THIRTEENTH EDITION

Research Methods: Design and Analysis

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Pearson

Research Methods, Design, and Analysis

Thirteenth Edition

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Preface

Welcome to *Research Methods, Design, and Analysis*. You are embarking on a study that will help you to think systematically, critically, and creatively in Psychology and other disciplines. We have two primary goals for this text. First, we have focused on writing a book that provides an understanding of the research methods used to investigate human thought and behavior. Research methods tend to change slowly, but they do change. This book provides coverage of the complete range of research methods available today. Psychology tends to favor experimental methods, so we devote more time to experimental research methods. Because nonexperimental research also is used in many areas of psychology, we carefully cover this method, including how to write a proper questionnaire. Because of the rapid growth of qualitative and mixed methods in psychology, we carefully cover these methods to complement the more traditional methods and to add to each student's repertoire of research skills.

A second overarching goal that has been maintained throughout all editions of the textbook is to present information in a way that is understandable to students. We have attempted to meet this goal by presenting material in as simple and straightforward a manner as possible and by accompanying complex material with illustrations taken from the research literature. We believe that such illustrations not only assist in clarifying the presented material, but also bring the material to life when it is placed in the context of actual research studies. This allows the student not only to learn the material, but also to see how it is used in a research study.

Overview and Organization of the Textbook

Research Methods, Design, and Analysis is written at the undergraduate level and is intended for use in the undergraduate methods course. The book provides an introduction to all aspects of research methodology, and assumes no prior knowledge. The chapters are divided into seven major parts, as follows:

Part I. Introduction (Chapters 1 and 2)

This section begins with a discussion of knowledge and science in an effort to provide students with an understanding of the nature, goals, and outcomes of science. We believe that most students have an incomplete understanding of science and that they must understand its goals and limitations in order to appreciate and understand the nature of the research process. This is followed by a discussion of the major types of research used to investigate mind and behavior in an attempt to make sure that the students connect the various research approaches with science. We also discuss the major methods of data collection to help students see how empirical data are obtained.

Part II. Planning the Research Study (Chapters 3 and 4)

In this section, the focus of the book moves to some general topics involved in all research studies. First, we explain how to come up with a research idea, conduct a literature review, and develop a research question and hypothesis. Second, we explain the key ethical issues that must be considered when planning and conducting a research study. We explain the ethical guidelines sanctioned by the American Psychological Association.

Part III. Foundations of Research (Chapters 5–8)

In Part III, we cover some concepts that the researcher must understand before critiquing or conducting a research study. We begin with a discussion of measurement. We define measurement, and explain how measurement reliability and validity are obtained. Next, we explain how researchers obtain samples of research participants from targeted populations. We explain the different methods of random and nonrandom sampling, and we show the important distinction between random selection and random assignment. We also briefly explain the sampling methods used in qualitative research. Next we explain how research validity (i.e., valid results) is obtained. This includes discussions of the major kinds of research validity (internal, external, statistical conclusion, and construct) that must be addressed and maximized in empirical research. This section also includes a chapter explaining the control techniques required to obtain valid research results and a chapter explaining the procedure and details of carrying out a research study.

Part IV. Experimental Methods (Chapters 9–11)

Part IV is focused on, perhaps, the most prominent approach to research in psychology and related disciplines (i.e., experimental research). The section includes a chapter explaining how to select and/or construct a strong experimental research design, including the importance of factorial designs and coverage of main effects and interaction effects. Next, is a chapter on quasi-experimental designs including the nonequivalent comparison group design, the interrupted time-series design, and the regression discontinuity design.

The final chapter of this section covers single-case designs including ABA, ABAB, combination, multiple-baseline, and changing criterion designs.

Part V. Nonexperimental, Qualitative, and Mixed Methods Research (Chapters 12–14)

This section includes chapters on additional major research methods used in psychology and related disciplines. First, the student is introduced to the goals, design, and conduct of nonexperimental quantitative research. The student will also learn how to correctly construct a questionnaire and/or interview protocol. Second, the book includes a full chapter on qualitative and mixed methods research. The relative strengths and weaknesses of quantitative, qualitative, and mixed methods research are discussed, the different qualitative and mixed methods approaches and designs are explained, and information is provided about how to conduct a defensible and rigorous qualitative or mixed methods study.

Part VI. Analyzing and Interpreting Data (Chapters 15 and 16)

This section explains descriptive and inferential statistics in a way that is both rigorous and fully accessible to students with no prior background in statistics. The descriptive statistics chapter explains the graphic representation of data, measures of central tendency, measures of variability, measures of relationship between variables, and effect size indicators. Chapter 16 explains how researchers obtain estimates of population characteristics based on sample data and how researchers conduct statistical hypothesis testing. In an effort to connect design and analysis, the appropriate statistical tests for the experimental and quasi-experimental research designs covered in earlier chapters are discussed. The student will also learn how to present the results of significance tests using APA style.

Part VII. Writing the Research Report (Chapter 17)

In Part VII we explain the basics of writing a professional, informative, and accurate research manuscript that can be submitted for publication. The guidelines from the latest edition of the *Publication Manual of the American Psychological Association* are explained in this chapter.

Pedagogical Features

The pedagogical features include concept maps and objectives at the beginning of each chapter. Each chapter highlights important terms and concepts and includes definitions of these in the chapter margins. These terms and concepts are highlighted not only to point out to students that they are important, but also to increase the ease with which students can learn these terms and concepts. Study questions are spaced throughout each chapter to help students review the material after they have finished reading a section; this feedback system will assist students in learning the material and assessing whether they understand the material. Each chapter ends with several learning aids. First, a summary of the material, a list of the key terms, and a set of useful Internet sites are provided. Next, to help students assess their knowledge of the chapter material, a Practice Test is provided at the end of each chapter. These tests include several multiple choice questions that students can use to assess their knowledge of the chapter material. The Practice Test is followed by a set of Challenge Exercises; these are designed to provide students with exposure to and experiences with activities required in the conduct of a research study.

New to the Thirteenth Edition

Many minor changes have been made to the thirteenth edition to update references, clarify material, and improve the student learning process. The major changes are as follows:

1. All chapters and references were updated to reflect the current state of methods in psychology.
2. All chapters were carefully edited to increase clarity without sacrifice of rigor.
3. Chapter objectives are now directly connected to the first-level chapter headings.
4. Chapter 1. Historical coverage of science was slightly reduced. A new section on Science in the Twenty-First Century was added that stresses the empirical nature of psychological science and the concept of producing evidence (not proof) of scientific claims. Two additional characteristics of scientific research were added: Empirical, and Evidence Not Proof. Definitions of randomized controlled trials (RCTs) and operationalizing a construct were added. A new table on how to evaluate theories was added.
5. Chapter 2. Coverage of path analysis, natural manipulation research, and cross-sectional and longitudinal studies was removed because the book now has a full chapter on nonexperimental quantitative research A brief introduction to mixed methods research was added. A new section on advantages and disadvantages of nonexperimental quantitative research was added. Updated definitions were added for experimental research, manipulation, descriptive research, nonexperimental research, qualitative research, mixed methods research, field experiment, Internet experiment, correlational research, quantitatively driven mixed methods research, qualitatively driven mixed methods research, and equal-status or integrative mixed methods research.
6. Chapter 3. There is an increased focus on the central role of research questions. The section Bias in Research Ideas was revised and renamed Breadth of Research Ideas.

The goal is to focus on the positive side of the issue and recognize the need for diversity of questions and ideas. There is a brief addition explaining the parts of a research article. The section on evaluating web pages was reduced and coverage of Internet search engines was reduced.

7. Chapter 4. The section on dispensing with informed consent was deleted. The example IRB proposal was deleted, and instead, there is an updated discussion on submitting IRB proposals. Definition of anonymity was clarified.
8. Chapter 6. Coverage of experimenter expectancies and participant effects was simplified. A brief discussion of single and multiple-group designs was added to enhance the discussion of threats to internal validity. The discussion of accessible populations was deleted. The term "experimenter effects" was modified to "researcher effects" to increase the applicability of the concept. The same was done for "experimenter expectancies" (changed to "researcher expectancies") and "experimenter attributes" (changed to "researcher attributes"). A new table was added, titled Summary of Threats to Internal Validity for Single and Multiple-Group Designs.
9. Chapter 7 on control techniques was revised so that it is applicable for both experimental and nonexperimental research. Control techniques were reorganized, and statistical control was added. Coverage of researcher and participant effects was reduced, and instead, the focus is on techniques to reduce researcher and participant effects. New or revised/clarified definitions were provided for carryover effect, single-blind technique, partial-blind technique. Double-blind placebo method is now called the double-blind technique.
10. Chapter 8 was previously Chapter 9. It was edited so that this chapter is now applicable for both experimental and nonexperimental research. We added "type of statistical test" as an additional factor affecting statistical power.
11. Chapter 9. A brief addition was made to the section on factorial designs to indicate (a) at least one of the IVs (but not all) must be manipulated, and (b) factorials may (or may not) include pretests. These changes match the inferential statistics chapter. A marginal definition of rival hypothesis stating that it is a synonym for alternative explanation was added.
12. Chapter 10. A new table titled Summary of Quasi-Experimental Designs was added.
13. Chapter 11. A new table titled Summary of Single-Case Designs was added. Removed definition of withdrawal. Renamed the interaction design the *combination design* for clarity.
14. Chapter 12 is a new chapter. It includes the strengths and limitations of nonexperimental quantitative research (NQR). NQR designs are discussed, including cross-sectional and longitudinal designs and descriptive, explanatory, and predictive nonexperimental quantitative research designs.
15. Chapter 13. Two additional kinds of scales were added to Exhibit 13.1 (agreement scale and evaluation scale).
16. Chapter 14. A new table titled Summary of Qualitative Methods was added. Interpretive validity is now called interpretive or *emic* validity. Idiographic causation is now idiographic or *local* causation. Inside-outside validity in mixed methods research is now called emic–etic validity. Added two types of mixed methods validity: pragmatic validity and multiple-stakeholders validity.
17. Chapter 16. Coverage of nonparametric statistics was added, including a table titled Popular Nonparametric Statistical Procedures and Their Parametric Alternatives. The section titled Chi-Square for Contingency Tables is now Chi-Square Test for Independence. New marginal definitions of parametric statistics and nonparametric statistics were added.

Acknowledgments

As with all previous editions, we offer our sincere appreciation and gratitude to our students. They inspire and motivate us to create a book that respects their intelligence and invites them to be full participants in the research enterprise. We also thank all of our external reviewers of the present and past editions of this book. Last, we thank the Pearson production team.

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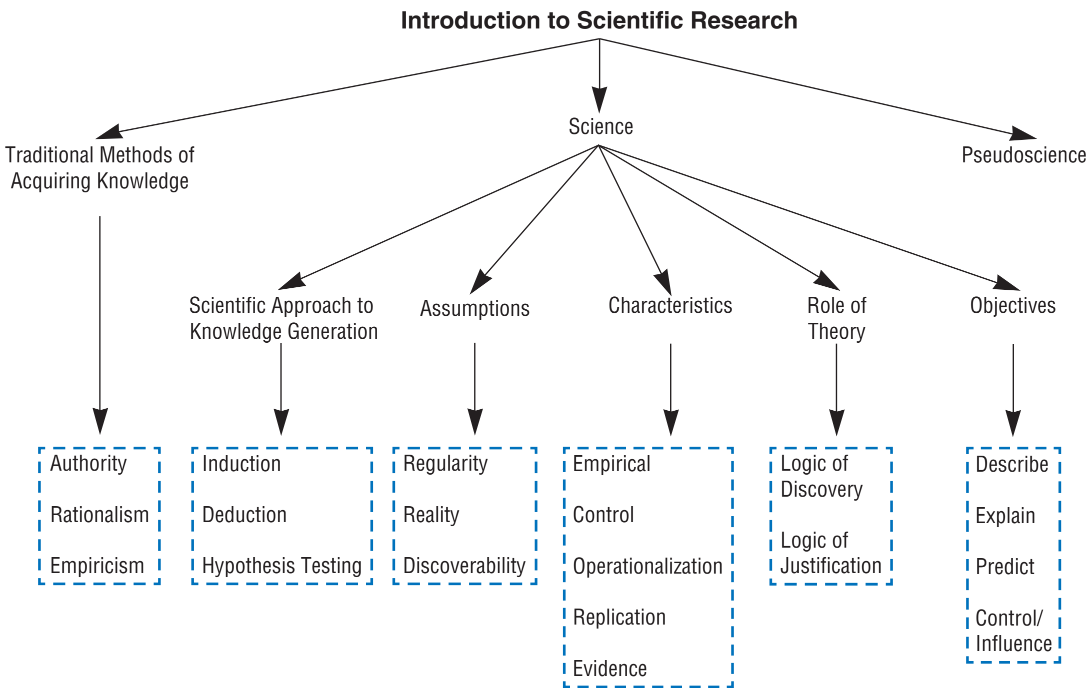
PART I Introduction

Chapter 1
Introduction to Scientific Research



Learning Objectives

1.1 Compare methods of knowledge acquisition in terms of their validity.

1.2 Summarize the scientific approach to knowledge generation.

1.3 Explain the importance of the basic assumptions that drive scientific research.

1.4 Describe the characteristics of scientific research and explain why each of these is important.

1.5 Summarize the relationship between empirical observation and theory in scientific research.

1.6 Summarize the objectives of scientific research.

1.7 Contrast the characteristics of pseudoscience with legitimate science.

In our daily lives, we continually encounter problems and questions about thoughts and behavior. For example, one person might have a tremendous fear of taking tests. Others might have problems with alcoholism or drug abuse or problems in their marriage. People who encounter such problems typically want to eliminate them, but often need help. Consequently, they seek out professionals, such as psychologists, for help. Likewise, business professionals might enlist the assistance of psychologists in understanding the thinking and behavior of employees or consumers. For example, salespeople differ greatly in their ability to understand customers and sell merchandise. One car salesperson might be capable of selling twice as many cars as another salesperson. If the sales manager could discover why such differences exist, he or she might be able to develop either better training programs or more effective criteria for selecting the sales force.

In an attempt to gain information about mental processes and behavior, people turn to the field of psychology. As you should know by now, a great deal of knowledge about thoughts and behavior has been accumulated. We have knowledge about treating problems such as test anxiety and depression. Similarly, we have identified many of the variables influencing persuasion and aggression. Although we know a great deal about mental processes and behavior, there is still much to be learned. In order to learn more about such psychological phenomena, we must engage in scientific research.

The course in which you are now enrolled will provide you with important knowledge about scientific research. Some students might wonder why this information is necessary. But, as Table 1.1 reveals, there are many reasons students should take a research methods course. One reason identified in Table 1.1 is to help students become more informed and critical consumers of information. We are all bombarded by information and we all need tools to interpret what is being reported. For example, saccharin has been demonstrated to cause cancer in laboratory animals, yet there are many people who consume saccharin and do not contract cancer. You as a consumer must be able to resolve discrepancies like this and make informed decisions about your behavior.

Table 1.1 Reasons for Taking a Research Methods Course

- Learn how to conduct psychological research.
- Provides a foundation for topic-specific courses such as abnormal, social, cognitive, biopsychology, and developmental psychology.
- Can be a more informed and critical consumer of information.
- Helps develop critical and analytical thinking.
- Provides information needed to critically read a research article.
- Necessary for admission into most graduate programs in psychology.

Traditional Methods of Acquiring Knowledge

1.1 Compare methods of knowledge acquisition in terms of their validity.

There are many ways we obtain information about the world. We acquire a great deal of information from the events we experience as we go through life. Experts also provide us with much information. We also use our cognitive skills to reason from current information and make inferences. In this chapter, we briefly discuss the traditional ways we acquire knowledge, and then we will discuss the scientific approach to acquiring knowledge. You will see that although the traditional approaches were incomplete, they are still used in the scientific process. The scientific approach is a very special approach to generating and justifying knowledge claims and to accumulating this knowledge over time.

Authority

Authority as an approach to acquiring knowledge refers to the acceptance of information or facts stated by another person because that person is a highly respected source. A problem with the authority approach is that the information or facts stated by the authority might be inaccurate, especially if the person is not an expert in the particular area of inquiry.

Authority A basis for acceptance of information because it is acquired from a highly respected source

If the authority approach is clearly fallible, how can this approach be used in science? In the beginning stages of the research process, when the problem is being identified and the hypothesis is being formed, a scientist might consult someone who is considered "the" authority in the area for advice about the hypothesis or research question. Virtually every scientific area has several leading researchers who are considered authorities or experts on a given topic.

Authority is also used in the design stage of a study. If you are unsure of how to design a study, you might contact someone who is considered an authority in the research area and get his or her input. Similarly, if you have collected data on a given topic and you are not sure how to interpret the data or how they fit with the other data in the field, you might consult with someone who is considered an authority in the area. As you can see, the authority approach is used in research. However, an authority is an expert whose facts and information are subject to testing using the scientific process.

Rationalism

Reasoning is an integral approach to acquiring knowledge. One traditional school of thought that takes a rather strong interpretation of the word "reasoning" is known as **rationalism**. This approach claims that formal deductive reasoning can be used to arrive at new knowledge, and it assumes that valid knowledge is acquired only when the correct reasoning processes are used. During the 16th century, rationalism was assumed to be the dominant mode by which one could arrive at truth. In fact, it was believed that knowledge derived from reason was just as valid as, and often superior to, knowledge gained from observation. Its leading advocate was the philosopher René Descartes (1596–1650). Descartes, who famously claimed, "I think, therefore I am," argued that "clear and distinct ideas" must be true, and from those foundational ideas, one should deduce all other beliefs. One danger of relying solely on rationalism for acquiring knowledge is that it is not unusual for two well-meaning and honest individuals to use reasoning to reach different conclusions.

Rationalism The acquisition of knowledge through reasoning

This does not mean that science does not use reasoning or rationalism. In fact, reasoning is a vital element in the scientific process. Scientists make use of reasoning both to derive hypotheses and to identify the outcomes that would be required if the hypotheses are true. Mathematics, which is a type of rationalism, is used extensively in many areas of science such as physics. There is also a well-developed line of research in mathematical psychology. In short, rationalism can be very important for science, but by itself it is insufficient.

Empiricism

We all gain knowledge based on our experiences. **Empiricism** is the approach to knowledge that relies on experience as the source of knowledge. Empiricism as a systematic and well-developed philosophy is traced to John Locke (1632–1704) and David Hume (1711–1776). These philosophers argued that virtually all knowledge is based on experience. Locke put it well when he claimed that each person is born a *tabula rasa* (i.e., individuals' minds are blank slates or tablets upon which the environment writes). The *origin* of all knowledge is from our senses (sight, hearing, touch, smell, and taste). Our senses take in information that our brains process.

Empiricism The acquisition of knowledge through experience

Although the empirical approach is very appealing and has much to recommend it, several dangers exist if it is used alone. Our perceptions are affected by a number of variables. Research has demonstrated that such variables as past experiences and our motivations at the time of perceiving can drastically alter what we see. Research has also revealed that our memory for events does not remain constant. The fallibility of eyewitness testimony is evidence that we are not always accurate in reporting events we have observed. Not only do we tend to forget things, but at times an actual distortion of memory might take place (Loftus, 2017).

Empiricism is a vital element in science, but in science, empirical observations must be conducted under controlled conditions, and systematic strategies must be used to minimize researcher and participant bias and to maximize objectivity. The later chapters in this book will carefully explain how to carry out empirical research that is scientific and, therefore, reliable and trustworthy.

Study Question 1.1 Explain each of the approaches to acquiring knowledge and the strengths and weaknesses of each approach.

The Scientific Approach to Knowledge Generation

1.2 Summarize the scientific approach to knowledge generation.

Science The approach to producing knowledge used by researchers employing the methods of science

The word *science* had its ancient origins in the Latin verb *scire*, meaning "to know." However, the English word "science," with its current meaning, was not coined until the 19th century by William Whewell (1794–1866). Before that time, scientists were called "natural philosophers" (Yeo, 2003). **Science** is the approach to producing knowledge used by researchers employing the methods of science. Although science incorporates the approaches to acquiring knowledge discussed earlier, it is superior in the sense that it is designed to systematically produce reliable and valid knowledge about the natural world.

One might think that there is only one method by which scientific knowledge is acquired. However, the enterprise of science relies on multiple logics, strategies, and methods to produce scientific knowledge. As discussed throughout this book, each of the approaches has its particular strengths and limitations and is usable in certain situations.

Induction and Deduction

Induction A reasoning process that involves going from the specific to the general

Two of the most important logics used in science are known as induction and deduction. As classically defined by Aristotle (384–322 BCE), **induction** is a reasoning process that involves going from the specific to the general.[1] For example, if on a visit to a

[1]In the philosophy of logic, induction and deduction have slightly different meanings from what is presented here. In philosophy of logic, inductive reasoning refers to drawing of a conclusion that is probably true, and valid deductive reasoning refers to the drawing of a conclusion that is necessarily true if the premises are true (Copi, Cohen, & Mcmahon, 2017).

daycare center you see several children hitting and kicking other children, you might infer that many children in that center are aggressive or even infer that children in daycare centers across the country tend to be aggressive. This inference is an example of induction because you moved from the particular observations to a much broader and general claim.

For example, Latané (1981) observed that people do not exert as much effort when working in a group as they do when working alone and inferred that this represented the construct of social loafing. When Latané made this generalization of social loafing from the specific observation that less effort was expended in a group, he was engaged in inductive reasoning. Inductive reasoning is also seen in the use of statistical analysis in psychological research. When researchers rely on samples and generalize to populations, they are using inductive reasoning.

Induction is a probabilistic form of reasoning. It provides statements of what is *likely* to be true and/or occur in the future, based on current observations. Inductive reasoning is used very frequently in science. It is not, however, the only reasoning process used in science. Deductive reasoning is also important.

Deduction A reasoning process that involves going from the general to the specific

Deduction, as classically defined by Aristotle, refers to going from the general to the specific. For example, Levine (2000) predicted that a person who views the group's task as important and does not expect others to contribute adequately to the group's performance will work harder. Here, Levine was logically moving from the general proposition of social loafing and deducing a specific set of events that would reduce social loafing. Specifically, Levine deduced that viewing the group's task as important and not expecting others to contribute adequately would cause a person to work harder or counter the social loafing effect. Today, when researchers develop hypotheses, they routinely deduce the observable consequences that must occur if they are going to claim (after collecting data) that the hypothesis is supported or not supported.

It is important to remember that science makes use of *both* inductive and deductive thinking. On the one hand, induction drives the exploratory or discovery arm of science. Scientists must continually discover the characteristics and patterns operating in the world. They observe and probe and study the world, or what scientists during the scientific revolution called reading "the book of nature." On the other hand, deduction drives the knowledge testing arm of science. It is of utmost importance that scientists continually test their knowledge claims. In fact, this characteristic is perhaps more important than any other characteristic of science. We test our ideas and we let the data tell us the degree to which we are right or wrong. This testing arm of science produces justified or warranted knowledge—that is, knowledge that consumers of science can trust. In sum, it is easy to see that science needs both an exploratory/discovery arm and a knowledge testing arm to more fully advance and justify scientific knowledge.

Hypothesis Testing

Hypothesis testing The process of testing a predicted relationship or hypothesis by making observations and then comparing the observed facts with the hypothesis or predicted relationship

Hypothesis testing refers to formulating a hypothesis and then comparing the hypothesis with the facts. For example, Jeong, Biocca, and Bohil (2012) investigated the effect of video game realism on the video game player's arousal. They hypothesized that increased game realism increases player arousal. They conducted an experiment, and the hypothesis was confirmed. As you can see, hypothesis testing relies on the logic of confirmation.

Classical hypothesis testing, where the researcher hopes to verify the hypothesis as true was criticized by the philosopher of science Karl Popper (1902–1994). Popper pointed out that the verification of hypotheses was based on a logical fallacy (known as affirming the consequent). To fix this "error," Popper argued that science should rest on a deductively valid form of reasoning (1968). One can claim conclusively using deductive reasoning that a general law is falsified if any of the data do not support the hypothesis, and this deductively valid approach is what Popper advocated. Popper argued that science should focus on stating bold hypotheses followed by attempts to falsify them. Popper's approach is known as **falsificationism**.

Falsificationism A deductive approach to science that focuses on falsifying hypotheses as the key criterion of science

A major strength of Popper's approach is that it helps eliminate false theories from science. However, Popper's approach has also been criticized because it focused *only* on falsification and completely rejected induction and the logic of confirmation. You might say falsificationism "threw the baby out with the bath water." Popper took a very strong form of falsificationism—he stated that "There is no induction [in good science]; we never argue from facts to theories, unless by way of refutation or 'falsification'" (Popper, 1974, p. 68). Unfortunately for Popper, induction is required in order to claim what theories are best supported (i.e., confirmed), to what degree, and what theories we should believe.

Popper's approach has also been criticized because even if the data appear to falsify a hypothesis, we still cannot conclude that the theory is necessarily false. That's because you have to make many assumptions during the hypothesis testing process, and one of those assumptions, rather than the hypothesis, might have been false. This idea that a hypothesis can*not* be tested in isolation (i.e., without making additional assumptions) is called the **Duhem–Quine principle**.

Duhem–Quine principle States that a hypothesis cannot be tested in isolation from other assumptions

A key point is that psychologists today rely on a hybrid (i.e., mixture) approach to hypothesis testing that includes probabilistic thinking, preponderance of evidence, and a mixture of classical hypothesis testing (i.e., where confirmation of a hypothesis provides evidence of its truth) *and* Popper's falsification approach (where claims of scientific progress are given to hypotheses that survive multiple attempts to falsify them).

Science in the 21st Century

The job of a scientist continues to be to produce reliable and valid knowledge about the natural world. The enterprise of today's science relies on many approaches that have been shown to be useful in producing warranted and justified knowledge. Science uses both inductive and deductive approaches. Science attempts to discover patterns and test hypotheses about the patterns with new people in different places. Science also continues to look for new approaches to help the advancement of knowledge.

Scientists must be curious, skeptical, creative, *and* systematic. They must identify problems, question current solutions that are not working, creatively and systematically come up with new solutions, and, most importantly, subject these new solutions to empirical testing. Ideally, the scientist's personal wishes and attitudes should not affect his or her observations. Although perfect objectivity usually cannot be obtained, objectivity can and should be approximated—**objectivity** is a normative or aspirational goal of science. When researchers subject important beliefs, observations, hypotheses, and claims to repeated empirical scientific testing, they will obtain the most reliable and valid knowledge possible.

Objectivity Goal in science to eliminate or minimize opinion or bias in the conduct of research

In sum, science is defined as the approach to producing knowledge used by researchers employing the methods of science. Furthermore, science is the preferred way of acquiring reliable, valid, and practical knowledge (i.e., trustworthy knowledge) about the natural world. However, to continue to be successful, science must always conduct research ethically, must critically self-examine its practices to determine what is working and what is not working, and must engage in ongoing learning and improvement. If science does this, scientific knowledge also will continue to advance.

Study Questions 1.2

- What is the difference between induction and deduction?
- Compare and contrast traditional hypothesis testing with falsificationism.
- What is science?
- What characteristics are important for a scientist?

Assumptions Underlying Scientific Research

1.3 Explain the importance of the basic assumptions that drive scientific research.

In order for scientists to have confidence in the capacity of scientific research to achieve solutions to questions and problems, they make several working assumptions so that they can get on with the day-to-day practice of science. You may not have thought about it, but you probably make these assumptions too.

Regularity in Nature

Science searches for regularities in nature. If there were no regularity, science would only amount to a historical description of endless unique and unrelated facts. B. F. Skinner (1904–1990) put it well when he stated that science is "a search for order, for uniformities, for lawful relations among the events in nature" (1953, p. 13). If there were no regularity in nature, there could be no understanding, explanation, or knowledge about nature. Without regularity, we could not develop theories or laws or generalizations.

Implicit in the assumption of regularity is the notion of a rather strong form of **determinism**—the belief that there are causes, or determinants, of mental processes and behavior. In our efforts to uncover the laws of psychology, we attempt to identify the variables that are linked together in causal chains. These causal chains describe **probabilistic causes** (i.e., causes that make outcomes more probable). But psychological researchers point out that most outcomes are influenced by multiple causal variables. The goal of science is to continue to investigate and increase understanding of these complex patterns.

Determinism The belief that mental processes and behaviors are fully caused by prior natural factors

Probabilistic causes A weaker form of determinism that indicates regularities that usually but not always occur

Reality in Nature

A related assumption is that there is **reality in nature**. For example, as you go through your daily lives you see, hear, feel, smell, and taste things that are real, and these experiences are real. We assume that other people, objects, or social events like marriage or divorce are not *just* constructions of our imagination, and we assume that many different types of "objects" can be studied scientifically. Stating that something is true or real "because we said it is real" does not work in science. In science, researchers check reality in many ways to obtain objective evidence that what is claimed is true. In short, researchers interact with a natural world (that includes social objects such as attitudes, beliefs, institutions), and, in science, this reality must have primary say in our scientific claims. This is why researchers collect and analyze data.

Reality in nature The assumption that the things we see, hear, feel, smell, and taste are real

Discoverability

Discoverability The assumption that it is possible to discover the regularities that exist in nature

Scientists believe not only that there is regularity and reality in nature, but also that there is **discoverability**—that is, it is possible to discover the regularities and reality. This does not mean that the task of discovering the regularities will be simple. Nature is very reluctant to reveal its secrets. Scientists have been working on discovering the cause and cure for cancer for decades. Although significant progress has been made, we still do not know the exact cause(s) of all forms of cancer. Similarly, a complete cure for cancer still does not exist. An intensive effort is also taking place within the scientific community to identify the causes of autism. However, scientists have yet to fully uncover nature's secrets in this arena.

The intensive effort that has existed to uncover the cause of such diseases as cancer or, within the field of psychology, such disorders as schizophrenia and depression reveals one of the basic processes of research. The research process is similar to putting a puzzle together: You have all the pieces of the puzzle in front of you, which you try to put together to get the overall picture. Scientific research includes the difficult task of first discovering the pieces of the puzzle. Each study conducted on a given problem has the potential of uncovering a piece of the puzzle. Only when each of these pieces has been discovered is it possible for someone to put them together to enable us to see the total picture. Consequently, discoverability incorporates two components: The first is discovery of the pieces of the puzzle, and the second is putting the pieces together, or discovery of the nature of the total picture.

> **Study Question 1.3** List the basic assumptions of scientific research, and explain why these assumptions are needed.

Characteristics of Scientific Research

1.4 Describe the characteristics of scientific research and explain why each of these is important.

We have argued that science is the preferred way to obtain reliable and valid knowledge about the natural world. In order to produce reliable and justified knowledge, the scientific process relies on several important characteristics.

Empirical

Empirical Research that is based on data

Science is **empirical**. This means science relies on data collected using the tools of science such as experiments and systematic observations. Rather than basing conclusions on someone's personal intuition or an authority's claim of truth, scientists carefully collect the relevant data and they "listen to what the data say." We cannot overstate the importance of answering your research questions using appropriately collected and analyzed data. In fact, we also say that our data are empirical as in "Science is based on empirical data."

We need to make two more points. First, in scientific writing, the word *data* is usually used as the plural form of datum. This comes from its origin in Latin. When talking about research, you should notice, for example, that researchers usually say "the data were" rather than "the data was," and they say "the data are" rather than "the data is." That usage might take some practice, but that's how it's most often used by scientists. Second, science sometimes relies on deductive logics such as mathematics to provide answers to some of its questions. However, even when mathematical conclusions are made, these conclusions are then turned into predictions that are tested with new empirical data. In sum, data reign supreme in psychological research!

Control

Control refers to holding constant or eliminating the influence of extraneous variables so that you can make an unambiguous claim about cause and effect. An **extraneous variable** is a variable that might compete with the presumed causal variable in explaining the outcome. Is the outcome due to the variable you believe is causing it, or is it due to some other "extraneous" variable? One of the most important tasks of the psychological researcher is to identify causal relationships, and without control for extraneous variables, this is not possible. It is important that you remember this point: *experiments are the preferred research method when you need to address the issue of cause and effect*. Experiments are conducted in an attempt to answer important research questions, such as why forgetting occurs, what reduces the symptoms of schizophrenia, and what treatment is most effective for depression. In order to provide unambiguous answers to such questions, researchers must rely on control.

Extraneous variable A variable that might compete with the presumed causal variable in explaining the outcome

For example, when testing the effectiveness of a new drug on depressive symptomology, researchers must control for participants' expectations that the drug will help their symptoms. That's because in some cases, participants will experience improvement in symptoms as a result of thinking that they have received a useful treatment, even when the treatment condition has no value (e.g., placebo). This type of improvement is referred to as the **placebo effect**. Therefore, in well-designed experiments testing the effectiveness of new drugs (sometimes called **randomized controlled trials or RCTs**), researchers randomly assign the participants to two groups: (a) an experimental group where the participants receive the real drug and (b) a control group where the participants receive a treatment in which the "drug" looks like the actual drug when, in fact, it does not have the active ingredient of the new drug. If participants receiving the real drug report more improvement than participants receiving the placebo, the researcher can be more confident that the new drug is the actual cause of the improvement. Without the control condition, the researcher would not know whether the cause of the improvement was the drug or the placebo effect.

Placebo effect Improvement due to participants' expectations for improvement rather than the actual treatment

Randomized controlled trial (RCTs) An experiment where participants are randomly assigned to the groups

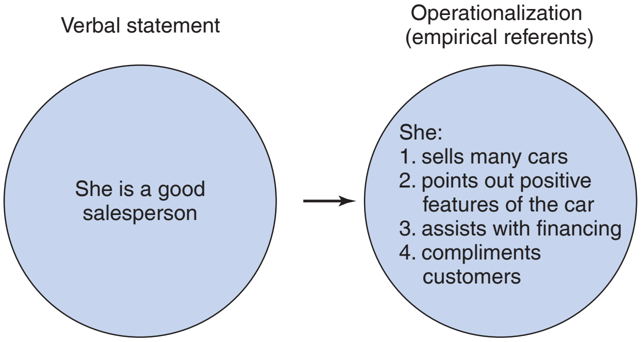
Operationalization of Constructs

In psychological research we study the relations among constructs (e.g., depression, types of therapy, types of personality, worker satisfaction, worker productivity). It is absolutely essential that we have good empirical measurement of the constructs in our research studies. Without good measurement, you cannot trust the results reported in a research study. In the language of research, we say, "We need to carefully 'operationalize' our constructs." **Operationalizing a construct** refers to identifying a specific instrument (or set of instruments) to accurately measure the construct of interest. Consider the construct of "good car salesperson." How would you operationalize a good car salesperson? What empirical referents would you use to characterize this construct? In Figure 1.1, we suggest that these empirical referents might consist of selling many cars, pointing out a car's good features, helping the customer to find financing, and complimenting the customer on an excellent choice. This is referred to as the *operationalization* of the construct or, more traditionally, as the **operational definition**.

Operationalizing a construct Identifying an instrument (or set of instruments) to accurately measure a construct

Operational definition The result of operationalizing a construct

Figure 1.1 Example of an operationalization of a good car salesperson.



Once this construct has been operationalized, meaning can be communicated with minimal ambiguity and maximum precision. When you read published psychological research, you always need to look at how the researchers operationalized the constructs, making sure that you are completely satisfied with their measurement procedures.

Replication

Replication The reproduction of the results of a study in a new study

Scientific knowledge is incomplete without replication. **Replication** refers to the reproduction of the results obtained from one study in additional studies (with different people, places, times). Before you can trust the findings of research, you must determine whether the findings are reliable. It is important to remember this key point: You should always be cautious when interpreting findings from a *single* study in isolation from other research. To make a general claim, you must know whether the same results will be found if the study is repeated. If the findings are not repeatable, they were either due to chance or they operate differently in different contexts or with different people. If the variables of interest operate differently in different contexts, then contextual factors must be systematically examined in additional research.

Although the need for replication is a central characteristic of scientific research, few researchers devote their time and energy to *exact replication*, in part, because the academic and publishing systems do not support or reward exact replications (Pashler & Wagenmakers, 2012). However, recently 270 scientists came together through the Open Science Collaboration and systematically replicated 100 psychological studies. They stressed not only the need for replicating empirical findings, but also the need to fully investigate theoretical explanations of those empirical findings. They point out, "Innovation points out paths that are possible; replication points out paths that are likely; progress depends on both" (Open Science Collaboration, 2015, p. 950). There is a clear need for both new, innovative research and replication.

A more common form of replication, *partial replication*, is seen when the key variables of interest are included in multiple research studies that are slightly different. For example, in other research studies, a slightly different combination of variables might be studied, but they still include the original variables of interest to you. When there are multiple studies that report the relation between the same variables, those studies can be aggregated with the use of meta-analysis.

Meta-analysis A quantitative technique for describing the relationship between variables across multiple research studies

Meta-analysis is a quantitative technique that is used to combine, integrate, and describe the relationships between variables across multiple research studies. Earlier we noted that you should not place too much trust in the findings of a single research study. You *should*, however, place significant trust in the results of a meta-analysis because the finding is shown to apply across multiple related research studies. Whenever you review the research literature on a topic of interest, be sure to search for meta-analysis research studies!

Evidence Not Proof

Although science is the strongest way to obtain knowledge about the natural world, you might be surprised to learn that researchers rarely use the words *prove* or *proof* in regard to their scientific claim. (You will hear advertisers claiming proof.) Although science does not provide full or final *proof* of psychological principles, it does provide evidence that varies from very weak to very strong. In empirical research, we leave open the possibility that future research could show that we have made a mistake