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## The Human Mind

The research tools discussed so far—the library, computer technology, measurement, statistics, and language—are effective only to the extent that another critical tool also comes into play. The human mind is undoubtedly the most important tool in the researcher's toolbox. Nothing equals its powers of comprehension, integrative reasoning, and insight.

Over the past few millennia, human beings have developed several general strategies through which they can more effectively reason about and better understand worldly phenomena. Key among these strategies are critical thinking, deductive logic, inductive reasoning, scientific method, theory building, and collaboration with *other* minds.

### Critical Thinking

Before beginning a research project, effective researchers typically look at research reports and theoretical discussions related to their topic of interest. But they don't just accept research findings and theories at face value; instead, they scrutinize those findings and theories for faulty assumptions, questionable logic, weaknesses in methodologies, and unwarranted conclusions. And, of course, effective researchers scrutinize their *own* work for the same kinds of flaws. In other words, good researchers engage in critical thinking.

In general, **critical thinking** involves evaluating the accuracy, credibility, and worth of information and lines of reasoning. Critical thinking is reflective, logical, and evidence-based. It also has a purposeful quality to it—that is, the researcher thinks critically in order to achieve a particular goal.

Critical thinking can take a variety of forms, depending on the context. For instance, it may involve any one or more of the following (Halpern, 1998, 2008; Nussbaum, 2008):

- **Verbal reasoning.** Understanding and evaluating persuasive techniques found in oral and written language.
- **Argument analysis.** Discriminating between reasons that do and do not support a particular conclusion.
- **Probabilistic reasoning.** Determining the likelihood and uncertainties associated with various events.
- **Decision making.** Identifying and evaluating several alternatives and selecting the alternative most likely to lead to a successful outcome.
- **Hypothesis testing.** Judging the value of data and research results in terms of the methods used to obtain them and their potential relevance to certain conclusions. When hypothesis testing includes critical thinking, it involves considering questions such as these:
  - Was an appropriate method used to measure a particular outcome?
  - Are the data and results derived from a relatively large number of people, objects, or events?
  - Have other possible explanations or conclusions been eliminated?
  - Can the results obtained in one situation be reasonably generalized to other situations?

To some degree, different fields of study require different kinds of critical thinking. In history, critical thinking might involve scrutinizing various historical documents and looking for clues as to whether things *definitely* happened a particular way or only *maybe* happened that way. In psychology, it might involve critically evaluating the way in which a particular psychological characteristic (e.g., intelligence, personality) is being measured. In anthropology, it might involve observing people's behaviors over an extended period of time and speculating about what those behaviors indicate about the cultural group being studied.

## Deductive Logic

**Deductive logic** begins with one or more *premises*. These premises are statements or assumptions that the researcher initially takes to be true. Reasoning then proceeds logically from these premises toward conclusions that—if the premises are indeed true—must *also* be true. For example,

If all tulips are plants, (Premise 1)  
 And if all plants produce energy through photosynthesis, (Premise 2)  
 Then all tulips must produce energy through photosynthesis. (Conclusion)

To the extent that the premises are false, the conclusions may also be false. For example,

If all tulips are platypuses, (Premise 1)  
 And if all platypuses produce energy through spontaneous combustion, (Premise 2)  
 Then all tulips must produce energy through spontaneous combustion. (Conclusion)

The if-this-then-that logic is the same in both examples. We reach an erroneous conclusion in the second example—we conclude that tulips are apt to burst into flames at unpredictable times—only because both of our premises are erroneous.

Let's look back more than 500 years to Christopher Columbus's first voyage to the New World. At the time, people held many beliefs about the world that, to them, were irrefutable facts: People are mortal, the Earth is flat, the universe is finite and relatively small. The terror that gripped Columbus's sailors as they crossed the Atlantic was a fear supported by deductive logic. If the Earth is flat (premise) and the universe finite and small (premise), the Earth's flat surface must stop at some point. Therefore, a ship that continues to travel into uncharted territory must eventually come to the Earth's edge and fall off, and its passengers (who are mortal—another premise) will meet their deaths. The logic was sound; the conclusions were valid. Where the reasoning fell short was in two faulty premises: that the Earth is flat and relatively small.



Deductive logic provides the basis for mathematical proofs in mathematics, physics, and related disciplines. It is also extremely valuable for generating research hypotheses and testing theories. As an example, let's look one more time at doctoral student Dinah Jackson's dissertation project about the possible effects of self-questioning during studying. Jackson knew from well-established theories about human learning that forming mental associations among two or more pieces of information results in more effective learning than does trying to learn each piece of information separately from the others. She also found a body of research literature indicating that the kinds of questions students ask themselves (mentally) and try to answer as they listen to a lecture or read a textbook influence both what they learn and how effectively they remember it. (For instance, a student who is trying to answer the question, "What do I need to remember for the test?" might learn very differently from the student who is considering the question, "How might I apply this information to my own life?") From such findings, Jackson generated several key premises and drew a logical conclusion from them:

If learning information in an associative, integrative manner is more effective than learning information in a fact-by-fact, piecemeal manner, (Premise 1)

If the kinds of questions students ask themselves during a learning activity influence how they learn, (Premise 2)

If training in self-questioning techniques influences the kinds of questions that students ask themselves, (Premise 3)

And if learning is reflected in the kinds of notes that students take during class, (Premise 4)

Then teaching students to ask themselves integrative questions as they study class material should lead to better-integrated class notes and higher-quality learning. (Conclusion)

Such reasoning led Jackson to form and test several hypotheses, including this one:

Students who have formal training in integrative self-questioning will take more integrative notes than students who have not had any formal training. (Jackson, 1996, p. 12)

The data Jackson collected in her dissertation research supported this hypothesis.

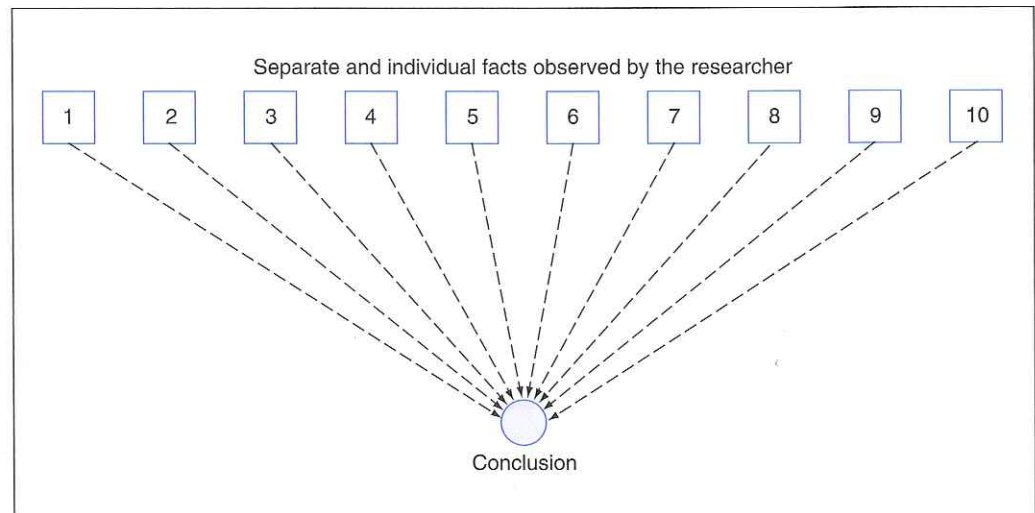
## Inductive Reasoning

Inductive reasoning begins not with a preestablished truth or assumption but instead with an observation. For instance, as a baby in a high chair many years ago, you may have observed that if you held a cracker in front of you and then let go of it, it fell to the floor. "Hmmm," you may have thought, "what happens if I do that again?" So you grabbed another cracker, held it out, and released it. It, too, fell to the floor. You followed the same procedure with several more crackers, and the result was always the same: The cracker traveled in a downward direction. Eventually you may have performed the same actions on other things—blocks, rattles, peas, milk—and invariably observed the same result. Eventually you drew the conclusion that all things fall when dropped—your first inkling about a force called *gravity*. (You may also have concluded that dropping things from your high chair greatly annoyed your parents, but that is another matter.)

In **inductive reasoning**, people use specific instances or occurrences to draw conclusions about entire classes of objects or events. In other words, they observe a *sample* and then draw conclusions about the larger *population* from which the sample has been taken. For instance, an anthropologist might draw conclusions about a certain culture after studying a certain community within that culture. A professor of special education might use a few case studies in which a particular instructional approach is effective with students who have dyslexia to recommend that teachers use the instructional approach with other students with dyslexia. A sociologist might conduct three surveys (one each in 1995, 2005, and 2015) asking 1,000 people to describe their beliefs about AIDS and then drawing conclusions about how society's attitudes toward AIDS have changed over the 20-year period.

Figure 1.2 graphically depicts the nature of inductive reasoning. Let's look at an example of how this representation applies to an actual research project. Neurologists Silverman, Masland, Saunders, and Schwab (1970) sought the answer to a problem in medicine: How long can a

**FIGURE 1.2** ■ The Inductive Process



person have a “flat EEG” (i.e., an absence of measurable electrical activity in the brain, typically indicative of cerebral death) and still recover? Silverman and his colleagues observed 2,650 actual cases. They noted that, in all cases in which the flat EEG persisted for 24 hours or more, not a single recovery occurred. All of the data pointed to the same conclusion: *People who exhibit flat EEGs for 24 hours or longer will not recover.* We cannot, of course, rule out the unexplored cases, but *from the data observed*, the conclusion reached was that recovery is impossible. The EEG line from every case led to that *one* conclusion.

## Scientific Method

During the Renaissance, people found that when they systematically collected and analyzed data, new insights and understandings might emerge. Thus was the scientific method born; the words literally mean “the method that searches after knowledge” (*scientia* is Latin for “knowledge” and derives from *scire*, “to know”). The scientific method gained momentum during the 16th century with such men as Paracelsus, Copernicus, Vesalius, and Galileo.

Traditionally, the term **scientific method** has referred to an approach in which a researcher (a) identifies a problem that defines the goal of one’s quest; (b) posits a hypothesis that, if confirmed, resolves the problem; (c) gathers data relevant to the hypothesis; and (d) analyzes and interprets the data to see whether they support the hypothesis and resolve the question that instigated the research. In recent years, however, the term has been a controversial one, because not all researchers follow the steps just listed in a rigid, lock-step manner; in fact, as noted earlier, some researchers shy away from forming any hypotheses about what they might find. Some of the controversy revolves around which article to use in front of the term—more specifically, whether to say “*the* scientific method” or “*a* scientific method.” If we are speaking generally about the importance of collecting and analyzing data systematically rather than haphazardly, then saying “*the* scientific method” makes sense. If, instead, we are speaking about a specific methodology—say, experimental research or ethnographic research (described in Chapter 7 and Chapter 9, respectively), it is probably better to say “*a* scientific method.” In any event, we are talking about a somewhat flexible—although certainly also rigorous—process.

As you may already have realized, application of a scientific method usually involves both deductive logic and inductive reasoning. Researchers might develop a hypothesis either from a theory (deductive logic) or from observations of specific events (inductive reasoning). Using deductive logic, they might make predictions about the patterns they are likely to see in their data *if* a hypothesis is true. And they often use inductive reasoning to generalize about a large population from which they have drawn a small sample.



## Theory Building

Psychologists are increasingly realizing that the human mind is a very *constructive* mind. People don't just passively absorb and remember a large body of unorganized facts about the world. Instead, they pull together the things they see and hear to form well-organized and integrated understandings about a wide variety of physical and social events. Human beings, then, seem to have a natural tendency to develop *theories* about the world around them (e.g., see Bransford, Brown, & Cocking, 2000; J. E. Ormrod, 2012).

In general, a **theory** is an organized body of concepts and principles intended to explain a particular phenomenon. Even as young children, human beings are inclined to form their own, personal theories about various physical and social phenomena—for instance, why the sun “goes down” at night, where babies come from, and why certain individuals behave in particular ways. People's everyday, informal theories about the world aren't always accurate. For example, imagine that an airplane drops a large metal ball as it travels forward through the air. What kind of path will the ball take as it falls downward? The answer, of course, is that it will fall downward at an increasingly fast rate (thanks to gravity) but will also continue to travel forward (thanks to inertia). Thus, its path will have the shape of a parabolic arc. Yet many college students erroneously believe that the ball (a) will fall straight down, (b) will take a straight diagonal path downward, or (c) will actually move *backward* from the airplane as it falls down (McCloskey, 1983).

What characterizes the theory building of a good researcher is the fact that it is supported by well-documented findings—rather than by naive beliefs and subjective impressions of the world—and by logically defensible reasoning. Thus, the theory-building process involves thinking *actively* and *intentionally* about a phenomenon under investigation. Beginning with the facts known about the phenomenon, the researcher brainstorms ideas about plausible and, ideally, *best* explanations—a process that is sometimes called **abduction** (e.g., Jaccard & Jacoby, 2010; Walton, 2003). Such explanations are apt to involve an interrelated set of concepts and propositions that, taken together, can reasonably account for the phenomenon being studied.

After one or more researchers have developed a theory to explain a phenomenon of interest, the theory is apt to drive further research, in part by posing new questions that require answers and in part by suggesting hypotheses about the likely outcomes of particular investigations. For example, one common way of testing a theory is to use deductive reasoning to make a prediction (hypothesis) about what should occur *if the theory is a viable explanation of the phenomenon being examined*. As an example, let's consider Albert Einstein's theory of relativity, first proposed in 1915. Within the context of his theory, Einstein hypothesized that light passes through space as photons—tiny masses of spectral energy. If light has mass, Einstein reasoned, it should be subject to the pull of a gravitational field. A year later, Karl Schwarzschild predicted that, based on Einstein's reasoning, the gravitational field of the sun should bend light rays considerably more than Isaac Newton had predicted many years earlier. In 1919 a group of English astronomers traveled to Brazil and North Africa to observe how the sun's gravity distorted the light of a distant star now visible due to a solar eclipse. After the data were analyzed and interpreted, the results clearly supported the Einstein–Schwarzschild hypothesis—and therefore also supported Einstein's theory of relativity.

As new data emerge that either do or do not support particular hypotheses, a researcher may continue to revise a theory, reworking parts to better account for research findings, filling in gaps with additional concepts or propositions, extending the theory to apply to additional situations, and relating the theory to other theories regarding overlapping phenomena (Steiner, 1988; K. R. Thompson, 2006). Occasionally, when an existing theory cannot adequately account for a growing body of evidence, a good researcher casts it aside and begins to formulate an alternative theory that better explains the data.

Theory building tends to be a relatively slow process, with any particular theory continuing to evolve over a period of years, decades, or centuries. Often, many researchers contribute to the theory-building effort, testing hypotheses that the theory suggests, suggesting additional concepts and propositions to include in the theory, and conducting additional investigations to test one or more aspects of the theory in its current state. This last point brings us to yet another strategy for effectively using the human mind: collaborating with *other* minds.

## Collaboration with Other Minds

As an old saying goes, two heads are better than one. Three or more heads can be even better. Any single researcher is apt to have certain perspectives, assumptions, and theoretical biases—not to mention gaps in his or her knowledge about the subject matter—that will limit how he or she approaches a research project. By bringing one or more professional colleagues into a research project—ideally, colleagues who have perspectives, backgrounds, and areas of expertise somewhat different from the researcher's own—the researcher brings many more cognitive resources to bear on how to tackle the research problem and how to find meaning in the data obtained (e.g., see Nichols, 1998).

Sometimes these colleagues enter the picture as equal partners. At other times they may simply offer suggestions and advice. For example, when a graduate student conducts research for a master's thesis or doctoral dissertation, the student is, of course, the key player in the endeavor. Yet the student typically has considerable guidance from an advisor and, especially in the case of a doctoral dissertation, from a faculty committee. The prudent student selects an advisor and committee members who have the expertise to help shape the research project into a form that will truly address the research question and—more importantly—will make a genuine contribution to the student's topic of study.

### USING TECHNOLOGY



As a general rule, productive researchers keep in regular communication with others who conduct similar research in their field, exchanging ideas, critiquing one another's work, and directing one another to potentially helpful resources. Such ongoing communication is also a form of collaboration—albeit a less systematic one—in that everyone can benefit from and build on what others are thinking and finding. Increasingly, computer technology is playing a central role in this cross-communication and cross-fertilization. For example, some researchers maintain professional [web pages](#) that describe their research programs and include links to relevant research reports; often you can find these web pages by going to the websites of the researchers' universities or other home institutions. Also of value are [list servers](#), which provide a mechanism for electronic discussion groups. A list server is essentially a mailing list, and any e-mail message sent to it is distributed to everyone who has subscribed to the list.

As the preceding sections should make clear, we human beings are—or at least have the potential to be—*logical, reasoning* beings. But despite our incredible intellectual capabilities—which almost certainly surpass those of all other species on the planet—we don't always reason as logically or objectively as we might. For example, sometimes we “discover” what we *expect* to discover, to the point where we don't look objectively at the data we collect. And sometimes we are so emotionally attached to particular perspectives or theories about a phenomenon that we can't abandon them when mountains of evidence indicate that we should. Figure 1.3 describes some common pitfalls in human reasoning—pitfalls we urge you to be on the lookout for and try to overcome. Good researchers are *reflective* researchers who regularly and critically examine not only their research designs and data but also their own thinking processes.

