SEVENTH EDITION

Introduction to BEHAVIORAL RESEARCH METHODS

Mark R. Leary

Pearson

Introduction to Behavioral Research Methods

Seventh Edition

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Pearson

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Brief Contents

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Preface

Regardless of how good a particular class is, the students' enthusiasm for the course material is rarely as great as the professor's. No matter how interesting the material, how motivated the students, or how skillful the instructor, those who take a course are seldom as enthralled with the content as those who teach it. We've all taken courses in which an animated, nearly zealous professor faced a classroom of only mildly interested students.

In departments founded on the principles of behavioral science—psychology, neuroscience, communication, human development, education, marketing, social work, and the like—this discrepancy in student and faculty interest is perhaps most pronounced in courses that deal with research design and analysis. On the one hand, faculty members who teach courses in research methods are usually quite enthused about research. Many have contributed to the research literature in their own areas of expertise, and some are highly regarded researchers within their fields. On the other hand, despite these instructors' best efforts to bring the course alive, many students dread taking research methods courses. They expect that these courses will be dry and difficult and wonder why such courses are required as part of their curriculum. Thus, the enthusiastic, involved instructor is often confronted by a class of disinterested students, some of whom may begrudge the fact that they must study research methods at all.

In many ways, these attitudes are understandable. After all, students who choose to study psychology, education, human development, and other areas that rely on behavioral research rarely do so because they are enamored with research. In fact, many of them are initially surprised by the degree to which their courses are built around the results of scientific studies. (I certainly was.) Rather, such students either plan to enter a profession in which knowledge of behavior is relevant (such as professional psychology, social work, teaching, counseling, marketing, or public relations) or are intrinsically interested in the subject matter. Most students eventually come to appreciate the value of research to behavioral science, the helping professions, and society, although some continue to regard it as an unnecessary curricular diversion. For some students, being required to take courses in methodology and statistics nudges out other courses in which they are more interested.

In addition, the concepts, principles, analyses, and ways of thinking central to the study of research methods are new to most students and, thus, require a bit of extra effort to comprehend and learn. Not only that, but the topics covered in research methods courses, on the whole, seem inherently less interesting than those covered in most other courses in psychology and related fields. Wouldn't most of us rather be sitting in a class in developmental psychology, neuroscience, social psychology, memory, or human sexuality than one about research methods?

I wrote *Introduction to Behavioral Research Methods* because, as a teacher and as a researcher, I wanted a text that would help counteract students' natural tendencies to dislike and shy away from research—a text that would make research methodology as understandable, palatable, useful, and interesting for my students as it was for me. Thus, my primary goal was to write a text that is *readable.* Students should be able to understand most of the material in a text such as this without the course instructor having to serve as an interpreter. Enhancing comprehensibility can be achieved in two ways. The less preferred way is simply to dilute the material by omitting complex topics and by presenting material in a simplified, "dumbed-down" fashion. The alternative that I chose is to present the material, no matter how complex, with sufficient elaboration, explanation, and examples to render it understandable. The feedback I've received about the six previous editions gives me the sense that I have succeeded in my goal to create a rigorous yet readable introduction to behavioral research methods.

A second goal was to integrate the various topics to a greater extent than is done in most research methods texts, using the concept of variability as a unifying theme. From the development of a research idea, through measurement issues, to research design and analysis, the entire research process is an attempt to understand variability in behavior. Because the concept of variability is woven throughout the research process, I've used it as a framework to provide coherence to the various topics. Having taught research methods courses centered on the theme of variability for over 30 years, I can attest that students find the unifying theme very useful.

Third, I tried to write a text that is interesting—one that presents ideas in an engaging fashion and uses provocative examples of real and hypothetical research. This edition has even more examples of real research and intriguing controversies in behavioral science than previous editions. Far from being icing on the cake, these features help to enliven the research enterprise. Research methods are essentially tools, and learning about tools is enhanced when students can see the variety of fascinating studies that behavioral researchers have built with them.

Courses in research methods differ widely in the degree to which statistics are incorporated into the course. My own view is that students' understanding of research methodology is enhanced by familiarity with basic statistical principles. Without an elementary grasp of statistical concepts, students find it very difficult to understand the research articles they read. Although this text is decidedly focused on research methodology and design, I've sprinkled essential statistical topics throughout. My goal is to help students understand statistics conceptually without asking them to actually complete the calculations. With a better understanding of basic statistical concepts, students will not only be prepared to read published studies, but they should also be able to design better research studies themselves. Knowing that instructors differ in the degree to which they incorporate statistics into their methods courses, I have made it easy for individual instructors to choose whether students will deal with the calculational aspects of the analyses that appear. For the most part, statistical calculations are confined to a couple of within-chapter boxes, Chapter 12, and the Computational Formulas for ANOVA section in the endmatter. These sections may easily be omitted if the instructor prefers.

Instructors who have used previous editions of the text will find that the statistical material in Chapters 11 and 12 has been rearranged. Behavioral science is in flux regarding the preferred approaches to statistical analysis as the long-standing emphasis on null hypothesis significance testing is being supplemented, if not supplanted, by an emphasis on confidence intervals and effect sizes. In my view, students need to understand all common approaches to analyses that they will encounter in published research, so Chapter 11 provides a conceptual overview of both traditional and "new" approaches to statistical inference, while Chapter 12 dives more deeply into analyses such as *t*-tests and analysis of variance. Other than moving some topics in these chapters, those who are familiar with the previous edition will find the organization of the text mostly unchanged.

As a teacher, researcher, and author, I know that there will always be some discrepancy between professors' and students' attitudes toward research methods, but I believe that the new edition of *Introduction to Behavioral Research Methods* helps to narrow the gap.

New to This Edition

- Replication research is discussed in greater detail, along with the use of registered replication reports.
- The difference between reflective and formative measures is covered to dispel the erroneous belief that all multi-item scales must have high interitem reliability.
- Additional material on the use of telephone surveys and internet-based research has been added in light of the explosion in cell phone usage and Web-based studies.
- Attention is given to shortcomings of traditional null hypothesis significance testing and to alternative approaches to statistical inference involving confidence intervals and effect sizes.
- The two chapters on basic statistical analyses have been reorganized so that conceptual issues in statistical inference appear in Chapter 11 and the details of analyses such as *t*-tests and analysis of variance appear in Chapter 12, providing greater flexibility in how fundamental statistical issues are covered.
- The problems of deductive disclosure and computer security have been added to the discussion of data confidentiality.
- The section on scientific misconduct has been expanded given egregious cases of fraud since the previous edition.
- A new section on "Ethical Issues in Analyzing Data and Reporting Results" has been added that addresses cleaning data, overanalyzing data, selective reporting, and post hoc theorizing.

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About the Author

Mark R. Leary (Ph.D., University of Florida, 1980) is Garonzik Family Professor of Psychology and Neuroscience at Duke University and Director of the Interdisciplinary Behavioral Research Center. Prior to moving to Duke in 2006, Dr. Leary taught at Denison University, the University of Texas at Austin, and Wake Forest University, where he was department chair.

Dr. Leary's research and writing has centered on social motivation and emotion, with an emphasis on people's concerns with interpersonal evaluation and the negative effects of excessive self-focused thought. He has published 12 books and more than 200 scholarly articles and chapters on topics such as self-presentation, self-attention, social emotions (such as social anxiety, embarrassment, and hurt feelings), interpersonal rejection, and self-esteem. His books include: *Social Anxiety*, *Interpersonal Rejection, The Social Psychology of Emotional and Behavioral Problems, Self-Presentation*, *Introduction to Behavioral Research Methods*, *Handbook of Self and Identity*, *Handbook of Hypo-egoic Phenomena*, and *The Curse of the Self*.

In addition to serving on the editorial boards of numerous journals, Dr. Leary was founding editor of *Self and Identity*, editor of *Personality and Social Psychology Review*, and President of the Society for Personality and Social Psychology. He is a Fellow of the American Psychological Association, the Association for Psychological Science, and the Society for Personality and Social Psychology. He was the recipient of the 2011 Lifetime Career Award from the International Society for Self and Identity and the recipient of the 2015 Scientific Impact Award from the Society for Experimental Social Psychology.

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Chapter 1

Research in the Behavioral Sciences

Learning Objectives

- **1.1** Recall the early history of behavioral research
- **1.2** Summarize the three primary goals of behavioral research
- **1.3** Discuss ways in which the findings of behavioral research do and do not coincide with common sense
- **1.4** Name four benefits of understanding research methods for students
- **1.5** Summarize the three criteria that must be met to consider an investigation scientific
- **1.6** Explain the difference between theories and models
- **1.7** Compare deduction and induction as ways to develop research hypotheses
- **1.8** Contrast conceptual and operational definitions
- **1.9** Explain how scientific progress occurs
- **1.10** Distinguish among the four broad strategies of behavioral research
- **1.11** List specialties that comprise behavioral research
- **1.12** Explain how animal research has contributed to knowledge about thought, behavior, and emotion
- **1.13** List the decisions that researchers must make when they conduct behavioral research

Stop for a moment and imagine, as vividly as you can, a scientist at work. Let your imagination fill in as many details as possible regarding this scene.

> What does the imagined scientist look like?
> Where is the person working?
> What is the scientist doing?

When I asked a group of undergraduate students to imagine a scientist and tell me what they imagined, I found their answers to be quite intriguing.

First, virtually every student said that their imagined scientist was male. This in itself is interesting given that a high percentage of scientists are, of course, women.

Second, most of the students reported that they imagined that the scientist was wearing a white lab coat and working in some kind of laboratory. The details regarding this laboratory differed from student to student, but the lab always contained technical scientific equipment of one kind or another. Some students imagined a chemist, surrounded by substances in test tubes and beakers. Other students thought of a biologist peering into a microscope. Still others conjured up a physicist working with sophisticated electronic equipment. One or two students imagined an astronomer peering through a telescope, and a few even imagined a "mad scientist" creating monsters in a shadowy dungeon lit by torches. Most interesting to me was the fact that although these students were members of a psychology class (in fact, most were psychology majors), not one of them thought of any kind of a *behavioral scientist* when I asked them to imagine a scientist.

Their responses were probably typical of what most people would say if asked to imagine a scientist. For most people, the prototypical scientist is a man wearing a white lab coat working in a laboratory filled with technical equipment. Most people do not think of psychologists and other behavioral researchers as scientists in the same way they think of physicists, chemists, and biologists as scientists.

Instead, people tend to think of psychologists primarily in their roles as mental health professionals. If I had asked you to imagine a psychologist, you probably would have thought of a counselor talking with a client about his or her problems. You probably would not have imagined a behavioral researcher, such as a developmental psychologist studying how children learn numbers, a physiological psychologist studying startle responses, a social psychologist conducting an experiment on aggression, a political psychologist measuring voters' attitudes, or an organizational psychologist interviewing employees at an automobile assembly plant.

Psychology, however, is not only a profession that promotes human welfare through counseling, psychotherapy, education, and other activities but also a scientific discipline that studies behavior and mental processes. Just as biologists study living organisms and astronomers study the stars, behavioral scientists conduct research involving behavior and mental processes.

1.1: The Beginnings of Behavioral Research

1.1 Recall the early history of behavioral research

People have asked questions about the causes of behavior throughout written history. Aristotle (384–322 BCE) is sometimes credited as being the first individual to systematically address basic questions about the nature of human beings and why they behave as they do, and within Western culture this claim may be true. However, more ancient writings from India, including the *Upanishads* and the teachings of Gautama Buddha (563–483 BCE), offer equally sophisticated psychological insights into human thought, emotion, and behavior.

For over two millennia, however, the approach to answering questions about human behavior was entirely speculative. People would simply concoct explanations of behavior based on everyday observation, creative insight, or religious doctrine. For many centuries, people who wrote about behavior tended to be philosophers or theologians, and their approach was not scientific. Even so, many of these early insights into behavior were, of course, quite accurate.

And yet many of these explanations of behavior were also completely wrong. These early thinkers should not be faulted for having made mistakes, for even modern researchers sometimes draw incorrect conclusions. Unlike behavioral scientists today, however, these early "psychologists" (to use the term loosely) did not rely on scientific research to answer questions about behavior. As a result, they had no way to test the validity of their explanations and, thus, no way to discover whether or not their ideas and interpretations were accurate.

Scientific psychology (and behavioral science more broadly) was born during the last quarter of the nineteenth century. Through the influence of early researchers such as Wilhelm Wundt, William James, John Watson, G. Stanley Hall, and others, people began to realize that basic questions about behavior could be addressed using many of the same approaches that were used in more established sciences, such as biology, chemistry, and physics.

Today, more than 100 years later, the work of a few creative scientists has blossomed into a very large enterprise, involving hundreds of thousands of researchers around the world who devote part or all of their working lives to the scientific study of behavior. These include not only research psychologists but also researchers in other disciplines such as education, social work, family studies, communication, management, health and exercise science, public policy, marketing, and a number of medical fields (such as nursing, neurology, psychiatry, and geriatrics). What researchers in all of these areas of behavioral science have in common is that they apply scientific methodologies to the study of behavior, thought, and emotion.

Contributors to Behavioral Research

Wilhelm Wundt and the Founding of Scientific Psychology

Wilhelm Wundt (1832–1920) was the first research psychologist. Most of those before him who were interested in behavior identified themselves primarily as philosophers, theologians, biologists, physicians, or physiologists. Wundt, on the other hand, was the first to view himself as a research psychologist.

Wundt began studying medicine but switched to physiology after working with Johannes Müller, the leading physiologist of the time. Although his early research was in physiology rather than psychology, Wundt soon became interested in applying the methods of physiology to the study of psychology. In 1874, Wundt published a landmark text, *Principles of Physiological Psychology*, in which he boldly stated his plan to "mark out a new domain of science."

In 1875, Wundt established one of the first two psychology laboratories in the world at the University of Leipzig. Although it has been customary to cite 1879 as the year in which his lab was founded, Wundt was actually given laboratory space by the university for his laboratory equipment in 1875 (Watson, 1978). William James established a laboratory at Harvard University at about the same time, thus establishing the first psychological laboratory in the United States (Bringmann, 1979).

Beyond establishing the Leipzig laboratory, Wundt made many other contributions to behavioral science. He founded a scientific journal in 1881 for the publication of research in experimental psychology—the first journal to devote more space to psychology than to philosophy. (At the time, psychology was viewed as an area in the study of philosophy.) He also conducted research on a variety of psychological processes, including sensation, perception, reaction time, attention, emotion, and introspection. Importantly, he also trained many students who went on to make their own contributions to early psychology: G. Stanley Hall (who started the American Psychological Association and is considered the founder of child psychology), Lightner Witmer (who established the first psychological clinic), Edward Titchener (who brought Wundt's ideas to the United States), and Hugo Munsterberg (a pioneer in applied psychology). Also among Wundt's students was James McKeen Cattell, who, in addition to conducting early research on mental tests, was the first college professor to integrate the study of experimental methods into the undergraduate psychology curriculum (Watson, 1978). In part, you have Cattell to thank for the importance that colleges and universities place on courses in research methods.

1.2: Goals of Behavioral Research

1.2 Summarize the three primary goals of behavioral research

Psychology and the other behavioral sciences are thriving as never before. Theoretical and methodological advances have led to important discoveries that have not only enhanced our understanding of behavior but also improved the quality of human life. Each year, behavioral researchers publish the results of tens of thousands of studies, each of which adds incrementally to what we know about the behavior of human beings and other animals.

Some researchers distinguish between two primary types of research that differ with respect to the researcher's primary goal. *Basic research* is conducted to understand psychological processes without regard for whether or not the knowledge is immediately applicable. The primary goal of basic research is to increase our knowledge. This is not to say that basic researchers aren't interested in the applicability of their findings. They usually are. In fact, the results of basic research are usually quite useful, often in ways that were not anticipated by the researchers themselves. For example, basic research involving brain function has led to the development of drugs that control symptoms of mental illness, and basic research on cognitive development in children has led to educational innovations in schools. However, the immediate goal of basic research is to understand a psychological phenomenon rather than to solve a particular problem.

In contrast, the goal of *applied research* is to find solutions for particular problems rather than to enhance general knowledge about psychological processes. For example, industrial-organizational psychologists are often hired by businesses to study and solve problems related to employee morale, satisfaction, and productivity. Similarly, community psychologists are sometimes asked to investigate social problems such as racial tension, littering, and violence in a particular city, and researchers in human development and social work study problems such as child abuse and teenage pregnancy. These applied researchers use scientific approaches to understand and solve some problem of immediate concern (such as employee morale, prejudice, or child abuse). Other applied researchers conduct *evaluation research* (also called *program evaluation*), using behavioral research methods to assess the effects of social or institutional programs on behavior. When new programs are implemented—such as when new educational programs are introduced into the schools, new laws are passed, or new employee policies are implemented in a business organization—program evaluators are sometimes asked to determine whether the new program is effective in achieving its intended purpose. If so, the evaluator often tries to figure out precisely why the program works; if not, the evaluator tries to uncover why the program was unsuccessful.

Although the distinction between basic and applied research is sometimes useful, we must keep in mind that the primary difference between them lies in the researcher's purpose in conducting the research and not in the nature of the research itself. In fact, it is often difficult to know whether a particular study should be classified as basic or applied simply from looking at the design of the study.

Furthermore, the basic–applied distinction overlooks the intimate connection between research that is conducted to advance knowledge and research that is conducted to solve problems. Much basic research is immediately applicable, and much applied research provides information that enhances our basic knowledge. Furthermore, because applied research often requires an understanding of what people do and why, basic research provides the foundation on which much applied research rests. In return, applied research often provides important ideas and new questions for basic researchers. In the process of trying to solve particular problems, new questions and insights arise. Thus, although researchers may approach a particular study with one of these goals in mind, behavioral science as a whole benefits from the integration of both basic and applied research.

Whether behavioral researchers are conducting basic or applied research, they generally do so with one of three goals in mind—description, prediction, or explanation. That is, they design their research with the intent of describing behavior, predicting behavior, or explaining behavior. Basic researchers stop once they have adequately described, predicted, or explained the phenomenon of interest; applied researchers typically go one step further to offer suggestions and solutions based on their findings.

1.2.1: Describing Behavior

Some behavioral research focuses primarily on describing patterns of behavior, thought, or emotion. Survey researchers, for example, conduct large studies of randomly selected respondents to determine what people think, feel, and do. You are undoubtedly familiar with public opinion polls, such as those that dominate the news during elections and that describe people's attitudes and preferences for candidates. Some research in clinical psychology and psychiatry investigates the prevalence of certain psychological disorders. Marketing researchers conduct descriptive research to study consumers' preferences and buying practices. Other examples of descriptive studies include research in developmental psychology that describes age-related changes in behavior and studies from industrial psychology that describe the behavior of effective managers.

1.2.2: Predicting Behavior

Many behavioral researchers are interested in predicting people's behavior. For example, personnel psychologists try to predict employees' job performance from employment tests and interviews. Similarly, educational psychologists develop ways to predict academic performance from scores on standardized tests in order to identify students who might have learning difficulties in school. Likewise, some forensic psychologists are interested in understanding variables that predict which criminals are likely to be dangerous if released from prison. Developing ways to predict job performance, school grades, or violent tendencies requires considerable research. The tests to be used (such as employment or achievement tests) must be administered, analyzed, and refined to meet certain statistical criteria. Then data are collected and analyzed to identify the best predictors of the target behavior. Prediction equations are calculated and validated on other samples of participants to verify that they predict the behavior successfully. All along the way, the scientific prediction of behavior involves behavioral research methods.

1.2.3: Explaining Behavior

Most researchers regard explanation as the most important goal of scientific research. Although description and prediction are quite important, scientists usually do not feel that they really understand something until they can explain it. We may be able to describe patterns of violence among prisoners who are released from prison and even identify variables that allow us to predict, within limits, which prisoners are likely to be violent once released. However, until we can *explain* why certain prisoners are violent and others are not, the picture is not complete. As we'll discuss later in this chapter, an important part of any science involves developing and testing theories that explain the phenomena of interest.

WRITING PROMPT

Description, Prediction, and Explanation

We have seen that the goals of behavioral research are to describe, predict, and explain behavior. Consider a psychological phenomenon (such as procrastination, drunk driving, etc.) that seems interesting or important to you. List three questions about this topic that involve (1) describing something about the phenomenon, (2) predicting the phenomenon, and (3) explaining the phenomenon.

▶ The response entered here will appear in the performance dashboard and can be viewed by your instructor.

Submit

1.3: Behavioral Science and Common Sense

1.3 **Discuss ways in which the findings of behavioral research do and do not coincide with common sense**

Unlike research in the physical and natural sciences, research in the behavioral sciences often deals with topics that are familiar to most people. For example, although few of us would claim to have personal knowledge of subatomic particles, cellular structure, or chloroplasts, we all have a great deal of experience with memory, prejudice, sleep, and emotion. Because they have personal experience with many of the topics of behavioral science, people sometimes maintain that the findings of behavioral science are mostly common sense—things that we all knew already.

In some instances, this is undoubtedly true. It would be a strange science indeed whose findings contradicted everything that laypeople believed about behavior, thought, and emotion. Even so, the fact that a large percentage of the population believes something is no proof of its accuracy. After all, most people once believed that the sun revolved around the Earth, that flies generated spontaneously from decaying meat, and that epilepsy was brought about by demonic possession—all formerly "commonsense" beliefs that were disconfirmed through scientific investigation.

Likewise, behavioral scientists have discredited many widely held beliefs about behavior, including the following:

- Parents should not respond too quickly to a crying infant because doing so will make the baby spoiled and difficult (in reality, greater parental responsiveness actually leads to less demanding babies).
- Geniuses are more likely to be crazy or strange than people of average intelligence (on the contrary, exceptionally intelligent people tend to be more emotionally and socially adjusted).

- Paying people a great deal of money to do a job increases their motivation to do it (actually, high rewards can undermine intrinsic motivation).
- Most differences between men and women are purely biological (only in the past 50 years have we begun to understand fully the profound effects of socialization on gender-related behavior).

Only through scientific investigation can we test popular beliefs to see which ones are accurate and which ones are myths.

To look at another side of the issue, common sense can interfere with scientific progress. Scientists' own commonsense assumptions about the world can blind them to alternative ways of thinking about the topics they study. Some of the greatest advances in the physical sciences have occurred when people realized that their commonsense notions about the world needed to be abandoned. The Newtonian revolution in physics, for example, was the "result of realizing that commonsense notions about change, forces, motion, and the nature of space needed to be replaced if we were to uncover the real laws of motion" (Rosenberg, 1995, p. 15).

Social and behavioral scientists often rely on commonsense notions regarding behavior, thought, and emotion. When these notions are correct, they guide us in fruitful directions, but when they are wrong, they prevent us from understanding how psychological processes actually operate. Scientists are, after all, just ordinary people who, like everyone else, are subject to biases that are influenced by culture and personal experience. However, scientists have a special obligation to question their commonsense assumptions and to try to minimize the impact of those assumptions on their work.

1.4: The Value of Research to the Student

1.4 Name four benefits of understanding research methods for students

The usefulness of research for understanding behavior and improving the quality of life is rather apparent, but it may be less obvious that a firm grasp of basic research methodology has benefits for a student such as yourself. After all, most students who take courses in research methods have no intention of becoming researchers. Understandably, such students may wonder how studying research benefits them.

A background in research has at least four important benefits:

First, knowledge about research methods allows people to understand research that is relevant to their professions. Many professionals who deal with people—not only psychologists but also those in social work, nursing, education, management, medicine, public relations, coaching, public policy, advertising, and the ministry—must keep up with advances in their fields. For example, people who become counselors and therapists are obligated to stay abreast of the research literature that deals with therapy and related topics. Similarly, teachers need to stay informed about recent research that might help improve their teaching. In business, many decisions that executives and managers make in the workplace must be based on the outcomes of research studies. However, most of this information is published in professional research journals, and, as you may have learned from experience, journal articles can be nearly incomprehensible unless the reader knows something about research methodology and statistics. Thus, a background in research provides you with knowledge and skills that may be useful in professional life.

Related to this outcome is a second: A knowledge of research methodology makes one a more intelligent and effective "research consumer" in everyday life. Increasingly, we are asked to make everyday decisions on the basis of scientific research findings. When we try to decide which new car to buy, how much we should exercise, which weight-loss program to select, whether to enter our children in public versus private schools, whether to get a flu shot, or whether we should follow the latest fad to improve our happiness or prolong our life, we are often confronted with research findings that argue one way or the other. Similarly, when people serve on juries, they often must consider scientific evidence presented by experts. Unfortunately, studies show that most adults do not understand the scientific process well enough to weigh such evidence intelligently and fairly. Less than half of American adults in a random nationwide survey understood the most basic requirement of a good experimental design, and only a third could explain "what it means to study something scientifically" (National Science Board, 2002). Without such knowledge, people are unprepared to spot shoddy studies, questionable statistics, and unjustified conclusions in the research they read or hear about. People who have a basic knowledge of research design and analyses are in a better position to evaluate the scientific evidence they encounter in everyday life than those without such knowledge.

A third outcome of research training involves the development of critical thinking. Scientists are a critical lot, always asking questions, considering alternative explanations, insisting on hard evidence, refining their methods, and critiquing their own and others' conclusions. Many people have found that a critical, scientific approach to solving problems is useful in their everyday lives.

A fourth benefit of learning about and becoming involved in research is that it helps one become an authority not only on research methodology but also on particular topics. In the process of reading about previous studies, wrestling with issues involving research strategy, collecting data, and interpreting the results, researchers grow increasingly familiar with their topics. For this reason, faculty members at many colleges and universities urge their students to become involved in research, such as class projects, independent research projects, or a faculty member's research. This is also one reason why many colleges and universities insist that their faculty maintain ongoing research programs. By remaining active as researchers, professors engage in an ongoing learning process that keeps them at the forefront of their fields.

Many years ago, science fiction writer H. G. Wells predicted that "Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write." Although we are not at the point where the ability to think like a scientist and statistician is as important as reading or writing, knowledge of research methods and statistics is becoming increasingly important for successful living.

1.5: The Scientific Approach

1.5 Summarize the three criteria that must be met to consider an investigation scientific

I noted earlier that most people have greater difficulty thinking of psychology and other behavioral sciences as science than regarding chemistry, biology, physics, or astronomy as science. In part, this is because many people misunderstand what science is. Most people appreciate that scientific knowledge is somehow special, but they judge whether a discipline is scientific on the basis of the topics it studies. Research involving molecules, chromosomes, and sunspots seems more scientific to most people than research involving emotions, memories, or social interactions, for example.

Whether an area of study is scientific has little to do with the topics it studies, however. Rather, science is defined in terms of the approaches used to study the topic. Specifically, three criteria must be met for an investigation to be considered scientific: systematic empiricism, public verification, and solvability (Stanovich, 1996).

1.5.1: Systematic Empiricism

Empiricism refers to the practice of relying on observation to draw conclusions about the world.

The story is told about two scientists who saw a flock of sheep standing in a field. Gesturing toward the sheep, one scientist said, "Look, all of those sheep have just been shorn." The other scientist narrowed his eyes in thought, then replied, "Well, on the side facing us anyway." Scientists insist that conclusions be based on what can be objectively observed and not on assumptions, hunches, unfounded beliefs, or the products of people's imaginations. Although most people today would agree that the best way to find out about something is to observe it directly, this was not always the case. Until the late sixteenth century, experts relied more heavily on reason, intuition, and religious doctrine than on observation to answer questions.

But observation alone does not make something a science. After all, everyone draws conclusions about human nature from observing people in everyday life. Scientific observation is *systematic*. Scientists structure their observations in systematic ways so that they can use them to draw valid conclusions about the nature of the world. For example, a behavioral researcher who is interested in the effects of exercise on stress is not likely simply to chat with people who exercise about how much stress they feel. Rather, the researcher would design a carefully controlled study in which people are assigned randomly to different exercise programs and then measure their stress using reliable and valid techniques. Data obtained through systematic empiricism allow researchers to draw much more confident conclusions than they can draw from casual observation alone.

1.5.2: Public Verification

The second criterion for scientific investigation is that the methods and results be available for *public verification*. In other words, research must be conducted in such a way that the findings of one researcher can be observed, verified, and replicated by others.

There are two reasons for this.

First, the requirement of public verification ensures that the phenomena scientists study are real and observable and not one person's fabrications. Scientists disregard claims that cannot be verified by others. For example, a person's claim that he or she was kidnapped by Bigfoot makes interesting reading, but it is not scientific if it cannot be verified.

Second, public verification makes science self-correcting. When research is open to public scrutiny, errors in methodology and interpretation can be discovered and corrected by other researchers. The findings obtained from scientific research are not always correct, but the requirement of public verification increases the likelihood that errors and incorrect conclusions will be detected and corrected.

Public verification requires that researchers report their methods and their findings to the scientific community, usually in the form of journal articles or presentations of papers at professional meetings. In this way, the methods, results, and conclusions of a study can be examined and possibly challenged by others. As long as researchers report their methods in detail, other researchers can attempt to repeat, or replicate, the research. Replication not only catches errors but also allows researchers to build on and extend the work of others.

1.5.3: Solvable Problems

The third criterion for scientific investigation is that science deals only with *solvable problems*. Scientists can investigate only those questions that are answerable given current knowledge and research techniques.

This criterion means that many questions fall outside the realm of scientific investigation. For example, the question "Are there angels?" is not scientific: No one has yet devised a way of studying angels that is empirical, systematic, and publicly verifiable. This does not necessarily imply that angels do not exist or that the question is unimportant. It simply means that this question is beyond the scope of scientific investigation.

In Depth

Science and Pseudoscience

The results of scientific investigations are not always correct, but because researchers abide by the criteria of systematic empiricism, public verification, and solvable problems, scientific findings are the most trustworthy source of knowledge that we have. Unfortunately, not all research findings that appear to be scientific actually are, but people sometimes have trouble telling the difference. The term *pseudoscience* refers to claims of evidence that masquerade as science but in fact violate the basic criteria of scientific investigation that we just discussed (Radner & Radner, 1982).

NONSYSTEMATIC AND NONEMPIRICAL EVIDENCE

As we have seen, scientists rely on systematic observation. Pseudoscientific evidence, however, is often not based on observation, and when it is, the data are not collected in a systematic fashion that allows valid conclusions to be drawn. Instead, the evidence is based on myths, untested beliefs, anecdotes about people's personal experiences, the opinions of self-proclaimed "experts," or the results of poorly designed studies that do not meet minimum scientific standards. For example, von Daniken (1970) used biblical references to "chariots of fire" in *Chariots of the Gods?* as evidence for ancient spacecrafts. However, because biblical evidence of past events is neither systematic nor verifiable, it cannot be considered scientific. This is not to say that such evidence is necessarily inaccurate; it is simply not permissible in scientific investigation because its veracity cannot be determined conclusively. Similarly, pseudoscientists often rely on people's beliefs rather than on observation or accepted scientific fact to bolster their arguments. Scientists wait for the empirical evidence to come in rather than basing their conclusions on what others think might be the case.

When pseudoscience does rely on observed evidence, it tends to use data that are biased to support its case.

Example

For example, those who believe that people can see the future point to specific episodes in which people seemed to know in advance that something was going to happen. A popular tabloid once invited its readers to send in their predictions of what would happen during the next year. When the 1,500 submissions were opened a year later, one contestant was correct in all five of her predictions. The tabloid called this a "stunning display of psychic ability." Was it? Isn't it just as likely that, out of 1,500 entries, one person would, just by chance, make correct predictions?

Scientific logic requires that the misses be considered evidence along with the hits. Pseudoscientific logic, on the other hand, is satisfied with a single (perhaps random) occurrence. Unlike the extrasensory perception (ESP) survey conducted by the tabloid, scientific studies of ESP test whether people can predict future events at better than chance levels.

NO PUBLIC VERIFICATION

Much pseudoscience is based on individuals' reports of what they have experienced—reports that are essentially unverifiable. If Mr. Smith claims to have been abducted by aliens, how do we know whether he is telling the truth? If Ms. Brown says she "knew" beforehand that her uncle had been hurt in an accident, who's to refute her? Of course, Mr. Smith and Ms. Brown might be telling the truth. On the other hand, they might be playing a prank, mentally disturbed, trying to cash in on the publicity, or sincerely confused. Regardless, because their claims are unverifiable, they cannot be used as scientific evidence.

Furthermore, when pseudoscientific claims appear to be based on research studies, one usually finds that the research was not published in scientific journals. In fact, it is often hard to find a report of the study anywhere, and when a report can be located, on the Web, for example, it has usually not been peer-reviewed by other scientists. You should be very suspicious of the results of any research that has not been submitted to other experts for review.

UNSOLVABLE QUESTIONS AND IRREFUTABLE HYPOTHESES

Pseudoscientific beliefs are often stated in such a way that they can never be tested. Those who believe in ESP, for example, sometimes argue that ESP cannot be tested empirically because the conditions necessary for the occurrence of ESP are compromised under controlled laboratory conditions. Similarly, some advocates of creationism claim that the Earth is much younger than it appears from geological evidence. When the Earth was created in the relatively recent past, they argue, God put fossils and geological formations in the rocks that only make it appear to be millions of years old. In both these examples, the claims are untestable and, thus, pseudoscientific.

1.6: Detecting and Explaining Phenomena

1.6 Explain the difference between theories and models

Scientists are in the business of doing two distinct things (Haig, 2002; Herschel, 1987; Proctor & Capaldi, 2001).

First, they are in the business of discovering and documenting new phenomena, patterns, and relationships. Historically, analyses of the scientific method have neglected this crucial aspect of scientific investigation. Most descriptions of how scientists go about their work have assumed that all research involves testing theoretical explanations of phenomena.

Many philosophers and scientists now question this narrow view of science. In many instances, it is not reasonable for a researcher to propose a hypothesis before conducting a study because no viable theory yet exists and the researcher does not have enough information about the phenomenon to develop one (Kerr, 1998). Being forced to test hypotheses prematurely—before a coherent, viable theory exists—may lead to poorly conceived studies that test half-baked ideas. In the early stages of investigating a particular phenomenon, it may be better to design studies to detect and describe patterns and relationships before testing hypotheses about them. After all, without identifying and describing phenomena that need to be understood, neither theory-building nor future research can proceed in an efficient manner. Typically, research questions evolve from vague and poorly structured ideas to a point at which formal theories may be offered. Conducting research in the "context of discovery" (Herschel, 1987) allows researchers to collect data that describe phenomena, uncover patterns, and identify questions that need to be addressed.

Scientists' second job is to develop and evaluate explanations of the phenomena they see. Once they identify phenomena to be explained and have collected sufficient information about them, they develop theories to explain the patterns they observe and then conduct research to test those theories. When you hear the word *theory*, you probably think of theories such as Darwin's theory of evolution or Einstein's theory of relativity. However, nothing in the concept of theory requires that it be as grand or all-encompassing as evolution or relativity. Most theories, whether in psychology or in other sciences, are much less ambitious, attempting to explain only a small and circumscribed range of phenomena.

1.6.1: Theories

A *theory* is a set of propositions that attempts to explain the relationships among a set of concepts. For example, Fiedler's (1967) contingency theory of leadership specifies the conditions in which certain kinds of leaders will be more effective in group settings. Some leaders are predominantly task-oriented; they keep the group focused on its purpose, discourage socializing, and demand that the members participate. Other leaders are predominantly relationship-oriented; these leaders are concerned primarily with fostering positive relations among group members and with group satisfaction. The contingency theory proposes three factors that determine whether a task-oriented or relationship-oriented leader will be more effective in a particular situation: the quality of the relationship between the leader and group members, the degree to which the group's task is structured, and the leader's power within the group. In fact, the theory specifies quite precisely the conditions under which certain leaders are more effective than others. The contingency theory of leadership fits our definition of a theory because it attempts to explain the relationships among a set of concepts (the concepts of leadership effectiveness, task versus interpersonal leaders, leader–member relations, task structure, and leader power).

Occasionally, people use the word *theory* in everyday language to refer to hunches or unsubstantiated ideas. For example, in the debate on whether to teach creationism or intelligent design as an alternative to evolution in public schools, creationists dismiss evolution because it's "only a theory." This use of the term *theory* is very misleading. Scientific theories are not wild guesses or unsupported hunches. On the contrary, theories are accepted as valid only to the extent that they are supported by empirical findings. Science insists that theories be consistent with the facts as they are currently known. Theories that are not supported by data are usually discarded or replaced by other theories.

Theory construction is a creative exercise, and ideas for theories can come from almost anywhere. Sometimes, researchers immerse themselves in the research literature and purposefully work toward developing a theory. In other instances, researchers construct theories to explain patterns they observe in data they have collected. Other theories have been developed on the basis of case studies or everyday observation. Sometimes, a scientist does not agree with another researcher's explanation of a phenomenon and sets out to develop a better theory to explain it. At other times, a scientist may get a fully developed theoretical insight when he or she is not even working on research. Researchers are not constrained in terms of where they get their theoretical ideas, and there is no single way to develop a theory.

However, even though ideas for theories can come from anywhere, a good theory must meet several criteria (Fiske, 2004).

What are the characteristics of a good theory in psychology?

Specifically, a good theory in psychology:

- proposes causal relationships, explaining how one or more variables cause or lead to particular cognitive, emotional, behavioral, or physiological responses;
- is coherent in the sense of being clear, straightforward, logical, and consistent;

- is parsimonious, using as few concepts and processes as possible to explain the target phenomenon;
- generates testable hypotheses that are able to be disconfirmed through research;
- stimulates other researchers to conduct research to test the theory; and
- solves an existing theoretical question.

1.6.2: Models

Closely related to theories are models. In fact, researchers occasionally use the terms *theory* and *model* interchangeably, but we can make a distinction between them. Whereas a theory specifies both how and why concepts are related, a *model* describes only how they are related. We may have a model that describes how variables are related (such as specifying that X leads to Y, which then leads to Z) without having a theory that explains why these effects occur. Put differently, a model tries to *describe* the hypothesized relationships among variables, whereas a theory tries to *explain* those relationships.

For example, the assortative mating model postulates that people tend to select mates who are similar to themselves. This model has received overwhelming support from numerous research studies showing that for nearly every variable that has been examined—such as age, ethnicity, race, emotional stability, agreeableness, conscientiousness, and physical attractiveness—people tend to pair up with others who resemble them (Botwin, Buss, & Shackelford, 1997; Little, Burt, & Perrett, 2006). However, this model does not explain *why* assortative mating occurs. Various theories have been proposed to explain this effect. For example, one theory suggests that people tend to form relationships with people who live close to them, and we tend to live near those who are similar to us, and another theory proposes that interactions with people who are similar to us are generally more rewarding and less conflicted than those with people who are dissimilar.

1.7: Research Hypotheses

1.7 Compare deduction and induction as ways to develop research hypotheses

On the whole, scientists are a skeptical bunch, and they are not inclined to accept theories and models that have not been supported by empirical research. Thus, a great deal of their time is spent testing theories and models to determine their usefulness in explaining and predicting behavior. Although theoretical ideas may come from anywhere, scientists are very constrained in the procedures they use to test their theories.

People can usually find reasons for almost anything *after* it happens. In fact, we sometimes find it equally easy to explain completely opposite occurrences. Consider Jim and Marie, a married couple I know. If I hear in 5 years that Jim and Marie are happily married, I'll probably be able to look back and find clear-cut reasons why their relationship worked out so well. If, on the other hand, I learn in 5 years that they're getting divorced, I'll be able to recall indications that all was not well even from the beginning. As the saying goes, hindsight is 20/20. Nearly everything makes sense after it happens.

The ease with which we can retrospectively explain even opposite occurrences leads scientists to be skeptical of *post hoc explanations*—explanations that are made after the fact. In light of this, a theory's ability to explain occurrences in a post hoc fashion provides little evidence of its accuracy or usefulness. If scientists have no preconceptions about what should happen in a study, they can often explain whatever pattern of results they obtain in a post hoc fashion (Kerr, 1998). Of course, if a theory can't explain a particular finding, we can conclude that the theory is weak, but researchers can often explain findings post hoc that they would not have predicted in advance of conducting the study.

More informative is the degree to which a theory can successfully *predict* what will happen. To provide a convincing test of a theory, researchers make specific research hypotheses *a priori*—before collecting the data. By making specific predictions about what will occur in a study, researchers avoid the pitfalls associated with purely post hoc explanations. Theories that accurately predict what will happen in a research study are regarded much more positively than those that can only explain the findings afterward.

The process of testing theories is an indirect one. Theories themselves are not tested directly. The propositions in a theory are usually too broad and complex to be tested directly in a particular study. Rather, when researchers set about to test a theory, they do so indirectly by testing one or more hypotheses that are derived from the theory.

1.7.1: Deduction and Induction

Deriving hypotheses from a theory involves *deduction*, a process of reasoning from a general proposition (the theory) to specific implications of that proposition (the hypotheses). When deriving a hypothesis, the researcher asks, If the theory is true, what would we expect to observe? For example, one hypothesis that can be derived (or deduced) from the contingency model of leadership is that relationship-oriented leaders will be more effective when the group's task is moderately structured rather than unstructured. If we do an experiment to test the validity of this hypothesis, we are testing part, but only part, of the contingency theory of leadership.

You can think of a *hypothesis* as an if–then statement of the general form, "If *a*, then *b*." Based on the theory, the researcher hypothesizes that *if* certain conditions occur, *then*