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THE SCIENTIFIC APPROACH

It [science] is not perfect. It is only a tool. But it is by far the best tool we have, self-correcting, ongoing, [and] applicable to everything. It has two rules. First: there are no sacred truths; all assumptions must be critically examined; arguments from authority are worthless. Second: whatever is inconsistent with the facts must be discarded or revised.

—Carl Sagan (1980, p. 333)

OVERVIEW

This chapter contains a description of the scientific approach as it applies to the theory and practice of research. You will learn why science, despite being the best approach to research, is not subject to proof from outside its own logical system. Scientific knowledge and its growth are a function of agreement, and you will learn how agreement is facilitated by the use of inductive reasoning. You will also learn about distinctions between scientific and nonscientific research, various misconceptions about science, and the importance of theory in the research process. You will learn how to use theory and other resources to facilitate your understanding, critical evaluation, and application of research.

INTRODUCTION

Many people think of scientific research as something done by intelligent-but-absent-minded people wearing white coats while surrounded by strange-looking equipment with blinking lights. Some may think of scientists as despoilers of a simple, nontechnical lifestyle. Others may think of scientists as the harbingers of an idyllic age. None of these views is correct; one of the goals of this chapter is to dispel these and other myths about science. Science is not something one does; rather, it is an approach toward doing things, and one of the most important things scientists do is research. Scientists certainly do not all wear white laboratory coats nor do we all use strange equipment, with or without blinking lights. Some scientists may be extremely intelligent or absent minded, but these qualities do not make a person a scientist; neither does adopting a scientific approach necessarily make someone intelligent or absent minded.

We noted in Chapter 1 that everyone, not just scientists, does research. What distinguishes scientific from other kinds of research is not the activity itself but the approach to the activity. Scientific research is, among other things, systematic. There are other guidelines about what is and what is not scientific research as well as guidelines about what to do with scientific research once we have it, including ethical guidelines. Scientists know what these guidelines are, agree about them, and attempt to adhere to them. Nonscientists either do not know them or do not consistently use them. It is not research that distinguishes scientists from nonscientists; it is the approach one takes toward research. As we also mentioned in Chapter 1, science is a systematic approach to the discovery of knowledge based on a set of rules that defines what is acceptable knowledge. Just as there are rules for such things as tennis or international diplomacy, there are rules for science. And just like tennis or international diplomacy, not everyone necessarily operates according to the same set of rules.

A PHILOSOPHY OF SCIENCE

Years ago, one of us was discussing religion with a friend. We disagreed about many things, but we were calmly discussing the relative merits of our personal beliefs. At one point, the friend was asked to explain why she believes what she does. She replied very simply, “I believe it because I know it’s true.” When asked how she knew it was true, she said, “I know in my heart it’s true.” Still, she could not explain why she believes what she believes. In all fairness, we both thought we were correct, but

neither of us could logically prove we were correct in any absolute sense. At best, we could point out that we were not alone in our beliefs. Of course, most people accept the notion that there is no absolute proof when the topic is religious beliefs. What many people do not understand is that the same is true about science.

Any set of rules that defines what is acceptable, empirical knowledge may be called a **philosophy of science**. Among philosophers of science and among scientists, however, there is more than one accepted philosophy. This is partly because philosophers, like members of any other discipline, are developing, changing, and assessing new ideas and formulations in an attempt to improve upon what we know. Whatever their differences, however, all philosophers of science need to address the same four basic questions: (1) When is something true? (2) If we have more than one explanation, how can we tell which one is better? (3) How can we put what we know into practice? and (4) Why do we do it the way we do it?

In this chapter, we will concentrate on a particular philosophy of science called *nonjustificationism* (Strauss & Smith, 2009; Weimer, 1979). The name of this viewpoint is derived from the position that a scientific approach cannot be justified—proven valid—except through unproven assumptions; **Nonjustificationism** is a *philosophy of science for which the major premise is that we cannot logically prove that the way we go about doing research is correct in any absolute sense*. While this conclusion may seem outlandish right now, the remaining discussion should help you understand why this outlandish conclusion is quite logical and not at all inconsistent with a scientific approach to understanding the world.

When Is Something True?

This first question to be answered through any philosophy of science is usually called the question of **rational inference**—*a philosophical problem concerning the difficulty inherent in supporting any claim about the existence of a universal truth*. Just as with the conversation about religious beliefs, in which there was more than one truth, there is more than one solution to the problem of rational inference. In order to be scientific, whatever we accept as our answer to the question of when something is true (i.e., our interim solution to the rational inference problem) must be based on **facts**—*objectively verifiable phenomena or characteristics available to anyone who knows how to observe them*. Recall Sagan's (1980) second rule of science: Whatever does not

Philosophy of science set of rules that defines acceptable, empirical knowledge

Nonjustificationism the way we go about doing research cannot be proved correct

Facts objectively verifiable phenomena or characteristics available to anyone

agree with the facts is wrong and must be changed or rejected completely. Although the statement is simple, deciding how to go about the process is a little more complex.

Behavioral scientists, for example, are interested in understanding how people interact with each other at a variety of different levels. We want to understand as much about people and human phenomena as possible. No matter how many facts we have, however, we cannot understand them until we have a way to summarize those facts. Summarizing facts—making them comprehensible—is what theories are all about.

But anyone can make up a theory about human behavior. Given enough time, just about everyone in the world can articulate some sort of theory for any given phenomenon. Thus, we have the equivalent of a very large warehouse that is full of theories. This imaginary warehouse contains as many different theories about people as there are people in the world, multiplied by the number of different theories each of those individuals has for each of the various phenomena that make up human behavior. Clearly, we need to imagine a very large (and probably quite disorganized) warehouse. Of course, each discipline has its own warehouse of theories, so deciding what to do with all the theories in all the sciences can be somewhat daunting, but it is not impossible.

At a very simple level, all we have to do is compare each theory in the warehouse to the facts: If the theory does not fit the facts, we change it or throw it out of the warehouse. This process may sound good, but it just does not work that way. Theories are made up of **concepts**—*abstract words that are used to represent concrete phenomena*. We can point to concrete examples of concepts, but the concepts themselves are abstract. For example, conflict, as a theoretical concept, is not the same thing as a family argument or a revolution. Family argument and revolution are, of course, concrete examples of conflict, but they are only examples and not complete definitions. No matter how compellingly practical a concept may be, it is only an approximation of reality, and any given concrete phenomenon is only an approximation of a concept (Wartofsky, 1968). Theories symbolize, represent, or summarize the real world in which we live and behave, but the concepts within the theories are not the same thing as the real world. Because concepts are abstract and the facts we rely on to test them are concrete, deciding whether or not a theory fits the facts is rather difficult.

This difficulty arises because we must rely on inductive reasoning when connecting facts to a theory. **Inductive reasoning** is *a process of generalization; it involves applying specific information to a general situation or future events*. That is, we are generalizing from a

Concepts abstract words used to represent concrete phenomena

Inductive reasoning a process of generalization

concrete fact to an abstract theory. As an example, consider the guidance issued by the US Centers for Disease Control (CDC) regarding the use of face coverings in the early months of the COVID-19 pandemic. In late February 2020, approximately six weeks after the first case of COVID-19 was detected in the United States, the CDC was not yet recommending the use of face masks by the general public as a means to help prevent the spread of this novel virus. While the full rationale behind the CDC's guidance is unclear, it's likely that the decision to not recommend universal masking earlier in the pandemic stemmed in part from a lack of context-specific evidence demonstrating the efficacy of cloth masks, along with the need to make inferences regarding the incubation period, transmissibility, and likelihood of asymptomatic/presymptomatic transmission. Such inferences were derived from generalizations of our limited knowledge of pathogens associated with previous disease outbreaks, of a similar nature, including those caused by other types of coronaviruses (e.g., SARS-CoV & MERS-CoV).

Several months into the pandemic, the CDC issued a press release which recommended the use of universal masking practices (Centers for Disease Control and Prevention, 2020). This new recommendation was made in part as a result of newly reported research findings, although the only sources cited by the CDC within the initial guidance recommending in favor of the practice of universal masking consisted of an editorial (Brooks et al., 2020) and a case report (among the weakest forms of evidence) which suggested cloth face masks might provide protection against transmission of SARS-CoV-2 (Hendrix et al., 2020), the virus which causes COVID-19. Still, evidence accumulated over time and we now know that transmission does occur from asymptomatic people (Kronbichler et al., 2020) and the characteristics of SARS-CoV-2 were later determined to differ from those types from which we made inferences regarding the characteristics of SARS-CoV-2.

Despite the inability of inductive reasoning to lead us to absolute truth, we must rely on it in any scientific approach to research. We simply cannot let all those theories pile up in the warehouse until we have all the facts nor can we wait for all the facts before we begin to construct theories to put in the warehouse. Instead, we simply accept the notion that inductive reasoning is the best process of generalization we have until something better comes along.

We have simplified the arguments involved in this issue, but the basic point of the rational inference problem is rather simple: Inductive inferences cannot be proved true. Nevertheless, we need to use them to construct theories until we have evidence to the contrary. If we have enough contrary evidence, we can throw a theory out of our warehouse, but that does not mean that any of the theories remaining in the

warehouse are true. We are left with no choice but to provide support for a theory by trying to show that alternative, competing theories are not true. If we make a prediction from a theory and test the prediction and if the prediction fits the facts, then we have *not* proved the theory to be true; instead, we have failed to prove that the theory is false. It is difficult to think in terms of double negatives—Theory *X* is not not-true—but that is the logic forced on us by the rational inference problem. Thus, research in which we test between two competing theories is more efficient than research in which we test only one theory because comparing theories is one way to deal with the rational inference problem.

How Can We Tell Which Theory Is Better?

The absence of absolute truth does not limit what we can learn in a scientific approach, but we are faced with a particular path in our quest to learn about behavior and other real-world phenomena. We can, as mentioned above, test between two different theories and decide which one is better. Testing between theories is like a grand tournament in which every theory is pitted against every other theory; the theory with the best win–loss record at the end of the tournament is the winner. That does not mean that the winning theory is true—only that it is the best theory we have until another, better theory is entered in the tournament. Like all tournaments, the tournament of scientific theories has some rules about which theories are entered and how many times a theory must lose in order to be eliminated.

The rules of the grand tournament of science bring us to the problem called **criteria for growth**—finding *standards that can be used to decide whether one explanation is better than another*. We all know, for example, that as an explanation of the apparent movement of the sun across the sky, current theories of astronomy are more accurate (but less poetic) than the myth of Helios, the sun god, waking every morning and driving his fiery chariot across the sky. We would scoff at anyone who seriously believed the Helios explanation, just as any ancient Greek would have scoffed at our current theories. How we came to decide that astronomy is better than mythology involves our criteria for growth: paradigms and facts.

Theories, whether in or out of our imaginary warehouse, do not exist in a vacuum. Every theory is related to at least one other theory through shared concepts or propositions. Kuhn (1962) was the first to use the term *paradigm* (pronounced “pair-a-dime”) to describe such groups of related theories. A **paradigm** is a *logical system that encompasses*

Paradigm theories, concepts, models, procedures, and techniques

theories, concepts, models, procedures, and techniques. The earth-centered solar system, for example, was once a paradigm in physics, just as instinct was once a paradigm in psychology (McDougall, 1908). At the time McDougall was theorizing about human behavior, the predominant explanations included some notion about instinctual processes; there was an instinct for survival, one for aggression, and so on. New observations about behavior were interpreted in terms of existing instincts, and if new observations did not fit, then new instincts were invented to account for the observations.

During the time in which a particular paradigm is accepted, which Kuhn (1962) referred to as a period of *normal science*, research is directed toward solving problems related to matching current theories with observations. At such times, research tends to be directed toward refining theories, toward trying to make them better, such as inventing new instincts to fit research observations. New research and the refinements of theories add to the strength of the paradigm, which in turn leads to the perception that the paradigm, including its associated theories and procedures, is the best way to explain what goes on in the world.

Eventually, however, problems with the paradigm emerge as more and more information cannot be fit into the existing theories. We note “eventually” because no matter how reasonable or useful a paradigm may be, it, too, is based on inductive reasoning and thus cannot be considered universal truth. When enough problems emerge and an alternative paradigm, complete with its own theories and procedures, arises that fits the observations better, then the old paradigm gives way to a new one during what Kuhn calls a *scientific revolution*. Thus Galileo started a scientific revolution with his notion of a sun-centered solar system, although it took years before the followers of the earth-centered paradigm accepted the new paradigm. Then the new paradigm becomes *the* paradigm and the field returns again to normal science until the next paradigm shift occurs.

Underlying all of normal and revolutionary science is reliance on facts. Observations are considered facts when people can point to concrete examples of the observation. Although it may seem tautological to require facts to be observable, that very requirement is one of the reasons McDougall’s instinct theories eventually gave way to modern explanations of behavior; there was no way to observe—to be able to point to concrete examples of—the processes by which instincts influence behavior. Today, of course, we have some evidence for instinctual processes as one of several possible explanations for some behaviors (see, for example, Lea & Webley, 2006; Snyder, 1987), but we do not use instinct as the primary explanatory concept for all behavior.

In addition to being observable, facts must also be objective. Within a scientific approach, **objectivity** means *that an observation can be replicated, observed by more than one person under a variety of different conditions*. If several other researchers note the same effect under different conditions, then we have a fact, an objective observation that needs to be incorporated into existing theories. If, however, you are the only researcher who can demonstrate a particular effect, it is not objective.

During normal science, theories are compared on the basis of their fit into the existing paradigm as well as our ability to use them to account for the existing facts. During revolutionary science, comparisons occur between old and new paradigms, but the basis for such comparisons remains the existing facts. Then, upon return to normal science, theories within the current paradigm are again evaluated in terms of their fit with the facts. It is important to note, however, that because a new paradigm may redefine what is an acceptable fact, the facts may change from time to time (Fleck, 1979).

Instances in which the results of a given study cannot be replicated represent a type of scientific failure (i.e., failure to observe expected outcomes). To some extent, such failures are an inherent component of scientific inquiry and frequently stem from overgeneralization of prior research findings or methodological failures including inadequate statistical power (Guttinger & Love, 2019). These failures, which have occurred in virtually all fields of study, can be considered essential to the scientific advancement, with their value being derived largely from the resulting process of reconciling conflicting results (Redish et al., 2018).

Still, the value of such failures must be viewed relative to the frequency in which they occur within a single discipline. In recent years, the social sciences, among other fields of study, have encountered an increased frequency of unsuccessful attempts to replicate previous study findings, a situation described as a replication crisis. While not limited to any one discipline, psychology has seemingly faced the greatest scrutiny, fueled in part by the findings of Nosek and colleagues (Open Science Collaboration, 2015) who reported less than 40% of studies they attempted to replicate led to the same results as the original published studies. Despite the resulting widespread criticism of psychological research some researchers have seized the opportunity to study this reproducibility problem, leading to recommendations for researchers to improve the reproducibility of their work (Shrout & Rodgers, 2018).

Objectivity

observations that can be replicated or observed by others

How Can We Put What We Know Into Practice?

By now, you may be having some serious doubts about how a scientific approach can be a path to anything except confusion. There are no absolute truths, and sometimes what were once considered to be facts are no longer considered to be so. We have arrived at the problem of **pragmatic action**—*determining how we should go about putting a scientific approach into practice*. Essentially, those who adopt a scientific approach must get together and decide how they are going to use that approach. The solution to the problem of pragmatic action, the answer to the question of how we put what we know into practice, lies in agreement.

Just as legal theorists assume that a decision made by 12 jurors is better than a decision made by 1 juror, scientists agree that evidence obtained by a number of different researchers is better than evidence obtained by one researcher; that is, objective data—repeatable observations—are agreed to be better than subjective data. The greater the number of researchers who produce the same research results, the more we consider those results to be facts to which we must fit our theories; notice that the theories must fit the facts, not the other way around (we don't change facts to fit the theory; we change the theory to fit the facts). A variety of reasonable arguments support this agreement about objectivity, but no one can prove, in any absolute sense, that the consensus is correct. As Sagan (1980) suggested, it is not perfect, but it is the best we have.

One of the problems inherent in the use of objectivity is the variety of different research methods available to study any particular phenomenon (see, e.g., Gone, 2015; Watson, 1967). When researchers use different methods to study the same phenomena, they often come up with different observations. Consensus, then, must extend into agreement about which research methods are appropriate for which research questions as well as agreement about whether or not a particular method was used properly. Essentially, that is what this book and the course you are taking are all about. You cannot rely solely on the assumption that the experts have used the correct research method to answer their question; you must be able to determine yourself whether the methods used by the researchers fit the way in which you want to use the research results.

For example, in the early years of research about differences between men and women, one of the more common methods was to select a group of men and a group

of women, have both groups do something (such as solve math problems), and then compare the performances of the two groups. If the performances of the groups were different, then the researchers concluded that the results reflected basic differences between the two sexes. Deaux and Major (1987), however, presented convincing, empirical arguments that such things as the context of the situation, self-presentation strategies, researchers' and participants' beliefs about whether or not the sexes ought to be different, and a variety of other factors can change the results obtained from such methods. Therefore, the potential influence of such factors must be considered before we conclude that gender differences reflect basic differences between men and women.

We now know that simply comparing a group of men to a group of women is not an effective way to examine gender differences. Then again, everyone “knew” back in the old days that such simple comparisons were the best way to study gender differences. Even though we rely on consensus for such purposes as fitting theories to facts and even for deciding what is a fact, we must keep in mind that a new consensus might emerge after we have obtained more information. Still, there can be no scientific approach without consensus.

Why Do We Do It the Way We Do?

Every time one of us discusses consensus as the basis for a scientific approach, he can hear his mother saying, “Would you jump off a cliff just because everyone else is doing it?” That was her response, for example, to his wanting to stay out late because his friends' parents allowed them to stay out late; We're sure you have heard the same response when you have tried to use similar reasoning or you have provided the same response when your children used that reasoning. What we have come to, then, is the problem of **intellectual honesty**—*the individual scientist's ability to justify the use of science itself*. If we can never prove that theories are true, if paradigms are only temporary, and if facts and methods for gathering them may change, then why would we ever accept a scientific approach as a valid way to learn anything?

Consider a simple survey of students' attitudes about current grading practices. In order to understand and apply that study, we must rely on a great deal of background information. We must accept research about students' reading levels when examining the questionnaire, accept research that suggests that a survey is a reasonable way to

Intellectual honesty scientist's ability to justify the use of science itself

measure attitudes, accept research concerning the best way to format the questions on the survey, accept research about which statistics are appropriate to analyze the data, and so on. All that research comes from within a scientific approach, and we are using that information to add more facts to the same scientific approach. Where does it all end?

The solution to the intellectual honesty problem—the answer to why we do it the way we do—can again be found in Sagan’s quote at the beginning of this chapter: It is “by far the best tool we have.” We do it the way we do it because we have not found a better way. Very simply, we adopt a scientific approach because we have a certain amount of faith in it because it works or, as is often said, “If it ain’t broke, don’t fix it.” Note, however, that the faith is placed in the approach itself, not in any particular theory that comes from the approach. Table 2.1 describes both justificationist and non-justificationist approaches to the four basic questions inherent in any philosophy of science.

UNDERSTANDING CHECK

How might you respond to any statement containing verbiage such as, *research has proven...* and what would be the basis for your rebuttal?

TABLE 2.1 ● Justificationist and Nonjustificationist Approaches to the Four Basic Questions Inherent in Any Philosophy of Science

The Questions	Justificationist Approach to Science	Nonjustificationist Approach to Science
The rational inference problem: When is something true?	Facts produce a single, correct theory	Facts are summarized by many incorrect theories
Criteria for growth: How can we tell which theory is better?	Better fit with paradigm and facts	Better fit with paradigm and facts
Pragmatic action: How can we put what we know into practice?	Consensus produces the correct paradigm	Consensus enables a better, but not correct, paradigm
Intellectual honesty: Why do we do science the way we do?	Science produces absolute truth	Science is the best way to obtain knowledge

SCIENCE AND NONSCIENCE COMPARED

We keep bringing up the notion that we all conduct research all the time. We are all, in one way or another, gathering new information to increase our knowledge about our world. Such everyday research is not necessarily scientific, but it does provide us with a way to satisfy our curiosity. In addition to the points noted above, the differences between scientific and nonscientific research generally revolve around avoiding mistakes. Mistakes can occur when we make observations, when we interpret observations, or when we accept various misconceptions about what is included in a scientific approach toward research.

Observation

Whenever we observe something, we make errors—period, no exceptions, ever. The errors, which researchers generally call *bias*, come from selecting what to observe and interpreting what we observe as well as from the act of observation itself. We cannot avoid bias entirely, but we can attempt to reduce error to a minimum and be aware of error that we have not been able to eliminate.

For example, what we decide to observe creates a form of bias because it prevents us from making other observations at the same time. This is an error of omission that results simply because we cannot be in two places at the same time. That does not mean that what we do observe is wrong or incorrect but rather that it is incomplete. Essentially, we need to keep in mind that what we have been observing is not all that could be observed. Duckworth et al. (2007), for example, noted that individuals were discussing concepts very much like grit as far back as the late 1800s, but no one had gotten around to measuring it until more than a century later; everyone was busy observing other “stuff.”

Of course, objectivity is another way to reduce, but not eliminate, the bias inherent in observation. When more people observe the same thing, under the same or different conditions, then the collection of observations becomes more accurate (less biased, more complete). Different observers, different situations, different locations, and different definitions of what to observe all contribute to the objectivity of data and all reduce observation error. Realizing that all observation contains some amount of error or bias is an important part of a scientific approach to research, for it prevents anyone from saying, “Your results are wrong and mine are correct.” If we accept the notion

that everyone's data are at least a little bit wrong (contain some error, some bias), then we can concentrate on trying to figure out why our observations do not agree; that is, we can begin to refine our theories so that they more closely fit the existing facts.

Logical Analysis

The quality of observations is one distinction between scientific and nonscientific research, but it is far from being the only one. Once observations are made, we must interpret them and draw conclusions about them. We have already discussed the scientific reliance on inductive reasoning, so it should come as little surprise that induction plays an important role in data **interpretation** (*the process whereby recorded observations are used to describe events, generate hypotheses, or test hypotheses*).

Suppose you look out your window and observe 90° displayed on the scale of a thermometer. You could, of course, reasonably conclude that the temperature outside is 90°, assuming you had reason to believe that your thermometer was accurate. Anyone else could also look out the same window and note the same reading, and they would probably come to the same conclusion. Inductive reasoning enters the interpretation process when we attempt to move your conclusions beyond the immediate area outside your window, beyond the immediate confines of the data collection environment. Beyond your window is the remainder of the neighborhood, the city, the county, the state, the country, and so on. How far beyond your immediate observations you can reasonably interpret those observations is both a matter of inductive reasoning and yet another distinction between scientific and nonscientific research.

Given our general knowledge about meteorology, you could reasonably conclude that the temperature around the neighborhood and city is about 90°. You might be reluctant to speculate about temperature across the state, as would most people. The same reluctance applies to interpreting data collected in a research project: how far we **generalize**, *relate findings gathered from the research situation to other situations*, is limited by common sense and background information about the research topic. We would feel comfortable, for example, generalizing the results of a study of nursing students' cardiopulmonary resuscitation (CPR) performance (Oermann et al., 2011) to actual nurses by claiming actual nurses use the same physical skills that the students used. However, we would not feel comfortable claiming that actual nurses would

Interpretation

observations are used to describe events, generate hypotheses, or test hypotheses)

Generalize relate findings gathered from the research situation to other situations

make the same *decisions* that the students did. The way in which students and nurses conduct CPR may be the same, but the decisions about when to use CPR may be quite different because they may pay attention to different information (have different biases) and may have different life experiences with which to interpret the information they receive. **Overgeneralization**—*drawing conclusions too far beyond the scope of immediate observation*—brings scientific research into the realm of nonscientific research.

Research Reports

From time to time, you may find yourself reading a research article in which it appears as though the researchers designed their study to test a theory, collected data, and supported the theory discussed in the introduction of the article. You should know, and the researchers should know, that logic does not enable us to support a theory. Yet they write such phrases as “research supports the theory of...” or “the theory of *X* has received a great deal of empirical support.” In such cases, the language of scientific research appears to conflict with philosophy of science.

Keep in mind that the reason that research cannot support a theory is that support for a theory comes not from finding results consistent with a theory but from failing to find results that do not fit the theory. Remember the double negative logic of science: Failing to disconfirm a theory is the only empirical way to provide support for a theory. But support for a theory does not mean the same thing as proof that a theory is correct. It is a little too verbose to write “a number of researchers have attempted to disconfirm Theory *X* and have failed to do so” continually, and so we sometimes write “Theory *X* has received empirical support.”

Most authors of research articles create the impression that the researchers knew, from the start, exactly how the major results of the study would come out. Instead, research is often conducted with extremely little certainty about how the results will turn out. The researchers are not trying to hide their inability to predict the results accurately; rather, they are succinctly providing a theoretical context for their results. No matter how unexpected the results of research may be, they cannot contribute to what we already know unless they can be placed into a theoretical context. Placing results in context, however, is not the same as making up a theory to fit the results one obtained. Kerr

Overgeneralization
drawing conclusions
too far beyond
immediate
observation

(1998) refers to such writing as HARKing (Hypothesizing After the Results are Known) and notes that there are costs associated with such writing (see also Rupp, 2011).

Definitive Studies

Although any study may satisfy someone's curiosity about a particular issue, no study ever satisfies all scientific interest in an issue. That is, despite the fact that one often hears the phrase used in one or another context, there is no such thing as a **definitive study**—*a research project that completely answers a question*. Because any particular phenomenon is extremely complex, someone will always ask, "But what if...?" Such questions point out the need for additional research. Proposing that a definitive study can exist produces premature closure of activity; as Yogi Berra is supposed to have said about a baseball game, "It ain't over 'til it's over." It is, of course, difficult to argue with such logic. Within a scientific approach to research, it is not over until it is no longer possible to ask "What if?"

Although definitive studies may not exist, there are highly influential studies that set an entire research program, or series of programs, in motion. These studies have a great deal of **heuristic value**—they *stimulate a great deal of additional research activity*. Milgram's (1963) research on obedience is one example of a study with high heuristic value. It not only generated a great deal of controversy concerning research ethics, it also stimulated extensive research on compliance of individuals and groups. Munsterberg's (1913) studies of the accuracy of eyewitnesses' recollections, many of which were demonstrations conducted in the classroom, were also highly heuristic. Many examples of current research on eyewitnesses can be traced to one or another of his demonstrations.

As a research consumer, you should neither look for nor believe you have found a study that conclusively proves whether or not a program is effective; you won't find such a study because they simply don't exist. You will, however, find many claims that others have found such a study. One of us recently searched for the phrase "science proves" on Google and turned up about 118,000,000 sites, not all of which were quack sites, which merely demonstrates that there are many individuals who don't understand the limitations of science. In case you are interested, another search for the phrase "research proves" resulted in about 117,000,000 sites; a quick scan of some of those sites convinced us that many writers confuse *prove* with *demonstrate*, a

Definitive study a research project that completely answers a question

confusion that could lead to erroneous conclusions about the value of a program or policy.

Determinism

Perhaps the most misunderstood concept in a scientific approach to research is **determinism**, *the philosophical assumption that every event has at least one discoverable cause*. As defined here, determinism means nothing more than “events do not happen by themselves.” We assume that there is always a causal agent and that the agent can be discovered through a scientific approach to research. If you think about it at all, you will realize that there could not be science without determinism. The purpose of psychology, for example, is to understand the causes of human behavior; if we did not assume that every human behavior had at least one cause, then there would be no point to trying to understand the causes of human behavior.

Many people, however, incorrectly mistake determinism for **predestination**, *the philosophical assumption that events are unalterable and that, once initiated, events cannot be changed*. The two assumptions clearly are not at all similar. Indeed, there is some notion in determinism that once we are able to discover the cause of an event, we can alter the cause and thereby alter the event. There may, of course, be theories that include the assumption of predestination, and some of those theories may be tested through scientific research, but predestination is an aspect of a specific theory and not an assumption inherent in science.

Table 2.2 contains a summary of the differences between what is and what is not included in a scientific approach to research. Although there may be many other comparisons that could be drawn, you should have enough background in philosophy of science to begin putting it into practice.

Determinism every event has at least one discoverable cause

Predestination events are unalterable and that, once initiated, events cannot be changed

UNDERSTANDING CHECK

Why is it important for you as a consumer of research to be able to recognize potential sources of bias within a research study in addition to maintaining awareness of your own implicit biases?

TABLE 2.2 ● Comparisons Between Science and Nonscience

Science Is	Science Is Not
A way to obtain new information	An activity per se
Described by a philosophy	Defined by only one philosophy
Generalizing from facts	A way to prove theories true
Grounded in paradigms	Blind acceptance of tradition
Based on consensus	Relying on personal authority
A matter of faith	Uncritical faith
Deterministic	Predestination
The best approach we have	Refusing to search for a better approach

Summary

- Science is not an activity but rather an approach to activities that share the goal of discovering knowledge. One of these activities is research.
- Like any approach, a scientific approach has limitations. These limitations include rational inference, criteria for growth, pragmatic action, and intellectual honesty.
- Rational inference is a limitation on the extent to which we can propose universal truths. Because we must rely on inductive reasoning for such proposals, we cannot prove their accuracy. Thus, we accept theories as temporarily correct while always assuming that another, better theory is likely to come along.
- Criteria for growth is a limitation on the standards by which to judge the relative merits of explanations. Although such judgments are based on objective observations, we must be aware that the objectivity and relevance of observations are limited to the paradigm on which their relevance and objectivity are based.
- Pragmatic action is a limitation on the practice of research concerning methodological issues. Consensus, based on sound reasoning, is the way we decide how best to practice research.
- Intellectual honesty is a limitation on our willingness to accept a scientific approach. Placing one's faith in the scientific approach, however, does not involve believing in one or another particular theory.
- It is axiomatic that all observations contain some degree of error. Objectivity—the extent to which more than one observer can make the same measurement—decreases measurement error but does not eliminate it.

- Although research reports are written so as to place research results in a theoretical context, it is often the case that the theoretical context was logically derived after the research was conducted. This is a shortcoming when the author suggests that the hypothesis was derived prior to data collection.
- Despite the fact that a scientific approach includes the goal of comprehensively testing theories, there is no such thing as a definitive study. No study produces the final answer to a research question, in part because there is always the possibility that another theoretical context raises additional questions.
- One of the basic assumptions of a scientific approach to research is determinism—the assumption that every phenomenon has at least one discoverable cause. Although people often confuse determinism with predestination, the two concepts are entirely different. Predestination refers to the belief that events cannot be altered.
- Regardless of the point at which one begins a research project, the project is always related to one theory or another. Variables—logically derived, concrete representations of theoretical concepts—are used to form hypotheses; it is hypotheses that are directly tested in a research project.
- Construct validity refers to the extent to which a variable represents a theoretical concept. Consensus is necessary for validity, but it is possible to misuse a variable on which consensus has been achieved. Avoiding the belief that a variable is the same as the concept it represents prevents such misuse.

Exercises

1. Find examples in which people have written or said things that indicate they do or do not understand the rational inference problem in science.
2. Find examples in which people have written or said things consistent with the notion of comparing one theory against another. (Note: This may be somewhat difficult because most popular-press reports usually mention only one theory, if any.)
3. Find examples of reports in which the author(s) claim(s) to be reporting a consensus about scientific conclusions. Can you determine the source of the reported consensus?
4. Find an example of what you think is biased reporting of research. Explain why you think it is biased. Can you think of any conflicts of interest you might have with the report?