Research Methods

Concepts and Connections

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University of Washington

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To my wife Bev, for her endless love, support, and grace,

and to Harold Sigall, my undergraduate mentor and friend, who nourished my interest in psychology and introduced me to the exciting enterprise of conducting psychological research

About the Author

Michael W. Passer is Senior Lecturer in Psychology at the University of Washington. Born and raised in Brooklyn, New York, he entered the University of Rochester fully expecting to be a physics or chemistry major, but he became hooked on psychological science after taking introductory psychology and a seminar course on the nature of the mind. He got his start as an undergraduate researcher under the mentorship of Dr. Harold Sigall, was a volunteer undergraduate introductory psychology Teaching Assistant, and received a Danforth Foundation Fellowship that partly funded his graduate studies and exposed him to highly enriching national conferences on college teaching.

Dr. Passer received his Ph.D. from UCLA, where he conducted laboratory research on attribution theory under the primary mentorship of Dr. Harold Kelley and gained several years of field research experience studying competitive stress, self-esteem, and attributional processes among boys and girls playing youth sports, mainly working with Dr. Tara Scanlan in the Department of Kinesiology. At the University of Washington he has conducted hypothesis-testing field research on competitive stress with youth sport participants, collaborated on several applied research projects in the field of industrial-organizational psychology, and for the past 20 years has been a Senior Lecturer and faculty coordinator of U.W.'s introductory psychology courses. In this role, he annually teaches courses in introductory psychology and research methods, developed a graduate course on the teaching of psychology, and is a U.W. Distinguished Teaching Award nominee. With his colleague Ronald Smith, he has coauthored five editions of the introductory textbook *Psychology: The Science of Mind and Behavior* (McGraw-Hill), and has published more than 20 scientific articles and chapters, mostly on attribution theory and competitive stress.

Contents in Brief

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Preface

I wrote this book for the same core reasons that I choose to teach the research methods course each year. First, I believe that regardless of a student's major or intended career, a research methods course in psychology or other behavioral science is among the most important classes an undergraduate can take. The course content is tailor-made to sharpen students' critical thinking skills and help students become savvier lifelong information consumers. The concepts they learn in this course should foster their ability and motivation to evaluate the soundness of conclusions and other claims they encounter, whether in scientific articles, textbooks, media reports, pseudoscientific writings, or advertisements.

The methods course can deepen students' appreciation of the scientific method and scientific values by enhancing their understanding of methodological concepts, different types of research and research design, and ethical and other challenges confronting behavioral scientists. While this methodological foundation has obvious benefits for students who take more advanced science courses or intend to become researchers, it also prepares all students to be knowledgeable citizens and professionals in an increasingly science-oriented world. Even if few of our students plan to pursue an academic research career, many hope to become practitioners in clinical or counseling psychology, industrial-organizational psychology, school psychology, social work, medicine or nursing, physical therapy, law, or business. As professionals, they will need to draw upon knowledge of research methods as they stay current with the literature in their chosen field and evaluate its implications for the way they conduct their work.

My second reason for writing this book is that, to put it mildly, teaching the methods course is a formidable challenge. Years ago, when the opportunity to teach it first arose, I was thrilled and eagerly prepared. A few days before the start of classes I ran into a colleague who asked, "What are you teaching?" "Research methods," I replied. "Oh," he said as he rushed off, "too bad!" Surprised but undaunted, I gave his comment little thought. (After all, while in graduate school I had volunteered to be a Teaching Assistant for the course, loved the experience, and had enthusiastic students.)

The next day I encountered another colleague who asked what course I was teaching. "Methods," I said. Her reply? "Too bad!" This time I had to ask why. The course, she said, was a tough sell. Up to half the students weren't psych majors and took it to satisfy a science distribution requirement. Among the psych majors, many were seniors who had kept putting the course off, and few students aspired to research careers. The bottom line, she said, was that the course content didn't intrinsically interest most students. I told her I already had heard about these issues and looked forward to the challenge of teaching such a diverse group.

During the course there were days when my students were highly engaged and others when their facial expressions suggested the end-of-class bell couldn't ring soon enough. Although I was an experienced and well-regarded instructor, teaching the methods course for the first time was a wake-up call. Still, when the official anonymous student evaluations arrived weeks later, I was pleased. Although many invoked the "tough sell" theme and noted that the textbook was dry, most students found the class engaging and worthwhile. As one student memorably remarked, "I expected this course to suck swamp gas, but it was really pretty interesting." Importantly, another theme frequently emerged: "This course changed the way I look at information / evaluate information / think about claims / think about evidence / judge whether something causes something else." To this day, there is no student feedback that inspires me more than such comments about enhanced critical thinking.

My hope is that this textbook will provide students with a solid foundation of methodological concepts that honors the importance of the methods course by promoting the learning goals discussed more fully below. I hope that the textbook's balance of breadth and depth, topic selection and diverse examples, personal writing style, chapter-opening vignettes and pedagogical features, and supporting materials will enhance students' interest and engage them in the material. In addition, except for instructors who absolutely require methodological and statistical coverage to be interwoven throughout the narrative, I believe that the modular statistics approach used in this book will facilitate students' learning and engagement by allowing instructors to tailor the amount and placement of statistics coverage easily and flexibly.

LEARNING GOALS: CONCEPTS AND CONNECTIONS

The American Psychological Association (2007), in its document *APA Guidelines for the Undergraduate Psychology Major*, recommends 10 broad learning goals for undergraduate psychology major programs. These are broad curricular goals, and there is no assumption that an individual course will focus on all of them. Still, the research methods course has the potential to address them all. In-class exercises and demonstrations, class research projects, labs, and discussion sections are among the components that can support these learning goals. I hope that this textbook and its supplements will help instructors to promote the goals that they deem most important. Here are some ways in which this package links to APA's undergraduate learning goals.

Research Methods **(APA Learning Goal 2).** This textbook is primarily intended to help students understand methodological concepts and different types of research designs and approaches—their nature, advantages, and disadvantages—rather than to provide detailed step-by-step guidelines for conducting research. Like most methods texts, this book devotes substantial attention to the experimental method and experimental design (five chapters), including separate chapters on quasi-experimental designs and single-case (i.e., single-subject, small-*N*) designs. Unlike many methods texts, this book also devotes considerable attention to descriptive research (three chapters). I chose to do this for five reasons:

- Both research approaches are pervasive in, and make vital contributions to, psychology and other behavioral sciences.
- If an instructor wishes to focus on one approach more than another in class meetings and assignments, this text remains a vehicle for exposing students to both experimental and nonexperimental methods.
- Throughout their lives, whether as undergraduates, professionals immersed in careers, or as lifelong media consumers, today's students will encounter and need to understand information derived from both research approaches.
- Students who will go on to conduct research in their careers may need to master a broad spectrum of research approaches.
- Although this book is primarily oriented to quantitative research, the nature and importance of qualitative research and data analysis are discussed in several chapters.

Critical Thinking **(APA Goal 3).** Science is a grand exercise in critical thinking, and an orientation toward deeper critical thinking is perhaps the most important lifelong outcome that most students will take away from the methods course. I hope this textbook will boost students' ability to think critically about scientific, pseudoscientific, and other types of information that they encounter in educational contexts and everyday life. This includes the ability to evaluate the appropriateness of different research approaches, designs, and procedures for addressing particular questions, to judge the soundness of

causal inferences and other conclusions and identify plausible alternative explanations for research findings, to understand that not all evidence is equal, and to weigh the quality of conflicting pieces of evidence.

This book supports critical thinking goals from the outset—for example, note the Chapter 1 opening example that illustrates different bases upon which people form beliefs. It also employs critical thinking as a recurrent theme woven into the narrative and illustrated by examples drawn from research, the media, and daily life. Each chapter concludes with critical thinking and application exercises, and critical thinking exercises also are provided in the Instructor's Manual. In addition, the topics of correlation and correlational research receive full-chapter treatment, with considerable attention devoted to the distinction between correlation and causation—a core critical thinking concept that can't be overemphasized, as many students continue to fall into the "correlation equals causation" trap.

Values in Psychology **[including Ethics] (APA Learning Goal 5).** The textbook's exploration of knowledge building, of the tentative nature of scientific conclusions, of factors affecting the validity of different types of inferences, of strengths and weaknesses of different research approaches, of confounding and the need to consider plausible alternative explanations, all speak to this APA learning goal, which overlaps partly with critical thinking goals and includes the ability to weigh evidence and demonstrate tolerance for ambiguity.

Awareness of the need for ethical conduct, another central aspect of this APA learning goal, is discussed in a meaty chapter on research ethics. This chapter goes beyond a mere description of ethics principles and regulations. It highlights how ethics codes and ethics review committees shape the process of conducting research, how ethics codes cannot address every ethical issue a researcher might face, and thus how striving to be an ethical researcher is itself an exercise in critical thinking. The chapter uses examples to stress how psychological scientists and other behavioral researchers must often grapple with thorny ethical dilemmas that result from conflicting ethical principles or ambiguities inherent in ethical standards. The chapter comes early in the book, but for instructors who prefer to address this topic later in the course, the chapter is easily assigned out of sequence.

Application of Psychology **(APA Learning Goal 4).** The textbook emphasizes the interplay between basic and applied research goals, and draws on actual studies and examples from across the basic–applied continuum to illustrate concepts and research designs. Applied examples occur throughout the book rather than being segregated into a small number of chapters, and draw upon fields such as clinical psychology, clinical neuropsychology, industrial-organizational psychology, human factors, health psychology, educational psychology, and applied behavior analysis. Discussions of topics such as program evaluation, the use of correlational findings for applied prediction, measurement reliability and validity, and threats to internal validity further reinforce connections between methodological concepts and the application of psychological science to societal, organizational, and other problems.

This learning goal also includes fostering students' ability to apply psychological knowledge to their daily lives and increasing their awareness of how ethical concerns can constrain applications of psychological knowledge. The textbook's emphases on critical thinking and extensive coverage of research ethics feed into these application goals.

Communication Skills **(APA Learning Goal 7).** Cognitive psychologist Pam Marek, a professor at Kennesaw State University and associate editor of the journal *Teaching of Psychology,* has written an outstanding guide on scientific communication and APA style. Produced specifically for this textbook and presented in Appendix A (Communicating Research Results), it expands upon basic information on scientific communication in Chapter 2 and discusses how to conduct a scientific literature

search, key elements of good scientific writing and of an APA style research report, essentials of APA writing style, and how to create an effective poster presentation. The guide includes an annotated manuscript of a research report and is supplemented online with additional information by Dr. Marek on grammar.

The textbook addresses quantitative literacy, another component of this learning goal, by discussing basic concepts in analyzing, graphing, and interpreting data. For instructors whose courses contain more statistical depth, the textbook's Statistics Modules unit, presented after the book's main chapters, contains more detailed conceptual discussion and shows how to perform various statistical calculations and tests.

Support of Other APA Learning Goals. The textbook addresses several components of APA's broad learning goal *Knowledge Base of Psychology* (APA Learning Goal 1). These include promoting students' awareness of

- what makes psychology a science;
- psychology's core goals of description, understanding, prediction, and control;
- ethical issues and the APA Ethics Code, and
- research in all the general domains listed in the APA undergraduate guidelines.

The book contributes to the goal *Information and Technology Literacy* (APA Learning Goal 6) by describing major psychological databases; different types of information sources; basics of how to perform an online literature search; APA rules for quoting, citing, and referencing sources; and scientific integrity, including the collection and reporting of data and avoiding plagiarism. Several of the textbook's WebLinks provide additional resources relevant to information and technology literacy.

To support the goal *Sociocultural and International Awareness* (APA Learning Goal 8), the textbook's Instructor's Manual contains a critical thinking exercise and accompanying materials on methodological and ethical challenges in conducting cross-cultural research. To remind students of the importance of examining topics pertaining to ethnicity, gender, and culture, the textbook uses several studies on sociocultural issues to illustrate various methodological concepts.

The textbook and ancillary materials promote the goal *Personal Development* (APA Learning Goal 9) mainly via the attempt to foster students' critical thinking skills and their appreciation for the value of applying such skills to their daily lives. The book's pedagogical features also provide students with ample opportunity to assess whether they understand the material as well as they think they do.

Finally, the textbook supports the learning goal *Career Planning and Development* (APA Learning Goal 10) by helping students acquire knowledge and skills that are relevant to a broad range of careers. Chapter 1 discusses ways in which taking a methods course can be relevant to diverse career paths. For students who are considering a career in psychology, I have tried to enhance their awareness of psychology's many subfields by drawing upon diverse research examples and, often, noting at least the lead researcher's area of study. Worth Publishers also has compiled an excellent collection of original essays in which leading psychological scientists discuss a major area of their research, its contribution to society, and how they became interested in the topic. This collection, *Psychology and the Real World*, comes packaged with new copies of the textbook.

TEXTBOOK FEATURES

Chapter Opening Vignettes and Examples From Diverse Subfields. Each chapter begins with one or more vignettes based on research studies or events in the media. My goals in using this approach are to engage students from the outset and draw them into the chapter, and provide opening examples that are periodically referred to later in the chapter to illustrate one or more key concepts.

Research methods instructors are in the enviable position of being able to draw research examples from diverse subfields. Certainly, boundaries between psychology's traditional subfields have increasingly blurred, but even so, drawing examples from diverse subfields illustrates how research methods are brought to bear on a wide variety of topics. It also broadens students' knowledge about exciting and important work being done by psychologists across many subfields and might help spark an interest—even a research interest—in a particular subfield.

Examples run the gamut from classic to recent studies. It's important to show that psychological science wasn't built in a day, but at the same time, to avoid having students feel that a textbook is dated. I believe that this textbook presents more examples of 21st-century studies than is the case in many methods textbooks. This textbook also covers topics, such as Internet research and the ethical issues it involves, that reflect our changing times.

Research Ethics Coverage. The relatively detailed chapter on research ethics reflects the paramount importance of conducting ethical research. I seek to highlight how ethics codes and regulation affect the process of designing and conducting research; that ethics codes are not cookbooks that provide concrete steps for solving every ethical issue a researcher might face; and how the desire to be an ethical researcher and adhere to ethics codes can generate difficult ethical dilemmas. The chapter stands independently and easily can be assigned at any point during the course.

Flexible Sequence of Chapters. Most methods textbooks, including this one, devote their earliest chapters to core topics such as characteristics of science, measurement, and so forth. Many books then cover descriptive (nonexperimental) research before experimentation, whereas many others cover experimentation before descriptive approaches. This textbook can easily be adapted to either sequence. Moreover, with some exceptions (e.g., covering basic experimental designs before factorial designs), instructors can easily adapt the sequence of chapters within each part of the book to their particular preferences.

Pedagogy. I have endeavored to provide the amount and types of pedagogy necessary to help students gain understanding and assess their progress, while maintaining a clear focus on the main text content.

Key terms are boldfaced and each term is immediately accompanied by an italicized definition in the narrative. A list of key terms also is presented at the end of each chapter, along with its page location in the chapter, and a glossary of key terms for the entire text is found at the end of the book.

A Concept Check feature is placed at the end of each main section of every chapter. End-of-chapter pedagogy includes a chapter summary, a list of open-ended Assess Your Knowledge questions, and a set of Thinking Critically and Applying Your Knowledge (CTAYK) exercises. Answers to the Concept Check and odd-numbered CTAYK exercises are presented in Appendix D. Answers to the even-numbered CTAYK exercise are available on the textbook's instructor website, providing instructors with the option to use these exercises as in-class critical thinking exercises or homework assignments, or to provide the answers to students for independent study.

In addition to these features, the textbook website offers may instructional aids to students (e.g., practice test items). The instructor website provides access to additional critical thinking and other exercises that can be employed during class to enhance students' learning and engagement.

Flexible Statistics Coverage: Statistics Modules. Some instructors separate statistics coverage from the methods course almost entirely, whereas others teach statistics and methodology in a highly integrated manner. No approach to covering statistics in a methods book will satisfy everyone, but I hope that the modular approach in this book

will enable instructors to easily emphasize or deemphasize statistics coverage, as they see fit. Several chapters introduce basic statistical concepts (e.g., descriptive statistics, statistical significance), and instructors who want more statistical depth can select from among 16 statistics modules (SM) presented after Chapter 12. Each module, and each subsection within, is numbered so that instructors can easily supplement chapter assignments with specific modules. For example, an instructor who wants students to read about null hypothesis testing and *t* tests in conjunction with covering single-factor experimental designs, could assign "Chapter 8, SM 9, SM 12". If the instructor only wants students to learn about the concept behind a *t* test, but not calculate a *t* test, the reading assignment would specify module SM 12.1 rather than SM 12 as a whole. Some modules are cited in certain chapters (e.g., "For more details, see SM 2"), but of course, can be assigned at whatever time the instructor best sees fit.

A Final Comment. I look forward to the possibility that through this textbook, I may have an opportunity to contribute to students' education and intellectual growth. Above all, I hope both instructors and students will have a great, rewarding experience in the research methods course.

MEDIA AND SUPPLEMENTS

FOR INSTRUCTORS

Research Methods: Concepts and Connections comes with a robust package of supplemental materials to support teaching.

- The **Instructor's Resource Manual** features a variety of teaching tips and activities to support the topics discussed in the text.
- The **Test Bank** by Joseph Palladino of the University of Southern Indiana includes multiple-choice, essay, and critical thinking questions, totaling more than 100 items for each chapter.
- **Diploma Computerized Test Bank** (available for Windows or Macintosh on a single CD-ROM). The CD-ROM allows instructors to add an unlimited number of new questions; edit questions; format a test; scramble questions; and include figures, graphs, and pictures. Student grades can be reported to an accompanying Gradebook.
- **Lecture Slides** provided in PowerPoint give teachers all the figures and images from the text in addition to a full lecture accompaniment for each chapter. Each lecture includes questions and activities to augment the material in the book and bring concepts to life.
- **Faculty Lounge** is an online forum provided by Worth Publishers where instructors can find and share favorite teaching ideas and resources, including videos, animations, images, PowerPoint slides, news stories, articles, WebLinks, and lecture activities. Sign up to browse the site or upload your favorite materials for teaching psychology at **www.worthpublishers.com/facultylounge.com**.

FOR STUDENTS

- The **Book Companion Website** at **www.worthpublishers.com/passer1e** is the home of Worth Publishers' free study aids and supplemental content. The site includes chapter objectives, online quizzes, interactive flashcards, and more.
- The **CourseSmart eBook** offers the complete text of *Research Methods: Concepts and Connections* in an easy-to-use, flexible format. Students can choose to view the CourseSmart eBook online or download it to a personal computer or mobile device. The CourseSmart eBook for *Research Methods: Concepts and Connections* can be previewed and purchased at **www.coursesmart.com**.

- The **iClicker** Classroom Response System is a versatile polling system developed by educators for educators that makes class time more efficient and interactive. iClicker allows you to ask questions and instantly record your students' responses, take attendance, and gauge students' understanding and opinions. iClicker is available at a 10% discount when packaged with *Research Methods: Concepts and Connections.*
- **SPSS: A User-Friendly Approach** by Jeffrey Aspelmeier and Thomas Pierce of Radford University is an accessible introduction to using SPSS. Using a proven teaching method, statistical procedures are made accessible to students by building each section of the text around the storyline from a popular cartoon. Easing anxiety and giving students the necessary support to learn the material, *SPSS: A User-Friendly Approach* provides instructors and students with an informative guide to the basics of SPSS: available for Versions 16, 17, and 18.
- ***Psychology and the Real World: Essays Illustrating Fundamental Contributions to Society*** is a superb collection of essays by major researchers that describe their landmark studies. Published in association with the not-for-profit FABBS Foundation, this engaging reader includes Elizbeth Loftus's own reflections on her study of false memories, Eliot Aronson on his cooperative classroom study, and Daniel Wegner on his study of thought suppression. A portion of all proceeds is donated to FABBS to support societies of cognitive, psychological, behavioral, and brain sciences.

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I also wish to express my gratitude to Dr. Laura Little, our faculty coordinator of the research methods course and a distinguished statistics instructor, for her detailed review of the textbook's Statistics Modules and her invaluable constructive feedback. To Dr. Pam Marek of Kennesaw State University, who wrote an excellent appendix for the book on Communicating Research Results, my (and my wife's) sincerest thanks. And of course, throughout the writing of this first edition, I relied on thoughtful feedback from reviewers, focus group attendees, and survey respondents. My thanks go to them for their expertise and for the time they set aside to help develop this textbook.

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CHAPTER

1

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SCIENCE AND PSYCHOLOGY

CHAPTER OUTLINE

Sarah is about to make a decision and wants your help. She is a contestant on a TV game show and is looking at three doors, labeled 1, 2, and 3. There's a fabulous prize behind one door: a brand-new car. Behind each of the other two doors there's only a booby prize: a goat. Sarah doesn't want a goat, and her college roommate isn't thrilled about that prospect either. Here are the game rules:

- I am the game show host. I know which door reveals the car and which doors reveal the goats. Sarah does not know.
- Sarah picks a door. The door will remain closed for now.
- I will then open one of the other two doors and show her what's behind it. For example, if Sarah picks Door 1, then I'll show her what's behind either Door 2 or Door 3.
- The door I open will *always* have a goat behind it. No matter what door Sarah picks, at least one of the other two doors has to have a goat behind it. If Sarah picks Door 1 and the car is behind Door 3, then I'll show her Door 2. If the car's behind Door 2, then I'll show her Door 3. If the car is behind Door 1 (the door she chose), then I'll pick Door 2 or Door 3 to open.
- And now, the moment of suspense arrives. I've just shown Sarah a door with a goat behind it, so there are only two doors left. I offer Sarah a choice: She can keep the original door that she chose (Door 1 in our example) *or* she can switch to the other door.

Sarah isn't sure what to do. She really wants that car. If Sarah's goal is to maximize her chances of winning the car, what advice would you give her? Will her odds of winning be (1) higher if she stays with her original choice, (2) higher if she switches to the other door, or (3) the same no matter which door she chooses?

Before discussing your advice, I want to welcome you to the research methods course. It's a course that can have many important connections to your life, as we'll see later. For now, I'll just say that no matter your reason for taking this course, the principles covered in your methods class have the power to change how you evaluate information and think about the world around you. I sincerely hope you will find the course intellectually stimulating and educational. Now let's get back to Sarah.

HOW DO WE KNOW?

Learning Objectives

After studying this section, you should be able to:

- Explain how tenacity, authority, reason, and empiricism differ from one another as methods of acquiring knowledge and beliefs.
- Illustrate the difference between everyday empiricism and systematic empiricism.

Sarah's hypothetical game show scenario is called the three-door problem. We'll use it to illustrate some concepts about how we acquire knowledge and beliefs about our magnificent universe. In turn, these concepts will establish a foundation for discussing the goals and characteristics of science.

THE THREE-DOOR PROBLEM

When I pose the three-door problem to my own students, about 90% of them say that it makes no difference whether Sarah stays or switches. "It's 50–50 either way," they confidently assert. In fact, the first time I presented this brain teaser to my class, I forgot to mention the "no difference" answer option. I asked my class only whether Sarah would be more likely to win if she "stayed" or "switched." In response, I received smirks and eye rolls accompanied by comments like "It's a trick

question because it makes no difference. With two doors left, she has a 50% shot with each one."

Was "it makes no difference" your answer as well? When I first read the three-door problem in *Parade Magazine* years ago, I confidently concluded that the odds of winning would be the same regardless of staying or switching: "Hah—a trick question. It's obviously 50–50." Obvious, yes; but also wrong. In fact, the odds will be 2 to 1 in Sarah's favor if she switches doors. At least that's the claim made by the famous magazine columnist who brought this brain teaser to the public's attention years ago. Is she right?

To find out, let's briefly cover some history. The three-door problem is loosely based on a popular American TV game show from the 1960s and 1970s called *Let's Make A Deal*. It's also called the Monty Hall problem in honor of the game show host. In 1990 a reader of *Parade Magazine* posed a brief version of the problem to Marilyn vos Savant, who has written the "Ask Marilyn" column for the weekly magazine since 1986. Readers send her brain teasers, trying to stump her, and vos Savant invariably solves them. On her website, vos Savant notes that she was listed for five years in the *Guinness Book of World Records* under the category of "Highest IQ."

Vos Savant's answer to the three-door problem touched off such a firestorm of controversy that, to this day, many websites are devoted to discussing how to solve it. In the "Ask Marilyn" column, vos Savant answered that the contestant (our "Sarah") should switch doors because a "switch strategy" will result in a two-thirds probability of winning the car, whereas a "stay strategy" produces only a one-third chance of winning. In the following weeks and months, despite the fact that vos Savant provided further explanation for her answer, letters of disbelief and complaint flooded in to *Parade Magazine* from mathematicians, statisticians, scientists, and other readers. One faculty member suggested that vos Savant needed to get hold of a basic textbook on probability theory. **Table 1.1** shows excerpts from several other letters.

Table 1.1 Feedback Sent to vos Savant Following Her "Switch" Solution to the Three-Door Problem

Each of the first three comments was sent in response to vos Savant's initial or expanded answer, both of which were published in *Parade Magazine* in 1990. The last response was sent following further discussion of the problem in the magazine a year later. All responses are from college faculty members (PhDs), except for the last one.	You blew it, and you blew it big! . . . Shame!
	. . . I'm very concerned with the general public's lack of mathematical skills. Please help by confessing your error. . . .
	You are utterly incorrect. . . . How many irate mathematicians are needed to get you to change your mind?
	I still think you're wrong. There is such a thing as female logic.

Source: vos Savant (2006, paras. 3, 4, 9, 58).

The following year vos Savant wrote another column explaining her answer even further, and suggesting that readers conduct an experiment to discover the solution for themselves (more on this shortly). Although many readers now wrote to say they agreed with her, others continued to say she was nuts. A physics faculty member noted that when he posted vos Savant's solution on a department bulletin board, his colleagues criticized and ridiculed him; one even bet him dinner that vos Savant was wrong. Later, he reported, most of his colleagues came around, and he won his free meal (vos Savant, 2006). Eventually, knowledge of the three-door controversy spread and the problem made its way into an episode of at least one popular prime-time TV show (*NUMB3RS*) and one Hollywood movie (*21*). Perhaps you were already familiar with it before reading it here. If so, try this exercise: Present the problem to a few people who are not familiar with it and see how many answer correctly.

WebLink 1.1
The Three-Door Problem

Now we'll consider the three-door problem in the context of acquiring knowledge and forming beliefs. I'll explain the answer during the course of this discussion. If you want more information about the history of the controversy, or other explanations for why Sarah is better off switching, see WebLink 1.1.

TENACITY: KNOWING BY FORCE OF HABIT

"I don't care what you say; it's like flipping a coin. There are two possible outcomes, and it has to be 50–50 because there are only two doors left." The last quote in Table 1.1 strikes the same chord, inanely dismissing vos Savant's arguments because, as the letter writer has long known, women have their own brand of logic.

Philosopher and scientist Charles Peirce (1877), in an article titled "The Fixation of Belief," described four methods by which people come to hold beliefs about the world: tenacity, authority, reason, and science. **Tenacity** *involves believing something simply because it is what we have long believed*. There is no exploration of one's beliefs, no reasoned contemplation of opposing viewpoints. Peirce argued that tenacity involves closing oneself off to information that is inconsistent with, or otherwise threatens, a firmly held belief. Although he clearly viewed tenacity as an unsatisfactory method upon which to base one's knowledge and beliefs, Peirce noted that it possessed "strength, simplicity, and directness" (1877, Section V, Para 12).

Of course, tenaciously held beliefs may be correct. We can distinguish between the method upon which knowledge is based and the accuracy of that knowledge. But tenacity, says Peirce, is like the proverbial ostrich putting its head in the ground and then, no longer seeing danger, assuming that everything is all right. Refusing to consider contrary evidence reduces the likelihood of forming accurate beliefs. Ultimately, it is a poor way to establish knowledge. And this brings us to Hawthorne, the cranky crab in **Figure 1.1**. Despite mounting evidence in support of global warming, some scientists' careful weighing of the evidence still leaves them unconvinced. That's well and good; scientific dissent often provides the spark for further and even more rigorous evidence gathering. Hawthorne's broad skepticism, however, seems based merely on tenacity, as his views on a "round earth" make clear.

AUTHORITY: KNOWLEDGE GAINED FROM OTHERS

Authority *involves relying on other people as our source of knowledge and beliefs,* and it's pervasive throughout our life. In childhood we begin to rely on parents, other caregivers, siblings, teachers, members of the clergy, friends, television, radio, the web, books—you

Figure 1.1 An example of tenacity. ("Sherman's Lagoon" © 2009, used with permission of Jim Toomey, King Features Syndicate, and the Cartoonist Group. All rights reserved.)

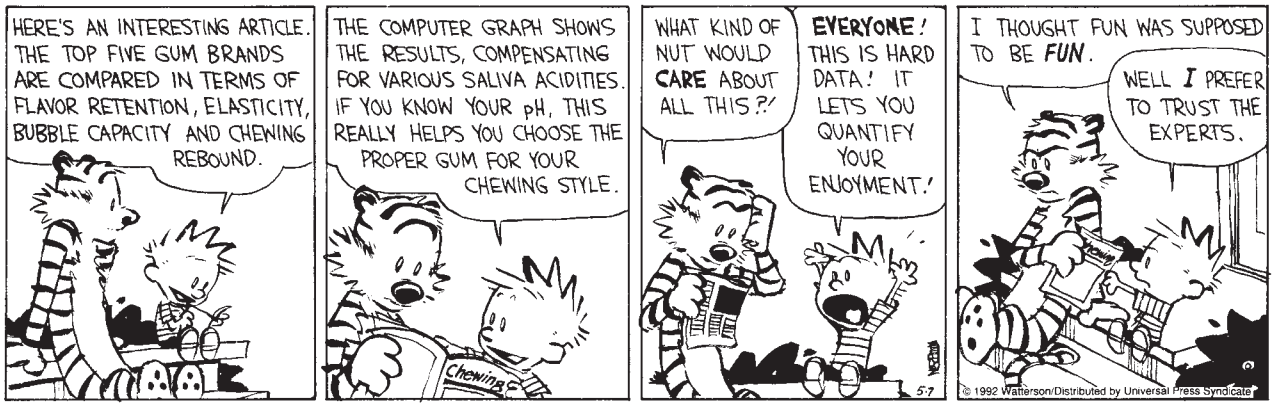

Figure 1.2 **In ways big and small, we often rely on authority for our knowledge.** ("Calvin and Hobbes" © 1992 Watterson/Dist. by Universal Press Syndicate. Reprinted with permission. All rights reserved.)

name it—for all sorts of knowledge (**Figure 1.2**). As a college student, you rely on authority when you acquire knowledge from your professors and textbooks. If you decide not to take a course from a particular instructor because a friend says "Don't do it, his lectures are really boring," then you've relied on your friend as an authority.

Of course, if you know your friend finds every course boring, then you may not give much weight to your friend's advice. You're also not likely to rely on your friend's opinions as to why you're feeling unusual illness or pain—at least, not unless your friend is a physician. Rather, we're more likely to rely on others for information when we perceive them as *credible*, and, in general, we are most likely to view someone as credible when the following are true:

- We believe that the person has expertise on the subject.
- We perceive the person as trustworthy.

Relying on authority can be highly efficient. It's how society passes down knowledge from one generation to the next, so that each new generation doesn't have to reinvent the wheel. Authority also has limitations and pitfalls. For one thing, experts may disagree. Second, even if they agree, it's still possible that they are wrong. This is what made the controversy over the three-door problem so fascinating. Many mathematicians and statisticians who wrote to vos Savant claimed she was wrong.

Authority's other pitfalls occur when we attribute expertise to sources that don't merit it or dismiss expert sources as being untrustworthy solely because their message contradicts our personal beliefs. Moreover, in this modern age when you can access the Internet, type in a few search terms, and instantly be linked to tons of information, there are additional dangers in uncritically relying on authority. First, people who are not experts can pass themselves off as ones and post inaccurate information or quack advice that readers accept as valid fact. Second, we can be swayed by quackery and nonsense even if a source claims no special expertise. For some people, just seeing information "on the web" or "on TV" may lead to an assumption that the information is accurate.

Given that we all rely on authority at times, how do we minimize these dangers? One key is to evaluate the source carefully, to try to assess the person's credentials. Another key is to think critically about the information itself. What evidence is provided to support the claim? Are there other explanations that could account for the evidence? We'll discuss critical thinking more fully later in the chapter.

REASON: RELYING ON LOGIC AND RATIONALITY

In everyday life the word *reason* has many meanings. As Peirce (1877) employed it, **reason** *rests on the use of logic and rational (i.e., intellectually sound) argument to reach a conclusion about how things "must be."* He focused on reason in the sense that many philosophers would try to resolve questions about the nature of reality through systems of logical argument. For example, his contemporaries would use reason to consider the question of whether the mind is an entity separate from the body.

The *Molyneux problem* provides another historical example of reliance on pure reason. Irish scientist William Molyneux (1656–1698) posed this problem to the famous English philosopher John Locke (1632–1704) over three centuries ago. Suppose that a man, blind from birth, can use his sense of touch to distinguish between a cube and a sphere of the same size. If this man suddenly regains his eyesight and is shown the cube and sphere, would he be able to tell by sight alone which object is which? At that time, in the absence of any known cases in which an adult regained vision after being born blind, the philosophical debate based on reason began and yielded opposing viewpoints. (To learn more about the history of this problem and "solutions" to it, see WebLink 1.2.)

WebLink 1.2
The Molyneux Problem

Logic and rational argument are integral to science, in the form of *reasoning*, the process of forming judgments (e.g., inferences, conclusions) based on facts or premises. Scientists use reasoning when they construct theories to account for known facts and when they derive hypotheses from theories in order to test those theories. But scientific knowledge is not based on the method of reason. The primary limitation of the method of reason is that different logical conclusions can be drawn depending on the premises one begins with. For example:

	1	2
Premise	Infants are not capable of understanding the concept of object permanence until they are 9 months old.	All infants understand the concept of object permanence by the time they are 7 months old.
Premise	Alice is a 7-month-old infant.	Alice is a 7-month-old infant.
Conclusion	Therefore, Alice is not capable of understanding the concept of object permanence.	Therefore, Alice understands the concept of object permanence.

Although opposite conclusions are reached, both conclusions are logically valid, given the starting assumption that their respective premises are true. But in reality, of course, both conclusions can't be true. Moreover, in the real world of human behavior, neither of the premises about infants' understanding of object permanence may be true. For example, the age at which children acquire an understanding of object permanence may vary from child to child. Perhaps it's the case that 70% of infants understand object permanence by 7 months of age. In that case we would have to phrase our conclusion in probabilistic terms: There is a 70% chance that Alice understands the concept of object permanence.

Pure reason is a poor basis for understanding behavior: It cannot establish the age at which children understand object permanence, nor the variability in their age of understanding. Nor can reason alone establish the functions of different brain structures, what type of psychotherapy is most effective for treating depression, or countless other answers about how we think, feel, and behave. What reason can provide, however, is absolute clarity about whether Sarah will be more likely to win the car if she stays or switches, or whether it's 50–50 regardless of what she does. That's because this problem is completely one of probabilities and logic. **Table 1.2** shows why Sarah is much better off switching.

Table 1.2 The Use of Reason: A Logical Analysis of All Possible Outcomes in the Three-Door Problem, When Initially Selecting Door 1

	Door 1	Door 2	Door 3	Outcome
Possibility 1	Car	Goat	Goat	If you stay, you win. Switch, you lose.
Possibility 2	Goat	Car	Goat	If you stay, you lose. Switch, you win.
Possibility 3	Goat	Goat	Car	If you stay, you lose. Switch, you win.

Analysis

(a) We begin with the premise that Sarah has chosen Door 1. You can apply the same analysis to any door that she initially chooses.

(b) All the game rules listed at the beginning of the chapter apply (see p. 2).

(c) There is a one-third probability that the car is behind Door 1, a one-third probability that it is behind Door 2, and a one-third probability that it is behind Door 3.

(d) Possibility 1: I show Sarah the goat behind one of the other doors (either Door 2 or Door 3). Sarah now chooses whether to switch to the other unopened door or stay with Door 1. If she switches, she loses the car. If she stays with Door 1, she wins the car.

(e) Possibility 2: I cannot show Sarah Door 1 (it's the door she picked) and I cannot show her Door 2 (it has the car behind it). Therefore, I must show her the goat behind Door 3. Sarah now chooses to switch doors or stay with Door 1. If she switches and takes the other unopened door (Door 2), she wins the car. If she stays with Door 1, she loses the car.

(f) Possibility 3: I cannot show Sarah Door 1 (it's the door she picked) and I cannot show her Door 3 (it has the car behind it). Therefore, I must show her the goat behind Door 2. Sarah now chooses to switch doors or stay with Door 1. If she switches and takes the other unopened door (Door 3), she wins the car. If she stays with Door 1, she loses the car.

(g) Conclusion: In two out of three possible cases—if the car randomly happens to be behind Door 2 or Door 3—Sarah will win the car if she switches doors. In only one out of the three possible cases—if the car randomly happens to be behind Door 1—Sarah will win if she sticks with Door 1. Her odds of winning are twice as great if she switches.

EMPIRICISM: KNOWLEDGE BASED ON EXPERIENCE

A great deal of what we know comes directly from our senses: from what we see, hear, touch, and so forth. *Knowledge based on the senses—on experiences with the world—is called* **empirical knowledge.** The related term, **empiricism,** *is the process of acquiring knowledge directly through observation and experience*. Empiricism also has another common meaning: *It is the philosophical viewpoint that all knowledge is derived from experience*.

As a method of acquiring knowledge, empiricism is a central building block of science. But especially in its raw personal form, as you and I learn about the world and form beliefs based on our direct experiences, empiricism has limitations and risks. First, no matter how full and varied our lives are, none of us experience everything. It's not likely that in my lifetime I will experience prolonged weightlessness from months spent in outer space or implement an educational antibullying program in an elementary school. Yet I can acquire knowledge about the bodily and psychological effects of prolonged weightlessness, and about the effectiveness of an antibullying program, by relying on authority in the form of accounts provided by credible experts (astronauts, researchers) who have had those experiences.

Second, our experiences may not be representative of other people's experiences or, more broadly, of the general state of affairs in the world. Based on differing interactions with a job supervisor, you and another employee may believe that she is a mean-spirited, poor leader, while the other 10 employees in your department may believe she is a kind, helpful, effective leader. Perhaps the supervisor has something against both of you or favors the other workers. No matter; if you assume that all your fellow employees feel the way you do, you'll be sorely mistaken. Their knowledge is different because they've had different experiences.

Third, even if our experiences are representative, we may interpret or remember them in a biased manner. Your supervisor may act fairly and consistently to all the employees, but you and your colleague might be hypersensitive to criticism. Therefore, you may interpret as criticism remarks made by the supervisor that most employees would interpret as constructive feedback. Moreover, in the month since you've arrived, perhaps there were times when your supervisor was genuinely helpful. But now, in thinking about the past month, you only make the effort to recall the instances of perceived criticism. Or you only talk about the supervisor with your one colleague who shares your opinion. Psychologists use the term **confirmation bias** (also called **congeniality bias**) to refer to *our tendency to selectively seek information that supports our views and avoid disconfirming information* (Hart et al., 2009).

In the three-door game, an empirical approach would be to play the game, or observe others playing it, and see what happens. So you observe Sarah playing: She stays with her original choice, and she wins the car. You observe three more contestants: One "stays" but doesn't win, one "switches" and wins, and one "switches" and loses. "OK," you say, "I was right after all: It's 50–50. Two people stayed, two people switched, and with each strategy one lost and one won." But though empirically based, this conclusion is flawed because it is based on only four observations, too few to establish a reliable pattern of results.

SCIENCE: RELYING ON SYSTEMATIC EMPIRICISM

Look in a good dictionary and you'll see science defined as a field of study, a body of knowledge, and a process for acquiring knowledge. In this present discussion, we are interested in the process of science. Broadly speaking, **science** *is a process of systematically gathering and evaluating empirical evidence to answer questions and test ideas.* The phrase "systematically gathering and evaluating empirical evidence," or *systematic empiricism* for short, reveals three important aspects of science. First, science relies on empirical evidence. Reason alone doesn't constitute sufficient evidence, nor do claims made by authorities without good empirical evidence to back up those assertions. Second, empirical evidence isn't gathered and interpreted haphazardly. Although informal observations often play a key role in triggering scientists' curiosity and lead to important questions and ideas, the evidence to answer those questions or test those ideas is gathered according to some system or plan. Third, collecting evidence without evaluating it and drawing conclusions won't get us far; we need to use *reasoning*. Reasoning plays a key role in science, both in evaluating evidence and in forming questions and ideas.

Our grand finale to the three-door problem nicely illustrates the value of systematic empiricism. Vos Savant (2006) reported that after publishing her initial answer to the three-door problem, she received thousands of letters from the general public. Of these, 92% stated that her advice to switch doors was wrong. Among letters from people at universities and colleges, 65% stated that she was wrong. Clearly, most people thought that on this issue, she was nuts. After a 1991 article in which vos Savant provided readers with a more detailed explanation of the logic behind her answer (see Table 1.2), there were still many doubters: 44% of the letters from the general public and 29% from people at academic institutions still contended she was wrong.

In that 1991 article, vos Savant (2006) also called upon her readers to perform a nationwide experiment to test the issue. She asked students in math classes across the country to simulate the three-door problem. Students were to pair up, with one member of each pair playing the role of the game show host and the other the role of the contestant, and follow a set of standardized procedures that she described. Each pair was asked to simulate 200 trials in which they adopted a "stay" strategy and 200 trials using a "switch" strategy, which would generate thousands of trials in each class. Many classes did this, and other people performed computer simulations. Vos Savant reported that among the letters she received from people who conducted the simulation "by hand," virtually 100% now believed that she was correct and that switching increased the odds of winning. Among people who simulated the game on a computer, 97% of them now believed she was correct. One scientist wrote:

> After considerable discussion and vacillation here at the Los Alamos National Laboratory, two of my colleagues independently programmed the problem, and in 1,000,000 trials, switching paid off 66.7% of the time. The total running time on the computer was less than one second. (DeVault, cited in vos Savant, 2006)

WebLink 1.3
Three-Door Problem Simulation

If you still doubt that switching doors is the best strategy, you can systematically gather your own evidence by going to WebLink 1.3.

CONCEPT CHECK 1.1 HOW DO WE KNOW?

Does each example below best illustrate reliance on tenacity, authority, reason, empiricism, or systematic empiricism as a way of knowing? Answers to Concept Check questions appear in Appendix D at the end of the book.

1. Trevor wants to buy a new smartphone, so he reads phone reviews by experts on cnet.com and endgadget.com.
2. Four-year-old Shonda has as a watercolor paint kit. She's curious about what color she will get if she mixes red and green paint, so she does it a few times to find out.
3. Claire takes her first multiple-choice test in junior high. When she gets it back, she pays attention only to the items she got wrong. She notices three questions for which she had initially chosen the correct answer but, after reconsidering, switched to a wrong answer. She fails to notice even more items for which she initially picked the wrong answer but switched to the correct answer. She concludes that "on multiple-choice tests, you should always stick with your first instinct."
4. In college, Claire learns that research consistently suggests the advice to "always stick with your first instinct on multiple-choice exams" is wrong. On average, when switching answers, students are more likely to change a wrong answer to a correct answer than vice versa. Claire rejects this and sticks with her "first-instinct" belief.

GOALS OF SCIENCE

Learning Objectives

After studying this section, you should be able to:

- Discuss four goals of science.
- Describe the concepts of distal and proximal causation as well as criteria for drawing a causal inference.
- Describe two contexts in which prediction and control are scientific goals.

Scientists seek to describe, explain, predict, and control events. Of these goals, description, explanation, and control are often considered to be the three fundamental objectives of science, with prediction (as we'll see) serving the goal of explanation.