difference between our groups. But what if the odds were one out of a thousand, or one out of fifty, or one out of ten? At what point do we lose confidence in our results? In the social sciences, for example, there are two acceptable standards: significance levels of .01 and .05. If research results are significant at the .01 level, the chance of the results occurring because of some sampling error is only one in one hundred, or 1 percent; thus we can be reasonably confident—but not certain—that our study is not that one time out of a hundred in which the results could have occurred by chance. A significance level of .05 is less stringent, indicating the results could occur by chance in five studies out of 100, but it is still acceptable to most scientists as indicating the likelihood of a real difference—that is, one not due to chance but to the variable being studied, such as a drug in a drug experiment, or the secret ingredient in a chicken egg-laying experiment.

How are we ever to know if it is chance or one of the variables under study that causes our results? We can become more certain if we repeat the study and find the same result. This is the importance of replication in the last step of the scientific method. Unfortunately, many studies are not repeated because researchers rely on the confidence levels of .01 or .05 or fail to be interested enough in a project to engage in a replication. But even results significant at the .01 level could still be due to chance. If someone else repeats the research design and gets the same results, however, then chance is probably not the explanation. Year after year we hear of possible cancer cures, only to be disappointed when others repeating the experimental design fail to get the same results.

The importance of the role of chance in research, and the way it can confound results, will vary somewhat from one science to another. But most scientific disciplines must contend with it. In 1989, for example, the American public had a major disappointment when a supposedly successful cold fusion experiment failed replication tests. These replication failures suggest that something else other than, or in addition to, the variable being studied was responsible for the initial positive results in these experiments.

In sum, when we hear about the results of a study, we must think about the role of chance and exercise appropriate caution in our interpretation. We should ask ourselves if the results are consistent with other findings; if not, it might be prudent to wait for replication studies.

**Think about it**

*How much confidence do you need to take action? What level of confidence do you need to run a red light, engage in unprotected sex, sky-dive, bungee-jump, or bet $1,000 on the lottery?*

**Sizeable Effects**

A *sizeable effect* is a large effect. Just because a study’s results are significant at, say, .01, does not mean that there is much to be concerned about. It is one thing to say the results of a study are not likely the result of sampling error; it’s another to say the study demonstrates a sizeable effect. If a well-conducted study finds that people who eat liver are less likely to get cancer, and the study has significance at .001, we can be quite confident that the results are not due to sampling error, especially if the results are replicated. But we can still ask, “How*much* does eating liver reduce the risk of cancer?” “Just a tad,” the researcher might reply. In that case, we need not change our diet to include the insufferable liver. On the other hand, if eating liver cuts our risk in half, then it might be time to change our palate—but not necessarily! If the original risk is ever so small in the first place, half of “ever so small” might still be ever so small and no reason to change our ways. Unfortunately, the popular media often presents study results without mentioning the size of the effect or the original risk.

**The Gambler’s Fallacy: Don’t bet on it!**

Lottery players and other casual gamblers sometimes fall prey to the gambler’s fallacy, the belief that the frequency of a random event’s occurrence in the past will affect the odds of that event occurring again. For example, it is the gambler’s fallacy to believe that if a penny has shown heads ten times in a row, then the odds must be enormous against it coming up with heads again because the likelihood of eleven heads in a row are extremely remote. In fact, however, the odds of a penny coming up heads or tails is not dependent on what came before it. Each throw has a 50/50 chance of coming up heads; each throw is independent of past throws. The key to understanding this lies in the past throws. If somebody gets 10 heads in a row, that is remarkable, but the odds of making it 11 heads in a row *at this point* (after 10 heads have already been thrown) are 50/50. The odds are *behind* us for the ten consecutive throws; those odds have been beaten. The next throw is only 50/50, and one would be wise to bet accordingly. Roulette wheels, penny tosses, and other devices that are based on randomness are subject to this fallacy. Bets on nonrandom events, such as dog and horse races, are not. If a dog wins several races, it is probably because he is a strong racer, so it is not fallacious to assume the dog will win the next one. In short, if you discover that a certain bingo number has not been called in weeks, you should not assume that it will, therefore, probably be called tonight.

## Experimenter Bias

*No intellectual activity, science included, is ever free from the shaping force of one particular ideology or another.*

W. BEVAN, *CONTEMPORARY PSYCHOLOGY*

Sometimes scientific failures are not due to chance or poor research design but to the experimenters themselves. This kind of error is known as *experimenter bias*—the tendency on the part of researchers to make errors in perception or judgment because of their expectations or desire for a particular result. It is part of a general tendency among all of us to see what we would like to see or what we expect to see. Sigmund Freud, Carl Jung, William James, and others argued that objective, rational inquiry may be more a fiction than a reality, a mere rationalization dictated by unconscious motives, seething emotions, and cherished beliefs. Our liking or disliking of a person, event, or idea can alter our perceptions, even if the foundation of our liking is based on nothing more than hearsay or unhealthy personal needs. Such bias affects teachers grading student exams, jurors judging a defendant, and scientists conducting research.

Many psychological studies have demonstrated this effect. In one classic experiment (Rosenhan, 1973), normal graduate students lied to gain admission to a mental health hospital, were given a psychiatric diagnosis, generally “schizophrenia,” and then behaved normally thereafter. Their normal behavior, however, was often seen by the hospital staff to be pathological. The label “schizophrenia” biased the staff’s perception and judgment of normal behavior.

In another early experiment (Rosenthal, 1966), two groups of graduate students were given mice to run in a maze. One group was told that their mice were “maze bright”—that is, bred particularly for adeptness at maze running. The other group was led to believe that their mice were “maze dull.” In fact, however, the students were working with the same population of mice. But graduate students who were told that their mice were maze bright recorded significantly fewer maze-running errors than the other group and perceived their rats to be brighter, more pleasant, and more likable. Other studies support these findings.

When interpretation of research variables is open to subjectivity, special care should be taken to guard against experimenter bias. Because such biased interpretation is not a conscious process, it is not enough to rely on a scientist’s good judgment and care. What is needed are more objective means of measuring the variables, or special procedures in the research protocol that will eliminate the possibility of bias.

A common procedure is to make sure that the researcher is unaware of some critical conditions of the experiment that would otherwise allow for experimenter bias. For example, if Dr. Z invented an antidepressant drug and runs an experiment to find out if the drug really can alleviate symptoms of depression, then Dr. Z, having a great deal of reputation and money at stake, might unknowingly bias his interpretation of the results. It would be more than just a little unwise to let Dr. Z assess the patients’ recovery when at the same time he knows which patients received his drug and which did not. It would be better to keep him ignorant about who took the real drug or have someone else who is unaware of these facts do the assessment of the patients’ recovery.

The motivation of the researcher or research organization is obviously something that everyone should be wary of. There is a big difference in credibility between the research of Burt’s Chemical Corporation on the carcinogenic properties of their own weed-control product and the research of an independent group that has nothing at stake in the outcome. It is certainly not impossible for good research to be conducted by organizations that have a vested interest in the research outcome, but the potential for experimenter bias effects and outright fraud is significant. “The rule, ‘I sing the song of him whose bread I eat’ has held good in all times” (Schopenhauer, 1859/1958b, p. xxviii). One survey of scientists found that 15.5 percent said they had changed the way a study was conducted or its results because of pressure from those funding the study (Wadman, 2005). Therefore, the special interests of the researcher or research organization must be taken into consideration when assessing scientific results, and those results must be weighed against any independent sources doing research on the same subject. If the television industry cites studies *financed by the television networks* that show television violence to have no impact on the viewer, and if those studies conflict with well-conducted research from independent sources—well, you be the judge.

A similar problem arises in the political arena in which, for example, a politician is expected to carefully weigh arguments for and against gun control while at the same time receiving generous amounts of campaign money from the National Rifle Association. As suggested in Chapter 2, the politician’s ability to think objectively would very likely be impaired by motivational considerations. In science, one’s ability to judge, perceive, and assess are also subject to these motivational factors. Unfortunately, safeguards against these factors are not always implemented because of practical reasons, a disregard for the bias tendency, or a deliberate attempt to defraud the public. In the mid-1990s the American public became painfully aware of the potential for scientific fraud and bias when the tobacco industries were found to have suppressed research that suggested nicotine was addictive. As it turned out, tobacco science was nothing more than “politicized science,” as one politician correctly put it.

**The Placebo Effect**

In any research in which it could be a problem, we must control for a researcher’s beliefs and expectations. But beliefs of *subjects* must also be controlled for, because such beliefs can often confuse study results. If subjects are given a drug that they believe will cure them, the belief itself may cause the cure and not the drug. This is called the *placebo effect.* To control for this, only the study’s experimental group is given the real drug while the control group is given a placebo, a pill containing no medicine, but led to believe that it is the real drug. If belief is responsible for the cure, both groups will be cured. If it is really the drug and not belief, then only the experimental group will be cured. The extent to which belief can cure is suggested by the Sapirstein and Kirsch study (1996). They analyzed thirty-nine studies involving a total of 3,252 depressed people and found that one-half of the drug response was due to the placebo effect. Clearly this study underscores the need to control for it in research.

The use of placebos in research is not without problems. For one, placebos are not well regulated. Thus, there are different types with different ingredients, and these ingredients are not completely inert. Even a simple sugar pill can alter blood sugar. Any pharmacological effects of a placebo could confound some study results by increasing or decreasing the outcome difference between the placebo and the active pill.

If a placebo has absolutely no detectable effects, we must be concerned about another problem. In a drug culture, like that of the United States, people are becoming quite sophisticated about potential side effects of medication. If people who participate in a drug study are told that they will be given a placebo or a real pill, they might easily figure out that they have the placebo because of an absence of side effects that often accompanies real medication. If subjects can catch on that they only have the placebo, placebo research won’t be able to control adequately for belief. But if we give subjects placebos that induce side effects, then we have rather active placebos with more potential to confound results. Even more alarming is the thought that the conclusions of some earlier drug research might be wrong because of these kinds of problems.

**Cases of Fraud**

The following are some examples of scientific misconduct cases that occurred between 1989 and 2000, reported in the *Chronicle of Higher Education.*

* [Oregon Regional Primate Center] An assistant scientist in the division of neurosciences used the same photographs of cells to represent different sets of data in published papers (Wheeler, 1991, p. A7).
* [Northwestern University] An associate professor of physiology fabricated data for two published abstracts and submitted a document with the forged signature of a graduate student to the investigating committee (Wheeler, 1991, p. A7).
* [Stanford University] Two professors of psychiatry misrepresented the status of research subjects in nine papers and plagiarized a book chapter (Wheeler, 1991, p. A7).
* [Medical College of Georgia] A nursing professor fabricated the existence of subjects and data in a mental health research study (Burd, 1995, p. A23).
* [Johns Hopkins University School of Medicine] A research program coordinator in oncology fabricated data on patient interviews and falsified updates on patient status, giving the appearance of more favorable outcomes (Walker, 1997a, p. A33).
* [University of the Witwatersand (South Africa)] Hematology and oncology professor confessed that he falsified data in a breast cancer treatment study (Vergnani, 2000, p. A52).
* [University of Ulm, the Medical University of Lubeck, University of Freiburg, and others] In Germany’s biggest case of scientific fraud in decades, two professors of hematology involved in gene therapy research stand accused by various university commissions of falsifying data in at least 47 scientific papers over a ten-year period. Hundreds of other papers written by them are currently being examined for fraud (Bollag, 1998, p. A57, A59–60).
* [University of Missouri at Columbia] Assistant professor in the department of veterinary biomedical sciences made up data on the weights of muscles and presented the data as if they were results of experiments that were, in fact, not conducted (Walker, 1997b, p. A29).

In most of the above cases, the offenders resigned from their university positions and were barred from receiving federal grants for several years. Journals that had published the falsified data were notified.

Cases of fraud occur at all levels, in all disciplines, and in all countries. According to one survey, 0.3 percent of scientists falsified data (Cook, 2005). As you can see, some of the most prestigious universities were associated with, and victimized by, the cases above.

## Pseudoscience

True scientific inquiry uses the steps of the scientific method in a careful, objective manner in an attempt to reach some truths about the world. At the same time it is open to the possibility of error in its conclusions and considers reasonable alternative explanations. True scientific inquiry looks at all the data and does not omit facts because they threaten a pet theory or belief or are difficult to explain; it carefully and objectively weighs all the evidence for and against various hypotheses and theories. True science develops hypotheses and theories that are testable and falsifiable. In other words, its inquiry is self-correcting: In principle there is the possibility of finding evidence or experimental results that would support or weaken a given hypothesis or belief such that the unsupported ideas are abandoned or modified. Any inquiry which pretends to be scientific but lacks these characteristics can be called a pseudoscience. In this sense of the term, “pseudoscience” is an activity, a flawed attempt at true scientific inquiry.

One common characteristic of pseudoscience is the tendency to give a *post hoc* (after the fact) explanation for an unfulfilled expectation or prediction *without planning to test the explanation,* or to give it in a manner that is untestable. Such explanations appear only to save face and protect a desired belief. Those who claim or believe in a fortune-teller’s psychic abilities, for example, could attribute a failure to perform psychic readings and feats to “bad timing,” an “uncooperative spirit,” or “negative energy.”

Some people use the term “pseudoscience” as a noun, labelling entire fields of inquiry as pseudosciences. However, even though some commonly labeled pseudosciences, such as astrology, are not built on a sound scientific foundation and fail miserably in their predictions, others cannot as easily be dismissed. Moreover, the tendency to label entire fields as pseudoscience can often be rooted in enculturation and personal barriers, such as religious bias or threats to a cherished world view. Darwin’s preoccupation with evolution, for example, was undoubtedly seen by many in his era as pseudoscience because it offended cherished religious beliefs and the “common sense” views of his time: “I repudiate with abhorence these new-fangled theories!” (Disraeli [1870] cited in Seldes, 1985, p. 109). Because such personal barriers so often influence our judgment about pseudoscience areas, one writer defined pseudoscience as “scientific work undertaken by anyone of whom one disapproves” (Sutherland, 1989, p. 351).

While there certainly are some theories and subjects that unquestionably have little if any scientific support and ought to be abandoned, there are others that are more arguable. In those areas reason dictates that we allow others the freedom to pursue their investigations and be critical only to the extent to which their inquiry fails to conform to the methods and spirit of true science.

In sum, it may be best to view pseudoscience simply as the activity of bad science, ranging from a careless or misguided scientific approach to a serious psychological virus capable of affecting scientists in *any* discipline, shredding their objectivity and infecting them with an unreasonable passionate belief in hypotheses and theories in which good evidence strongly suggests otherwise.

## Summary

Because we live in an era in which science permeates our culture, it is important to understand its basic methodology, assumptions, and limitations in order to think more critically about the scientific world around us. The methodology of science consists of four basic steps: observation, hypothesis formation, experimentation, and verification. It differs from other forms of inquiry primarily in its emphasis on systematic observation. This is also its limitation, for science can study only the empirical world, the world of observation and measurement. Answering metaphysical questions and determining values, for example, are outside the reach of science.

Although many scientists work with the concept of probability, science generally assumes a deterministic and orderly universe, including the universe of human behavior. Considerable debate occurs about the extent of this determinism when it is applied to human beings. Ironically, we tend to judge people as though they are free, but we study them as though they are not.

The methods of researchers are many and include experimental and quasi-experimental designs, ex post facto studies, and correlational designs, surveys, and case studies. Because the ex post facto method must find the difference between groups instead of creating the difference, as is done in a controlled study, it has more problems with hidden variables as alternative explanations for the results, and cause-and-effect relationships cannot as easily be inferred. The correlational designs, which examine the degree of relationship between two or more variables, is also a weak approach for discovering cause-and-effect relationships. In spite of the limitations of ex post facto and correlational studies, they are well suited for situations in which more controlled studies would be impractical or unethical. Additionally, correlational methods are quite useful in making predictions when strong correlations exist between variables. Sometimes the use of animal subjects arguably avoids ethical problems and allows scientists to use more controlled studies, such as the experimental or quasi-experimental designs. However, the question about the validity of generalization often arises when using animals to learn about human beings. Generalization is a problem in all studies if the sample is not representative of the larger population. And it is invalid to generalize from a single case study.

Even when there are no problems in the studies themselves, there is always the question of the results occurring by chance. Results are generally accepted if their significance level is .05 or better, meaning that the results could have occurred by some sampling error five times out of a hundred or less. Replication of research can help to strengthen confidence in study results. Such increased confidence, however, does not prove a theory, because everyone’s standard for proof varies.

Researchers are human beings with cherished beliefs, pet theories, and great hopes like everyone else. These biases can consciously or unconsciously influence their judgment of the research variables. Such influence is called experimenter bias. It is important for researchers to insulate their research from this bias as much as possible. One technique, used particularly in drug experiments, is to make the experimenter and subjects ignorant about crucial conditions in the experiment.

The techniques of controlled, objective observation make science a valuable tool for unraveling the mysteries of the world. A failure to use science appropriately, and with the right scientific attitude, is considered pseudoscience. Sometimes pseudoscience is driven by a pet theory or other cherished belief which overrides our critical scientific judgment.

As our awareness of the strengths and shortcomings of scientific procedures increases, we can make better judgments on the claims we see and hear, and we can apply the solid principles of science to our own thinking about the world, to our own attempts to find answers in an enigmatic universe.

### Scientific Thinking Challenges

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| 1. | Is it possible to have a cause-and-effect order in the universe without determinism? Explain. |

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| 2. | What kind of research method would you use to test the effects of depression on thinking? |

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| 3. | Imagine you heard the following: “Doctors found a relationship between being underweight and having cancer.” What hidden variable can you think of that might explain this relationship? |

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| 4. | Were you ever in an argument in which you tried to prove a point and were unsuccessful? Why? |

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| 5. | Short of actually discovering intelligent life elsewhere in the universe, what would it take to prove to you that such life probably exists? |

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| 6. | Outline different ways in which you could determine if broccoli or some other food prevents cancer? What are the strengths and weaknesses of each method? |

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| 7. | List the ten most important things that you would like to know. For how many of them is science the appropriate tool for finding an answer to your question? |

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| 8. | When you hear the claim “Doctors recommend Goody’s Pills,” what questions should you ask? |

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| 9. | How satisfied are you with significance levels of .05 and .01 for determining confidence in experimental results? Can you think of situations in which you would want stricter criteria? |

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| 10. | Are you free enough to be held responsible for what you do? How much does your social and psychological environment determine your behavior? How much is determined by your genetics? |

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| 11. | Is experimenter bias a factor in the classroom? |

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| 12. | Given that the speed of light is constant, if you shine a flashlight ahead of you as you travel forward at half the speed of light, how fast would the light from your flashlight travel? If you find this intriguing, read a book for the layperson on Einstein’s theory of relativity. |

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| 13. | What do you think about the definition of pseudoscience as “scientific work undertaken by anyone of whom one disapproves”? |

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| 14. | Conduct your own survey about a topic of interest using the four criteria for good surveys. How did you do? Can you generalize from your sample to a larger population? |

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| 15. | Ask people the same question but in different ways. Do you tend to get different responses depending on how the question is asked? |

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| 16. | Surveys are often conducted in shopping malls. What is a drawback to this technique? |

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| 17. | Have you ever made the mistake of using your personal experience and then generalizing to a larger population? |

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| 18. | If you noticed poverty and crime in mainly inner-city areas, what would be some of your hypotheses? |

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| 19. | If you conducted a survey on the Internet in such a fashion that you picked up a representative sample of Internet users, what do you think would be the makeup of your respondents? |

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| 20. | You want to find out if praying is good for your health, so you compare the health of some monks in a nearby monastery who pray every day with the health of a local atheist group. You find that the monks are healthier. Besides praying, what other variables might explain the greater health of the monks? |

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| 21. | Can the opinions of the general public about UFOs, astrology, or psychic phenomena be used to determine any facts about these subjects? Why or why not? |

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| 22. | Think back to the last scientific study you heard or read. Was the size of the effect mentioned? What type of scientific design was probably used? |

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| 23. | If you are taking medication, to what extent do you think your belief about the medication is contributing to its effect? Do you think some medications are more susceptible to the placebo effect than others? How can you know for sure? |

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| 24. | The views of astrologers have not been supported by scientific studies. Why then do so many people continue to believe in astrology? |

## Chapter 13 Evaluating

*The test is: Will the concept work? Does it give an unforced unity to the experience of man? Does the concept make life orderly, not by edict, but in fact?*

JACOB BRONOWSKI, *SCIENCE AND HUMAN VALUES*

What a great idea! Sometimes we are struck by our own brilliance: the idea is great. It might be applauded by others and we feel duly appreciated, but sometimes it is rejected or scorned outrightly. What then? Does the rejection and scorn make our idea bad? When we rethink our idea we may understand why it was rejected, we may see the flaw in our thinking, or the poor factual foundation, but at other times we may still be convinced of the greatness of our idea. Who’s right? How then do we validate our thinking?

When we evaluate our thinking, we are judging it. We are calling upon that function of our mind that psychologist Benjamin Bloom considered one of the highest acts of the human intellect. We are sitting in judgment with Solomon and the great Supreme Court justice John Marshall, exuding wisdom—or so we hope. In this chapter we use our judging intellect to understand how we need to test our thinking through dialogue; we consider the tests of reproductivity, simplicity, predictability, perspective, balance, completeness, and longevity; and we revisit our thinking bases—our senses, feelings, language, memory, logic, creativity, and organization—as major checkpoints to evaluate our thinking. Although our approach here is systematic and thorough, in our individual acts of evaluating we do not usually move systematically through each checkpoint; rather, we tend to sweep across the bases and examine those areas that seem to contain weak thinking.

**The Necessity to Test Thinking**

Testing, or validation, is the final step of the scientific method, and whenever possible we need to apply it to our own thinking. Without testing, the scientific method can fail miserably. The Hubble telescope was not tested before it was sent into orbit; it was aimed at a distant formation and gave blurred results; then it was discovered that the mirror was inaccurately ground and did not focus light precisely. Astronomers and taxpayers were angry, frustrated, and rather incredulous that such a simple step had been overlooked. NASA sent a multimillion dollar piece of equipment into space before seeing whether or not it worked.

Testing is a step we need to apply to our thinking whenever possible. How many times have we had a great idea and, when we tried it, were embarrassed because we had overlooked an obvious obstacle. In the abstract, our thinking can seem fine. For instance, a group of students were trying to get everyone over a wall as part of a character-building program. At first thought it seemed natural that the bigger students would boost the smaller ones to the top of the wall, so that is what they did. At the end, the last and largest student was stuck on the ground. By trying out their idea, the group found that they had to reverse their thinking plan and get the bigger students to the top of the wall first because it took many smaller students to lift them. The bigger students could then reach down and pull up the lighter students. Sometimes our thinking seems fine until we try it out, but without testing it first, our thinking could fail like the Hubble telescope.

It is not always simple to test our thinking and rarely can we achieve conclusive results. Although we might like to have a scientific “certainty” in all realms of thinking, often the best corroboration we can get is strong agreement from others.

**The Crucible of Critical Dialogue**

Critical dialogue is to thinking what testing is to science. We test our ideas in the crucible of active interchange, refutation, modification, and acceptance of ideas. In a community of thinkers, what is written can be critiqued and what is said can be debated and discussed. Unless our thinking is to remain valuable to us alone, we must express it and test it, or it will die with us.

If marketers want to know whether a new product will sell, they form focus groups of typical customers, give them the product, and listen to their criticisms. If an author wishes to test her book, she sends it to readers and asks for their reactions. Similarly, all areas of human living such as cooking, poetry, work, art, architecture, fashion, entertainment, and sports are critiqued by others.

Ultimately others become our jury. Writers turn to readers, politicians turn to voters, marketers turn to buyers, and ministers turn to parishioners. Sometimes we can select our jury before the actual trial. We can take our thoughts and papers to those whose thinking is respected by the community, to those who are knowledgeable, to those who are not biased toward us or our ideas. Even as you now read this book, you are part of the jury for the authors’ thinking. You can evaluate the work. You can ask these questions about this book, and about other works you are evaluating. Was the purpose clear? Did it help you understand the nature of thinking? Was the book both broad and deep, yet accurate and clear. Did it avoid biases? Did it spark further ideas? Did it provide answers? Did it lead to further questions?

**Thinking Activity****13.1. Using Dialogue**

List three or four ideas you have had or actions you have taken that would have been better if they had been tested by dialogue. List a few times when you did talk with someone about your ideas and were glad you did. List two or three decisions you might be making in the future that would be aided by critical dialogue. Who are the people you want to talk to?

**Critical Monologue**

When we do not have competent critics at hand, we have to go it alone to test our own thinking; we have to hold a dialogue, as it were, with ourself. In that case, as we noted in Chapter 1, writing is one of the best tools to objectify, or mirror, our thinking. After we have written out our thoughts, we should set them aside. The longer we wait before we read them, the better chance we have to read them critically, as if they were not our own, as if the words on the paper were the only clues to the meaning of our topic.

One way to gain this objectivity is to imagine our harshest critics reading our writing while we are watching and getting their reactions. Under such scrutiny we will write nothing that we cannot support. Through this critical monologue, our thinking will tighten.

**The Elegance of Simplicity**

*Genius is the ability to reduce the complicated to the simple.*

C. W. CERNAN

Since many great insights are simple, simplicity can sometimes be part of the evaluation process. Consider a few simple but great ideas: if we roll a ball, it keeps going until something stops it; when a bullet explodes from the barrel, it recoils back on the rifle; the sun and the earth, or any two objects, attract each other, and the bigger and closer they are, the more they attract. These three examples are the three great laws of motion stated by Newton, and they are elegantly simple. So too is the simple pattern of the DNA molecule, which varies only four steps up a winding staircase (adenine, thymine, cytosine, and guanine); and Mendeleyev’s periodic table, which embraces all matter, simply counts protons from 1 to 92: 1 proton = hydrogen, 2 protons = helium, and so forth.

E = mc2 is beautifully simple.

Simplicity is valued in most fields; complexity is often a failure to communicate simply. In philosophy we have referred to the elegant simplicity of Occam’s razor. In language we saw the clarity and force of brevity. Some of the most-quoted passages in literature are profoundly simple. What would you think of a six-word phrase in which five of the words had only two letters and the fourth word had only three letters? “To be, or not to be, that is the question.” Most of us have been frustrated by the compounded intricacies of legal documents. (We know one author who spent longer negotiating a publishing contract than she spent writing the book.) Against this legal verbiage Montaigne affirms simplicity: “The most desirable laws are those that are fewest, simplest, and most general” (1967, p. 345). Suspect complexity. Think simple.

**The Flattery of Imitation and Development**

Fertile ideas reproduce. If our testing has upheld our thinking, we may be rewarded with the imitation and expansion of our ideas, both of which are additional tests of the worth of our thoughts. Imitation is a high form of flattery and a partial validation of an idea because good ideas are often repeated. Without imitation of some kind, a loudly proclaimed idea can collapse like the “discovery” of cold fusion. An even higher form of flattery occurs when the ideas are so good that they are used as the basis for other ideas. This expandability is also a partial test of the worth of an idea. Plato’s and Aristotle’s foundational ideas were expanded into the towering structure of Western philosophy. Shakespeare’s rhythms and metaphors form the center of the last 400 years of literature. Freud opened the door to the unconscious mind through which countless psychologists still walk. Watson and Crick began unraveling the spiral DNA, and the fine-tuning of the genome continues.

**The Power of Predictability**

Like expandability, predictability also tests the worth of ideas. Mendeleyev’s simple table predicted all the elements long before they were found. Einstein’s relativity theory predicted that mass would bend light—an occurrence that eventually was measured during an eclipse as starlight bent around the sun. The contemporary quark/lepton theory predicted that six quarks would be found, and described the nature of each; The discovery of the last quark, “Top,” was announced late in 1992. So we should ask ourselves, does our thinking help to predict how other ideas or pieces of the puzzle might fit around this one?

**Perspective, Balance, and Completeness**

Mount Everest used to be called “Peak 15.” That’s because it didn’t look big to the British survey team that first named it; they were too far away. Without the proper perspective the highest mountain in the world was just another large peak. The perspective we have changes our view. If we are lying in the grass, we have a limited view; if we stand up we see more. If we climb a tree, board a plane, or look down at the earth from a satellite camera, our perspective changes. Which is better—in the grass or up in a satellite? It depends. Are we studying an ant or the earth’s weather patterns? We need the correct perspective for the thinking task at hand. Pascal cautions us:

If we are too young or too old we do not judge well. If we think too much or not enough about a topic we can get infatuated or obstinate about it. If we enter something too soon or put it off too long, if we are too close or too far away we cannot see accurately. (1958, p. 103)

Keeping perspective takes balance. As Pascal notes, extreme distance, age, effort, and time can all cause distortions in judgment. We need balance, the balance of Aristotle’s golden mean. This is not a lukewarm mediocrity but the balance on a high wire, the tension in a prewar debate in Congress, the judge upholding the law and being merciful to one who stole out of hunger. *Virtus stat in medio* (“Virtue stands in the middle”). And we might add *veritas*. *Truth* stands in the middle.

Part of keeping balance is completeness. Do all three legs of the tripod touch ground? Are all of the necessary facts involved in the thinking (remember the blind men feeling different parts of the elephant)? A newspaper described the first-place and third-place awards in a sand-sculpting contest. Readers were disturbed that second place was not announced, even though they did not know the participants. Completeness of thought is part of evaluating thought; as Shakespeare says, “Ripeness is all.”

**The Test of Time**

Chronology is a quick test. Does our information line up in the order it happened? Chronology is also a long test: Will our thinking stand the test of time? Aristotle’s old idea that there is nothing new under the sun has been assailed by newness yet has stood the test of many sunsets. Of course we cannot wait centuries to test our thinking, but if our ideas are sound and profound they will likely grow and endure; if they are fragile and faddish, they will likely flash and fade. Although time is an old test, however, it is good to remember that not all old ideas are true, for as Montaigne tells us, “Truth is none the wiser for being old” (1967, p. 364).

**Thinking Activity****13.2. Does Time Always Test True?**

If it lasts it’s good; if it doesn’t, it’s bad. How accurate is the test of time? Can you think of any historical people, events, or inventions that were misjudged by “time”? Can you recall any idea that has stood the test of time, even for centuries, but has now been “proved” wrong? If time was wrong in that interim, how do we know it is right now? How many ways can time be wrong? Make some guesses about which current ideas or authors will become classics—that is, will still be valued hundreds of years from now.

**Testing Against Our Thinking Bases**

Let’s quickly return to our thinking bases to evaluate the effectiveness of our thinking.

**Personal Barriers**

When we do not have the counterpoint of vigorous dialogue, we especially need to be wary of our personal barriers. If the topic we are thinking about elicits strong emotions from us, we need to think carefully and objectively to avoid any distortion in our thinking. We need to be careful that we are not thinking in a stereotypical and enculturated manner and that our personal wishes and personal pride are not overwhelming our good sense. We must also be aware of our level of stress, the condition of our body, and the effects these may have on our ideas.

**Perceptions and Memory**

A quick check: Do we have the data right? Are we sure of our sensual perceptions? Do the appearances reflect the reality? Have we listened acutely and sensitively, and can we trust the speaker or writer? Are our facts correct? Are we confident that our memory is accurate? If any of our sensual sources or recollections are suspect, we can express our thinking conditionally and then research our doubts.

**Language**

Remember, our language does not just carry our thoughts; it is inextricably intertwined with our thinking. If we have time to write out our thoughts, we can analyze the language of our thinking. We want to use clear definitions, appropriate connotations, fitting analogies, correct word order, contextual awareness, concrete nouns and active verbs, and we want to keep our thinking as tight and precise as possible.

“Brevity is the soul of wit,” says Shakespeare’s verbose Polonius in self-reflecting mockery. And we can be sure that Polonius would have railed pompously against bureaucracy if he had heard Chicago officials announce three days after the Chicago River surged into the tunnel system and shut the city down, “Chicago is speeding up its paperwork in order to get the Federal Government to declare it a disaster area.” Amazingly, the third largest city in the United States closed while waiting for paperwork. Can our thinking be like the government? Can we afford a bureaucracy of words?

Brevity adds to clarity, and although brevity is the sister of simplicity, it is not simple to be brief. It is hard to trim our thinking, which is, says Montaigne, our child. However, if we take the attitude that trimming our thinking makes our child smarter, stronger, and more beautiful, it is easier to place the good (but inappropriate) thoughts into other files.

**Think about it**

*Voltaire said, “I would have written a shorter letter if I had more time.”*

**Feelings**

Are our feelings there? Can we reach down and identify them? Thinking without feeling is often cold and sterile. We need these feelings as the force behind our thoughts. How do we feel toward the topic? Toward the audience? We need to harness the powerful, positive force of these feelings as the heart behind the eloquence of our mind.

**Creativity Check**

Do our ideas glisten? Or is our mind a desert and our thinking dry? If so, we can be sure that the sand dunes will mount in our receiver’s mind. We need water-spring metaphors for our thoughts to bloom. Remember the metaphor—the heart of language, of thinking, of newness, of great thinkers. If our thoughts are clichéd, our thinking will be repetitious, unoriginal, and boring, as desiccated as the desert. We want to remember to starburst, brainstorm, and in other ways coax our creativity to find that key analogy that will connect our thinking to the world and to other people.

**Organization**

Does our thinking have a clear structure: a chronological, topical, analogical, causal, or other natural or mental structure? Can we state our goal clearly? Can we name the three or four most important supporting ideas? Do all the ideas link together? Does our thinking have the perspective, balance, and completeness to stand the test of time?

**Logic Check**

Is our thinking well-grounded and tightly constructed? How sound are our premises and our assumptions? Will they be accepted by our audience? Do we reason solidly down from these premises, following the laws of logic, to a valid conclusion? Is our inductive thinking based on solid and repeated observations? Is our cause-and-effect analysis sound? Have we avoided reasoning fallacies, especially those that are deceptively appealing to us?

**Thinking Activity****13.3. Our Tone Toward Our Thinking**

In a reflective move, turn your analysis inward and try to discover what your own feeling, or tone is toward your own thinking. How do you feel about how you think? In reading this book, have you become more aware of your own thinking processes? How did you formerly feel about your thinking? What is your feeling about it now? Wonder? Confusion? Pride? Fear? Excitement? Try to reflect on the positive aspects of your thinking and feel optimistic about your ability to think, and to think better.

**Summary**

We have considered the tests of dialogue, simplicity, expandability, predictability, perspective, balance, and longevity; and we have touched back on former thinking bases to evaluate our thinking. We have found that we need accurate data provided by our senses and memory: clear, concise, contextually accurate language; controlled and effective feelings; clear structure; and solid logic. When we have evaluated our ideas as good and our thinking as solid, it’s time to act. The next chapter will show us how to put thought into action.

**Evaluation Challenges**

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| 1. | How do you know when to accept the thinking of others as valid? How do you know when your own thinking is accurate? |

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| 2. | What do you do to gain perspective? Are there some things or people (such as parents or good friends) who are too close to you to judge objectively? List those persons. |

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| 3. | Are there some topics you are too far away from to have a reasoned opinion about? Give some examples. |

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| 4. | Who are some of the people with whom you might engage in critical dialogue about specific issues? Would different people be better depending on whether the thinking area is professional, educational, or personal? |

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| 5. | How long does an idea have to last to be good? |

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| 6. | What types of thoughts are foundational, the kind on which others can build? |

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| 7. | Take a piece of your writing and trim it down with Occam’s razor; cut out all unnecessary words. |

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| 8. | Alexander Pope tells us, “Be not the first by whom the new is tried, nor yet the last to lay the old aside.” Is this advice cowardly or wise, or does it depend on the situation? |

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| 9. | How do you achieve balance in your own thinking? At what points or on what topics are you likely to stumble, or lose your perspective? |

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| 10. | Much is made of the golden mean as the test of human excellence. What keeps this golden mean from turning into lukewarm mediocrity? |

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| 11. | How do our courts of law evaluate guilt? Does this legal evaluation involve any of the methods for evaluating thinking discussed in this chapter? You may wish to read Bertolt Brecht’s *The Caucasian Chalk Circle* and compare the unorthodox validation methods of a wise judge in the play with the judges in our legal system. |

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| 12. | When you hear, “Mr. X was indicted for murder,” what do you think about Mr. X? What does the term indicted actually mean? If Mr. X is found innocent, how will the media handle the news? How do you evaluate your thinking about the word indicted? |

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| 13. | A critical monologue is one way to evaluate our thinking. Horace tells us that when we have written something, we should put it away for nine years, evaluate it, edit it, and then publish it only if we still find it worthy. Nine years seems excessive, but how much intervening time do we need before we can evaluate our own thinking? |

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| 14. | Part of the evaluation process is taking care of the final details. In writing, we revise and proofread our thoughts to avoid costly or ridiculous errors; for example, one book in the draft stage accidentally carried the word feces instead of faces. A small letter but a great difference. What methods do you use to give a final polishing to your thinking? |

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| 15. | Like science, we want results; but unlike science, the results of our thinking do not approach certainty. Consequently, much of our judgment lies in the area of probability. How do you know when you have enough probability to judge your thinking to be worthy of action? |

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| 16. | Part of evaluating the thinking, is evaluating the thinker. Peter Facione has given us a description of the ideal critical thinker who is “habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fairminded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results” (1998, p. 14). While this list is daunting, and you might ask how could anyone meet all those criteria, it might be a good idea to check those that you do have and decide to maintain them, and to check those that are lacking or that you need to work on. Pick just one of them to start, and try it for a month, then go to the second. |

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| 17. | Write a personal assessment of your evaluation methods, considering both strengths and weaknesses. Review the chapter and decide what you do well and what you need to work on to judge your thinking more accurately. |

## Chapter 14 Decision and Action

*Everyone who’s ever taken a shower has had an idea. It’s the person who gets out of the shower, dries off, and does something about it who makes a difference.*

N. BUSHNELL, *FOUNDER OF ATARI*

## Why Act?

Once we have thought something out carefully and our thinking meets all our tests, we need to act. Our thoughts must give birth to action or remain sterile. Thinking without acting is like chewing food without swallowing. The complete thinker is the doer. “Suit the action to the word,” says Shakespeare. If our knowledge goes into action, if we act on our best thoughts, we have our best chance to feel good about ourselves. And if we make good decisions frequently, we may someday be called wise. Furthermore, following our thoughts with action may even improve our thinking, as the old proverb says:

* I hear and I forget.
* I see and I remember.
* I do and I understand.

Montaigne describes an ideal decision: he wants nothing to take “place that has not the consent of every part of [himself], without divisions and without inner rebellion” (1967, p. 13). Yet decision making is rarely that harmonious. Sometimes life or death is at issue when we choose, support, or vote for euthanasia, abortion, suicide, war, or capital punishment. Sometimes the result of our decision is simply to go to a movie or stay home. Whatever the case, we do need to decide. To live is to decide, and to live fully is to decide well.

In this chapter we explore how to decide. We look at a process of deciding; we present some difficulties that block our deciding such as fear, lack of knowledge, confusion, and conflict of values; we learn ways to deal with these difficulties by facing fears, firming our facts, drawing on character, using our feelings, role-playing, and imaging; we look at the timing of decisions, the actual moment of decision, at the action, and the evaluation after the action; we draw up an action plan to solidify these steps; and we practice turning thinking into action.

## Decision

*A Native American said he had two dogs fighting inside himself, one mean and the other good. When asked which one wins, he replied, “Whichever one I feed the most.”*

I will. I won’t. I’ll go. I’ll stay. I should. I shouldn’t. Yes. No. Yes. Maybe. At times we teeter on the cliff of decision. We feel stressed by indecision as we vacillate through “decisions and revisions which a minute will reverse” (T. S. Eliot). Our thinking bases have already laid the groundwork for deciding. If our thinking has been solid, usually the decision will follow. When it doesn’t, we can assist it through a three-step process by considering the goals, alternatives, and probable outcomes of each alternative. The goals are what we would ideally like to result from our decision and action. The alternatives are the ways we get those results. The probable outcomes are what we think will happen after we have chosen the alternatives. Let’s look at an example:

* Step 1: State the goal.

To get rich; more specifically, to acquire $1 million by age 55, retire, and then live off my investments.

* Step 2: List the alternatives:

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| Plan 1: Starting at age twenty-five, save $5,000 a year, earning 10 percent compounded in a tax-deferred plan. |
| Plan 2: Set up a specific investment plan in stocks and bonds. |
| Plan 3: Set up a progressive real estate purchase plan. |

* Step 3: Describe the probable outcomes:

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| Plan 1: Will work if I can earn, save, and get the 10 percent. |
| Plan 2: Might work with a good brokerage firm and some luck. |
| Plan 3: Might work with a knowledgeable agent in an area of the country that is appreciating in value. |

### Difficulties in Deciding

Although the three-step process may appear simple, our mind does not work like a machine, nor do human institutions such as the stock market and real estate market follow a linear projection. Frequently we struggle to formulate goals, to assess the data, and to project possible outcomes. We also struggle with our own values. Let’s look at some of the difficulties we can run into.

#### The Fear of Deciding

What if I’m wrong? Probably the greatest block to deciding is fear, which we have seen also hampers our creative thinking and our problem-solving abilities. Fears, anxieties, and doubts may be critically involved in leadership decision making. Fear chokes our thinking. When we worry about how our thoughts will be received, rejected, scorned, or ridiculed, we have difficulty deciding. It is safer to tread the traditional path and avoid decisions that cause change and threaten our self-esteem. When we feel we always need to be right, then often we will fear to decide. Or when we fear the conclusions we are reaching, we might abort the decision-making process. What if our lover doesn’t love us? What if the boss of our company is crooked? What if our friends have betrayed us? In these instances we might not want to embrace the truth because it is harsh. We do not want to lose our lover, our friends, our job, so we avoid following our thoughts to a decision.

#### The Grip of Habit

Lack of knowledge is another reason (and usually a good one) to hesitate before deciding. However, even when we have the knowledge we do not always act. For example, modern studies show that physical punishment is no more effective than other forms of discipline and has serious drawbacks; consequently, the American Academy of Pediatrics has urged that it be outlawed in schools and avoided at home. Echoing this position, the surgeon general in 1985 said corporal punishment should be forbidden in schools and discouraged at home; yet in a survey published in the *Journal of the American Medical Association* (June 17, 1992), 59 percent of pediatricians and 70 percent of family physicians still supported spanking, though their positions have recently changed. Why do these experts seem to act contrary to expert conclusions? Have they learned to doubt their colleagues? Or is it that old habits run deep?

#### Too Much Thinking

Sometimes we have too much information. It may be confusing, conflicting, or we may think too much about it. Thinking too much can stall action. Perhaps we know people like this or have met them in literature. The Underground Man by Dostoevski is a prisoner of his own thinking. Hamlet is a study in thought, in thinking too long and acting too late. Hamlet reflects on his own inaction:

* And thus, the native hue of resolution
* Is sicklied o’er with the pale cast of thought,
* And enterprises . . . lose the name of action.

We have Hamlets in the classroom. One English major thought, double-thought, triple-thought about everything before he spoke or acted; finally he became so enmeshed in his terrible mind-lock that he found it difficult to speak at all. Not just in literature but especially in philosophy, some students begin to think so intricately and involutedly that they actually question whether they are real or not. One philosophy major said, “I don’t know if I am alive, if I’m dreaming. I don’t know anything for sure.”

#### Clashing Motives

Conflicting needs, drives, and values can stop our decisions. Saint Augustine fought the battle of two wills: his body wanted sex yet his mind wanted chastity. Sometimes we act one way even when we think another way is better. One chocolate ice-cream addict placed a half-gallon of it deep in the basement freezer away from temptation. That same day he descended the stairs with a spoon in his hand and refused to listen to any guilt-producing thoughts. If we want something badly enough, we will try to suppress or ignore our thinking.

A student captures some of the feelings, tensions, insights, and results of a decision:

My mind screamed NO! My thoughts argued with each other repeatedly. The fear had my speech and body paralyzed. Only my mind was functioning, tossing the negative messages like liquid mercury separating when put on a hard surface. I closed my eyes when I heard the Justice of the Peace say, “I now pronounce you man and wife.” I started to cry! My new husband mistook those tears as joyful tears. Only I knew of the estranged feelings that existed, knowing instantly that I had done myself a violent injustice. The vivid echoing memory of those vows creates a haunting mirage distressing all functions of my well-being.

I was a young know-it-all of seventeen. A typical sample of a teenager. I had my mind made up to disband my family. I was spiteful. I wanted to prove my parents wrong! This dishonoring ill attitude that existed is still unexplainable to this day. I know I longed for some acceptance.

Fifteen years too late, the reflection is clear why I accepted those vows. I fell in love with my husband’s family. His mom and dad loved me back. I had a new family that loved me just the way I was. Yeah, I really felt important being a wife and daughter-in-law. These roles turned stale real fast. This was the beginning of my devastating trials in the adult world.

I’ve often thought of what my life would be like if I had made a different choice. This choice resulted in a brutal, costly divorce. It left me financially and emotionally distraught. An important part of my life was wasted and a long recovery was ahead of me. I can’t replace the precious time lost, but I’ve learned to balance and weigh all my choices.

Each choice is a drop of water. That drop of water forms a puddle in time; this then becomes a stream to go on flowing as the river of life.

### How to Decide

#### Facing Fear

If fear is the greatest obstacle to deciding, then courage and calm help us to decide. If we can free ourselves from obeisance to others, if we can strike strongly out on our own and let the chips and opinions fall where they may, we increase our decision-making power. An example of high praise given to a citizen activist was “He put his body where his words were.” Courage is not bottled and sold, but it can be bought with hard work. We can change our thinking with mantras such as “I think it’s right; I’ll do it; others can do what they want.” Easier said than done, but courage can build with practice.

#### Firming Our Foundation

When the decision is important and we have the time, the more thorough we are in our thinking preparation, the easier our decision will be. If we have covered our thinking bases, we have gone a long way toward deciding. We can make our thoughts objective and visible by writing them down.

A good way to capture our thoughts and facilitate decision making is to make a list of pros and cons (see Chapter 12, “Problem Solving”). Pick any decision issue you wish (changing jobs, asking someone out on a date, breaking up with someone, taking a certain course, and so forth). Write it down on the chart below, then write all the thoughts for and against that decision.



Sometimes these lists surprise us. Perhaps one list is much longer than we would have guessed, but does the longest list win? What if one of the cons is that we will die? That single con would outweigh a long list of pros. To make our list more accurate, we can evaluate the items for importance by indicating a weight of 1 to 10 in the box alongside each item, using 10 if it is extremely important and 1 if it is of negligible importance. Now simply total the boxes and watch the scales of decision begin to tip in one direction.

Each decision we make has its own set of relevant criteria. For example, before buying a house we might want to consider criteria such as location (neighborhood, urban or rural setting, proximity to schools, churches, and stores), price, size, materials, condition, and market comparisons. Before applying for a job we might consider the job description, our qualifications, the hours, salary, and benefits. Before bidding on the construction of a house, we look at the blueprints and specs. Before marketing a product, we do consumer surveys and profiles. The more complete our information, potentially, the better our decision.

#### Calling on Character

Sometimes, no matter what we know, the decision is hard because the results may be hurtful to us or to those we care about, or because the decision pits our greed against our good. When our character is in conflict, then we dig deep and decide who we are and who we want to become; we reach for principles, motivation, and values; we realize that our choices define us, that we become what we choose. To help us through these trying decisions, we can turn to Marcus Aurelius, Roman emperor, warrior, and philosopher. He tells us to perform each action as if it were our last. Similarly, Ignatius of Loyola, soldier and founder of the Jesuits, tells us to imagine ourselves on our deathbed and then choose as if the choice were the last event in our life.

In cases of character conflict, once the objective analyses are finished and we have concluded that waiting longer will not clarify the problem, we can then “push” the decision by focusing on the positive side and then, when we are able, decide quickly so as not to prolong the pain of conflicting choice. If we struggle and win, if we make the good choice, we are molding our character and subsequent choices will be less difficult.

**Changing Criteria: Putting on the Gloves**

Jennifer used to buy gloves for price, warmth, and color. One winter her wrists were cold, so she bought longer gloves. Then she read about the insulating power of Thinsulate and she bought a pair filled with this material. But they slipped on her steering wheel, so she searched out a nonslip variety. Her original list of three criteria grew to six: price, warmth, color, length, material, and grip. With time, our criteria will change and become firmer.

#### Feelings: A Boost Toward Decision

Hegel thinks that “nothing great in the world has been accomplished without passion” (1837/1944, p. 23). That same passion can sometimes be that extra push toward a decision. Many of us make decisions not knowing that our feelings are driving our thoughts. If, however, we are highly aware of our feelings, if we are aware of how they act as barriers and can mislead us, if we are honest with ourselves and know ourselves reasonably well, if we give them input but not control, we can use feelings as part of the deciding process. Antonio Domasio is studying the emotional architecture of the brain, watching the “split-second emotional assessments of situations that unfold so quickly that we’re usually not aware of the process. . . . Emotions turn out to be essential to our rational decision-making processes. If we didn’t have those gut responses, we’d get caught in an endless cycle of analysis, drawing infinite pros-and-cons lists in our heads. . . . It’s not that I’m saying the emotions decide things for you, it’s that the emotions help you concentrate on the right decision” (Johnson, 2004, pp. 45–49).

**Thinking Activity****14.1. Feelings and Decisions**

We have just suggested a rather dangerous procedure: to use feelings to assist us in deciding even though feelings often sabotage thought. At this point it might be wise to reflect back on when they have helped or hindered decisions. Which of our feelings might help us to make a sound decision? How or when can we trust them?

#### Imaging the Action

Another help in deciding is to form an image of ourselves doing the action. This method is similar to the systematic desensitization method of Joseph Wolpe, which can help us eliminate our fears. For instance, if we cannot decide to go to a stern school authority or a terrifying boss, we can visualize ourselves walking down the hallway toward the person’s office. When we can do this without significant anxiety, then we can visualize ourselves knocking on the door, then walking in, and finally, saying the difficult message. It is important to be relaxed at each step before we image the next one. Imaging can prepare us for difficult decisions and actions.

#### Role-Playing into Reality

After we have imaged it, then we can act it out, or role-play it. Delancy Street, a community prison in San Francisco, used role-playing to change thinking. Male prisoners had to get haircuts, wear suits, and even walk “normally.” They were asked to act as if they were successful, good citizens. This acting seemed to change their thinking, for their recidivism rate was quite low. About 80 percent of the role-players entered society and stayed there; apparently, many became the citizens whom they role-played.

We too can draw upon the power of acting to help ourselves carry out a decision. When the decision demands change and we don’t seem to have the power to decide, we may be able to role-play the action. At first we will probably feel stiff, but repetition will make it easier; consequently, it will become easier to think about acting that way routinely. Finally, we will have the strength to do what we have been role-playing, and then our minds and our bodies will work together. By playing the role we can become the role.

**Thinking Activity****14.2. Role-Playing**

With a group of friends, or perhaps a group assigned in class, brainstorm some topics that would frequently call for a decision. Try to determine the desired outcome and then act as if that were the outcome. For instance, if you wish to be positive and confident in approaching a difficult person, then act positive and confident while other people play the roles of the difficult person. This activity can easily be adapted to fit many situations. Continue to role-play until the role begins to feel more natural.

### When to Decide

*When* is a big part of *how*. If the decision does not have to be made immediately, time and further knowledge may make the decision clearer. A president of a small college in Indiana told us that he did not like to decide quickly because time would often make the decision unnecessary. Horace, a Roman poet, wins the cunctator award: in his *Ars Poetica* he advises waiting nine years after a work is written before publishing it. But congressman Francis Culkin wanted to wait too long to approve the Grand Coulee Dam. He said “there is no one to sell the power to except the jackrabbits and rattlesnakes.” Not long afterward, the hydroelectric plant played a huge part in powering the U.S. industrial effort in World War II (Dietrich, 1995).

How long is too long? In general, the more serious the situation, the slower we should be to take action. If we are thinking about getting married, divorced, or investing our life’s savings, we want a well-deliberated decision. Sometimes, however, even when the result could be catastrophic, a fast decision is needed. What if nuclear missiles are headed our way? What if a tornado is a hundred yards away? What if the oncoming car is in our lane heading toward us? What if a young child is choking and turning blue? When is a big part of how, and the answer to when is often now.

### The Deciding Moment

With the problem faced and partially solved, the moment comes: “I’ll do it!” As we bask in our decision, we are unaware that something has happened in our brain. About 300 milliseconds before we consciously knew our decision, a “PSI 300 wave” occurred. Does that mean our decision is out of our control? Fortunately, Benjamin Libet, who studies the decision wave at the University of California at San Francisco, has shown that we can stop our decision one- to two-tenths of a second before we act on it (Restak, 1979, p. 49). Perhaps our control lies as much in censoring as in deciding.

## Action

For the most part we advocate: Think first, then act. However, some research suggests that acting on unconscious thought sometimes leads to better decisions (Dijksterhuis, 2004). Gladwell Malcolm (2005, pp. 3–8) has popularized this concept. He gives a great example of trusting your first impressions, especially if you are an expert: The J. Paul Getty Museum in California had spent 14 months doing all the scientific studies on an “ancient” Greek statue, and they were ready to pay almost $10 million for it. An Italian art historian glanced at it, stared at the fingernails of the statue, and felt that something seemed wrong. A second art historian glanced at the statue and the word “fraud” went through his head. Neither expert could articulate what exactly was wrong, but the museum investigated longer and found it to be a forgery.

If the risk is not too great, we can simply test our thoughts by doing them, and observing the results. Thomas Savery and Thomas Newcomen built the thoughts of the French physicist Denis Papin into steam pumps. Thus began the industrial revolution. The force of Papin’s ideas placed into action changed our world forever.

Not all actions are so tangibly testable. Thomas More’s ideal society, described in *Utopia,* was never tested. However, the conceptual force of the book was tested. More compared England, a Christian society, with Utopia, a pagan society, and found England lacking. The English were shocked, and the concept of “utopia” has forever since enriched our ideological world.

Action completes thinking, but action is not the end of thought. Action gives input into the cycle of thinking-deciding-acting, which leads to further thinking. As we carry a decision into action, we are continually thinking about how to make it work: “A plan depends as much upon execution as it does upon concept,” says Frank Herbert, in his novel *Dune* (1987, p. 244). If we want the action to be successful, we must plan the execution. Here are some steps for developing a successful action plan:

### Action Plan

1. Exactly what will I do?
2. When will I begin?
3. Who might help me?
4. How might I fail?
5. Is my plan realistic, achievable, measurable?
6. What motivations, rewards, or punishments will I set for myself in order to carry it out?

Sometimes even when our thoughts are clear and accurate and when we make the best decision possible, we still can’t control the outcome. The Player King in *Hamlet* says, “Our thoughts are ours, their ends none of our own.”

## After Action

After action comes the test of our thinking. How did the results turn out? How do we feel about ourselves? Was this a good decision or a bad decision? At this point we are just seeking objective evaluation. If our plan collapsed, we can recall that we made the best decision that we could based on what we knew then. As Scottish poet Robert Burns noted, “The best laid schemes o’ mice and men gang aft agley [often go astray].” But to help ensure that our plans do work, we evaluate them after the fact. We can add a seventh step to our action plan above: When will I review the success of my plan?

If we want our action plan to have an enduring effect, we have to periodically rethink, return to the premises, adjust the plan, and reinvigorate ourselves. And remember, while staying objective in our evaluation we can also stay positive: We can look on the rain as refreshing or depressing; we can look on college as a prison of the body or a freedom of the mind.

## Summary

In this chapter we have seen that the complete thinker is also the decider and the doer. We have found that our other thinking bases prepare us to decide; we have learned to set goals, consider alternatives, and estimate probable outcomes; we have learned to follow up decisions with an action plan; and we learned the following specific ways to help us decide: Firm our facts, face our fears, call on our character and our feelings, and image and role-play the action. We have found that timing is part of the decision, and that after the decision and action we can judge it, adjust it, and set action plans to continue effective thinking and acting.

### Decision and Action Challenges

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| 1. | Think of a decision that you have been putting off. What are some of the factors in your delay? Do you need more information before you decide? What are the consequences of deciding wrongly? Of not deciding? Can you think through the process on paper and make the decision? |

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| 2. | A woman in her late thirties wanted to get married and have children. She had passed up several opportunities and was afraid her options were running out. Two men wanted to marry her: One man was fun but would make a poor father; the other was dull but would make a good father. She could marry one, the other, or neither. How would you choose if you were in the woman’s place? |

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| 3. | Although some of us wish ourselves so lucky, how would you choose a partner if you loved two persons and they both wanted you? |

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| 4. | Does the deciding process described in this chapter work in affairs of the heart? What are the qualities you would like in your ideal mate? List them in order of importance. |

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| 5. | Should you smile at a stranger? How do you make this decision? Why might you hesitate? |

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| 6. | Decision: Sexual relations? How do you decide? |

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| 7. | Decisions usually have a downside. What is the downside of deciding you want to be rich? |

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| 8. | In the movie *Sophie’s Choice,* the heroine is in a Nazi concentration camp and is forced to choose one of her two children to be executed. How would you have decided in that position? |

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| 9. | *Notes from Underground* by Dostoyevsky shows us one of the most turgid, twisted, convoluted, densest, brightest minds in literature. Read Part 1 of this short novel to understand how too much thinking can overload the mind’s circuit. |

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| 10. | Has excessive self-consciousness (thinking about oneself too much) ever made it difficult for you to speak or act? Have you ever thought yourself into a knot? How did you cut through that knot and act? |

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| 11. | Does new knowledge change old decisions? Studies have shown that swimming after eating does not cause drowning, yet people from an older generation have difficulty entering the water after eating. |

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| 12. | What is the meaning of the saying “I do and I understand”? |

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| 13. | Is not deciding really deciding? |

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| 14. | As we choose, we choose ourselves. What does this statement mean and how accurate is it? |

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| 15. | What do common expressions such as “Put your money where your mouth is,” “He’s a blowhard,” and “She talks a good line” say about our attitude toward action? |

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| 16. | Image the following action: You have to make a difficult decision. Picture yourself gradually, in steps, getting closer to doing it. |

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| 17. | Try out the advice of Marcus Aurelius and Ignatius of Loyola. Select a difficult choice you have to make. Then, imagine that you are dying today and that this is the last choice you will make, and then choose. Did you gain some perspective on your choice? |

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| 18. | Besides giving us the confidence to decide, role-playing can help us prepare for a difficult situation. Role-play a meeting with the dean of students, or role-play asking for a date from someone who might turn you down. Practice with another person or in front of a mirror. |

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| 19. | Could a flip of a coin ever be a useful way to make a decision? Could even a very important decision be settled on a flip? |

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| 20. | Montaigne wore a medallion with the inscription *Je m’abstiens* (“I restrain myself”). How necessary is restraint for making decisions? |

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| 21. | If you wish to engage one of the greatest issues of philosophy, religion, and social science, you can ask the questions, Can I really decide? Am I really free? |

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| 22. | “There is nothing either good or bad but thinking makes it so.” Does this thought from*Hamlet* vitiate the worth of deciding? How can we draw power from this thought?

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| 23. | How can you apply the decision-making process to decisions made in groups? What parts would be the same? What parts would be different? What else would you need to add? |

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Chapter 15 The Challenge to Go on Thinking*When Robert Peary, the American explorer, asked his Eskimo guide what he was thinking, the guide replied: “I do not think. I have plenty of meat.”*Thinking does not stop with the end of a book or the end of a course. As long as we live we think, but how we think will be our choice. If we choose, we can probe the reaches of the unfolding universe, we can explore the intricacies of the mind, we can carve our thoughts into written words, and we can speak our thoughts with persuasive force.We began this book citing some of our brilliant thinking predecessors. We can begin to end it by listening to the blunt challenge of Sartre, and the lofty exaltation of Kant. Sartre tells us: “Man is nothing else but that which he makes of himself”(1946, Lecture). The choice is ours. By our thinking and by our choices and actions, we will define ourselves. Kant says that the ability to be conscious of ourselves raises us infinitely above all other creatures on earth. Let us earn that adulation! Let us use that ability to think.Let’s think about our future thinking. How wide will we range? How deep will we plunge? How well will we build?How wide? Philosopher José Ortega y Gasset says that many things fail to interest us because they don’t find enough surfaces in our mind on which to live. We have to expand our mind so that more themes—more of life—can find a place within.How wide will we cast our senses to feed our mind? What is the sensual milieu in which we will place ourselves? What are the sights and sounds that we will seek out or reject? What physical weaknesses might distort our sensing, and what personal barriers might warp our perceptions? What strengths will focus and magnify them? And how can we select, increase, clarify, and intensify the myriad streams of sensual data that impact our sensory receptors and settle in our mind?**Think about it***The preceding paragraph asks us to think about the deluge of sensual data that inundates us by chance, by default, and by choice. Spending time in self-reflection, in discussion, and in writing increases our understanding of the sensory world and helps form and solidify the sensing patterns that best nourish our minds. Throughout this chapter, pause after each question and think about the possibilities for enlarging your own thinking.*How far will we let our creativity roam? How hard will we strive to break the lock of habit? How long will we prod the problem and seek the solution? How often will we break the crust of custom and begin the dance of creativity? How much will we trust ourselves to reform and blend old things, ideas, and structures into new inventions, thoughts, and organizations?With what words will we stock our mind? What books will we read? What movies will we watch? With whom will we talk? How long will we wrestle with our written words? Will we crack our clichés and recast them? Will we search for better metaphors to carry our meaning?Breadth without depth would leave us shallow. If we had to choose only one of these dimensions, would it be “better to know something about everything than to know all about one thing” (Pascal, 1958, p. 10)? To what extent can we have both?How deep will we plunge? As we stand on the precipice of our personal barriers and look down, will we recognize our enculturation and ego defenses? Will we listen to our feelings when they inspire us and transcend them when they do not? Will we admit our prejudices and fears? Will we struggle against our biases and reach toward objectivity? Will we admit when we’re wrong? Will we read and research to gain the deep knowledge that we need in certain chosen areas? Will we struggle not to win but to understand and express our best thinking?Breadth and depth interrelate. Our deep areas make no sense isolated from the broader context of the world. Our depth will be greatly aided by breadth. New ideas for our deep interests will come from the cross-fertilization of our wide interests.No matter how wide or deep our knowledge, its use will be in our thinking. How well will we build? How will we work to develop effective thinking patterns in our mind? How will we link our ideas together? How tight will we keep our lines of logic? How will we combine our thoughts into newness? How persuasively will we present our thoughts? By effort and by choice we can change old thinking habits and adopt powerful thinking patterns to develop what Montaigne calls a “well-formed intellect.” How will we form that intellect?\* \* \*Thinking is not an island separated from the rest of our human nature. It does not exist in isolation from our feelings, intuitions, or dreams. It is only one part of us, yet an essential part in all of us. From poet and artist to mathematician and philosopher, from musician and designer to scientist and engineer, better thinking will tend toward a better life.The human species has used its thinking marvelously, but it still knows very little about so very much, asking today many of the same questions that were asked by minds thousands of years ago. Great thinking can unlock many doors, but there may be some that it cannot open. Yet how wondrous is the thinker; in the words of Shakespeare, “How noble in reason! How infinite in faculty! . . . in apprehension how like a god!”  |  |

Kirby G. R. and Goodpaster J.R. (2007), Thinking. An Interdisciplinary Approach to Critical and Creative Thought, Fourth Edition, Upper Saddle River, New Jersey, Pearson Education