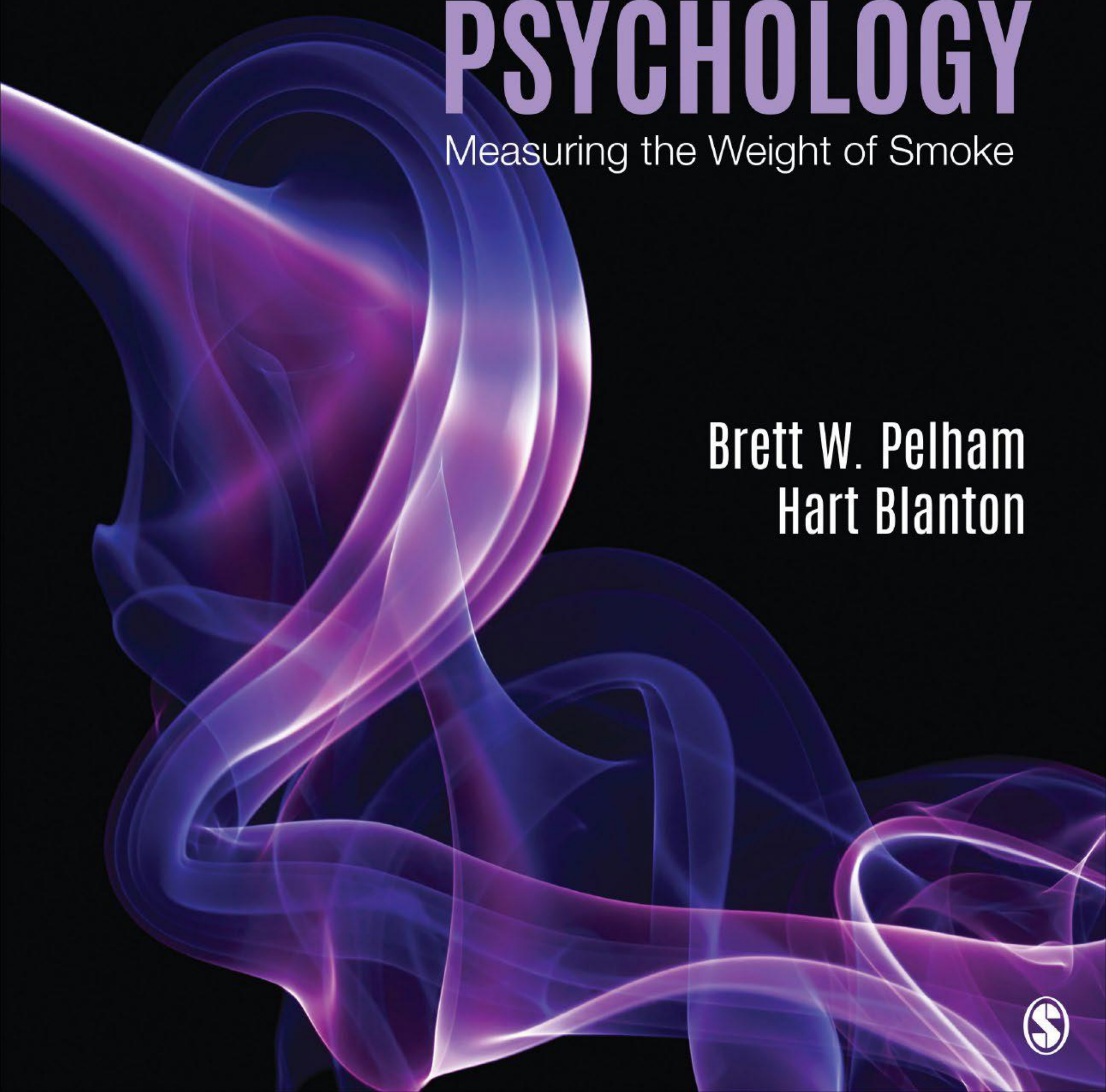
FIFTH EDITION

Conducting Research in PSYCHOLOGY

Measuring the Weight of Smoke



Brett W. Pelham
Hart Blanton

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Fifth Edition

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Fifth Edition

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PREFACE

Before you begin this book, we would like to make a simple observation: Most undergraduate students dread courses in research methods. This fact was brought home by one of our own students, who (as part of a class exercise) wrote that he anticipated that "few things could be more boring, useless, intimidating, or impenetrable than research methods." We find opinions such as this disturbing, not only because we each teach courses in research methods but also because we firmly believe that few things could be more interesting, useful, inviting, or intuitive than research methods. If this belief strikes you as strange, that is fine with us. However, we take it upon ourselves to convince you in this book that most students' dread of research methods has much more to do with how the topic is presented than with the nature of research methods.

To make this point in a different way, we suspect that, with a little effort, we could write a boring, useless, intimidating, and impenetrable book about such topics as skydiving, juggling, or romantic trysts. The key to doing so would be to focus heavily on the rules and technical details of skydiving, juggling, or trysting without much attention to the actual experience of these inherently interesting activities. Unfortunately, common approaches to research methods frequently focus too much on the rules and technical details. In our opinion, this is a major reason why research methods courses have such a bad reputation. In contrast, the approach we adopt in this book takes you behind the scenes of psychological research. In this text, of course, we do describe and explain the technical skills you need to conduct solid research. However, we also try to communicate some of the excitement and pleasure that comes from actually conducting research. Along the way, we point out many interesting and surprising things scientific research methods reveal about human nature. To these ends, we generally pursue a hands-on, common sense approach to research, supplementing lively examples and stories with hands-on exercises that will give you a sense of what it is like to conduct your own research. In summary, our approach to this book is based on two important premises. First, research methods become easy to understand when you can relate them to things that you already know. Second, research methods become interesting when you can use them to discover things you never would have known otherwise. Although the study of survey wording, experimental design, and inferential statistics can be made difficult and boring, they can also be made both interesting and informative.

Because we both happen to be social psychologists, another important aspect of this text is that we emphasize what is social about psychological research methods. Being a good experimental psychologist requires the use of the same methodological rules that apply to all other scientific disciplines. However, the fact that people are social beings generates some practical dilemmas that are not likely to plague researchers in astrophysics, metaphysics, or psychophysics (a branch of perceptual psychology). The most ubiquitous of these problems is that when people know that their behavior is being studied, they often behave unnaturally. The challenge of experimental psychology is to study "natural" behavior in unnatural (laboratory) situations. The clever solutions psychologists have developed to deal with this problem make experimental research methods in psychology a little different and arguably much more interesting than experimental research methods in general. Because of the human element in psychological research, good experimental psychology is not just good science; it is also good art. It takes a good scientist to generate precise tests of psychological theories, but it takes a good artist (and occasionally a good con artist) to translate these tests into laboratory experiences that are psychologically real to research participants.

NEW IN THE FIFTH EDITION

Now that this book is in its fifth edition, we'll avoid the temptation to review all of the many ways in which it has evolved over time. Instead, we'll focus mainly on the two most important revisions that we made to the fifth edition. In this fifth edition, we added two new chapters (and deleted one old one to make some room for the new ones). We added each of these new chapters (Chapters 3 and 4) to accommodate the needs of instructors who incorporate student research projects into their courses. When we've done that ourselves, we've always faced a dilemma. When we waited until students knew enough about research methods to have them start a research project, there was always very little left time for them to finish it (and then write a paper about it). When we required students to start planning and conducting a project very early in the term, they usually made many methodological mistakes they never would have made five or six weeks later.

The two new chapters are designed to avoid this dilemma by doing two things. The new Chapter 3 offers a conceptual overview of psychological research methods by spelling out the essential ingredients of good research—and by providing two simple rubrics (the *OOPS!* heuristic and the *GAGES* heuristic) for evaluating research. As far as we know, no other research methods text in psychology does anything like this. The new Chapter 4 provides a careful summary of the process of designing and carrying out research. For example, it includes the *IDEA* method for generating a good research idea, and it provides concrete tips for converting your idea into a testable hypothesis, for getting IRB approval and for data collection and analysis. Because these two new chapters provide students with easy-to-learn frameworks for critically analyzing research, they also promote critical thinking and methodological analysis in ways that can transform student learning.

Of course, we have also updated the other chapters and activities in this text to reflect the new framework we present in this fifth edition. Finally, because it has been seven years since we last updated the book, we have edited the entire book in ways that reflect recent developments in psychological science. For example, we have provided updated examples of contemporary research in nearly all of the previously existing chapters of the book. Finally, if you are an instructor who previously assigned the chapter we deleted, you will be happy to know that it is not gone forever. We have posted an updated version of the chapter on SAGE's web page. You can find it at study.sagepub.com/pelhamresearch.

ACKNOWLEDGMENTS

Marianne Taflinger, senior acquisitions editor at Brooks Cole Publishing, convinced Brett Pelham to write the first edition of this book. She continued to serve as a wise and encouraging editor for the second edition. Tracy DeHart also contributed in a myriad of ways to the second edition. The third edition benefited from the editorial guidance of Vicki Knight. The main editor of the fourth edition was Tim Mattray. In this fifth edition of the book, we have found a new home at SAGE publications, and we thank our editor Lara Parra for convincing us to come to SAGE and for helping us work through all aspects of the transition.

We also are indebted to the outside reviewers of the manuscript who have made many insightful and constructive suggestions that allowed us to improve the book. The reviewers of the first edition were: Bernard C. Beins, Ithaca College; Brian C. Cronk, Missouri Western State College; Joel S. Freund, University of Arkansas–Fayetteville; Thomas E. Nygren, Ohio State University; and Carl Scott, University of Saint Thomas. The reviewers of the second edition were: Janet Andrews, Vassar College; Wendy Francis, The University of Texas at El Paso; Matthew Johnson, Binghamton University, State University of New York; Doug Matheson, University of the Pacific; Dawn McBride, Illinois State University; and Celia Reaves, Monroe Community College. The reviewers of the third edition were: David Campbell, Humboldt State University; Jim Eck, Rollins College; David Haaga, American University; Steve Haase, Shippensburg University; Robert Hessling, University of Wisconsin–Milwaukee; Andy Karpinski, Temple University; Michael Mallen, Iowa State University; Dawn McBride, Illinois State University; Monisha Pasupathi, University of Utah; Kristen Salomon, University of South Florida; and Annette Taylor, University of San Diego.

Brett, the first author, also thanks his dad, who first taught him to be a critical thinker, and his mom, who first taught him to be patient with his dad. Brett also thanks Daniel McBrayer, Robert McCrae, David McKenzie, Dennis Selvidge, Julian Shand, and Edward Vatza, who taught him to love science. Brett also thanks his graduate advisers, Dan Gilbert and Bill Swann, who taught him to be a psychological scientist. The first author has learned about research methods from many other people since graduate school, and he has thanked many of them in previous editions of this text.

In the interest of space, however, he would like to offer only one more thank you in this fifth edition. I warmly thank the one person from whom I have learned more about psychological science than anyone else I've ever known—the brilliant and ever-thoughtful Curtis Hardin.

Hart, the second author, thanks the two undergraduate advisers who turned him into a budding psychologist: Caryn Carlson, who convinced an engineering dropout to try a different major, and Danny Axsom, who inspired Hart's love of social psychology. Hart also thanks the teachers of his graduate methods and statistics courses, Dale Miller and Debbie Prentice. Hart hopes that this book will reveal that he usually listened to their lectures, even though he showed no outward signs of having done so at the time. He also thanks his methodologically savvy postdoctoral advisers, Jenny Crocker, Meg Gerrard, and Rick Gibbons. Without them, Hart would have had to abandon psychology and become a miserable, bitter, and wealthy man. He also thanks Norbert Schwarz. Norbert invited Hart to team-teach a graduate course with him at the University of Michigan, and much of Hart's input for this book was inspired by Norbert's wise and thoughtful lectures. Hart also thanks his former colleague, current collaborator, and longtime friend, Jim Jaccard. Much of the wisdom in this text (Hart's part at least) was stolen directly from casual comments Jim Jaccard happened to make while in Hart's company. Finally, Hart joins Brett in tipping his cap to Curtis Hardin, who has been incredibly thoughtful and supportive to Hart at several key points in Hart's career.

A NOTE TO STUDENTS

For both aesthetic and pedagogic reasons, we do not include any definitions in the margins of this text. However, to help you identify crucially important theoretical and technical terms, these terms appear in boldface type (**like this**) throughout the text. In addition, when introducing crucial terms, we provide an explicit definition, description, or summary of the term in the text. These explicit definitions of key terms are summarized more formally in the glossary that appears at the end of the book. Theoretical and technical terms that are important but secondary to the crucial terms are typically printed in italics (*like this*), and they, too, are almost always accompanied by an explicit definition. Finally, to help you organize your knowledge of research methods, we have organized the material in each chapter using major and minor subheadings. Paying attention to these headings will help you organize your knowledge of the major themes in each chapter.

Brett W. Pelham
Hart Blanton

ABOUT THE AUTHORS

Brett W. Pelham grew up as the second of six children near the small town of Rossville, Georgia. Brett received his BS from Berry College in 1983 and received his PhD from the University of Texas at Austin in 1989. He wrote the first edition of this book while working as an associate professor at UCLA. After leaving UCLA to be closer to his family, he took a wide variety of jobs, and he eventually settled into a professorship in psychology at Montgomery College, Maryland. The bulk of his research focuses on social cognition, close relationships, gender, health, and the self-concept. He teaches courses in introductory psychology, social psychology, research methods, statistics, and human development. In his spare time, he enjoys spending time with his family. When not doing that, he enjoys cooking, doing construction and home repairs, drawing cartoons, juggling, listening to alternative rock music, and traveling. He recently completed a textbook *(Genes, Environments, and Time)* in evolutionary psychology, and he hopes that he will soon complete a textbook in introductory psychology.

Hart Blanton grew up as the second of three children in a small town in Appalachian Virginia. He is absolutely NOT a participant in any witness protection plans. Hart received his BA from Virginia Tech in 1990 and received his PhD from Princeton University in 1994. He worked on the second edition of this book while at SUNY, Albany, the third edition while at the University of North Carolina, Chapel Hill, and the fourth edition while at the University of Connecticut. He recently moved to the Communication Department at Texas A&M University. The bulk of his research is on social influence and social communication. He has taught courses in research methods, social psychology, statistics, the self, social comparison, and social influence. He has recently become interested in "negative psychology." This he conceptualizes as the formal study of social structural and individual emotional factors that lead people to die before their time. He hopes to finish his work on this new research area very quickly because, well, one never knows.

1

HOW DO WE KNOW?

For if we show that what follows from the thing in question is not the case, we shall have demolished the thing in question.

—Aristotle (in Barnes, 1984)

Thus I arrived, by the end of 1919, at the conclusion that the scientific attitude was the critical attitude, which did not look for verifications but for crucial tests; tests which could* refute *the theory being tested, though they could never establish it.

—Karl Popper (1974/1990)

INTRODUCTION: WHAT THIS TEXT IS ABOUT

It is said that in the late 16th century, Sir Walter Raleigh made a very audacious bet. In an effort to impress Queen Elizabeth I, he bet a young courtier that he could *measure the weight of smoke*. The courtier considered Sir Walter's claim ridiculous and eagerly accepted the bet. After establishing the details of the wager, Sir Walter produced two identical cigars and weighed them on a very precise scale. He then lit one of the two cigars and placed it back on the scale. After the cigar burned away, Sir Walter weighed the remaining ashes and announced that the weight of the smoke was to be found in the ashes. Specifically, it was the *difference* between the weight of the intact cigar and the weight of the ashes. The courtier had to agree and reluctantly paid the bet.

It is highly unlikely that this story is true. For one thing, when cigars aren't continually puffed on, they typically do not remain lit. For another, it wasn't until the late 18th century that Antoine Lavoisier demonstrated (by means of some very careful experiments) that the part of a burning object that seems to disappear when burned continues to exist but goes elsewhere (Harré, 1981). Although this story may not be very accurate, it is very scientific. For one thing, it illustrates that seemingly immeasurable things can sometimes be measured very well. For another, this story illustrates that it often takes a good deal of creativity—and a small leap of faith—to figure out *how* to measure the seemingly immeasurable. If Sir Walter Raleigh had actually made a bet about measuring the weight of smoke, he could have won the bet only if the young courtier possessed an intuitive appreciation of the law of conservation of matter. That is, Sir Walter's argument about the cigars is valid only if one takes it as a given that matter can neither be created nor destroyed.

In psychology, we are in the business of measuring things even more fleeting and ephemeral than smoke. The objects of our research attention are elusive concepts, such as passion, perception, prejudice, and persuasion. We cannot directly observe any of these psychological concepts, but we can often make reasonable inferences about them by making *indirect* observations. This is why, when asked what he does for a living, one of the authors sometimes tells people that he is in the business of measuring the weight of smoke. When asked what this book is about, we are tempted to give the same answer. It is about how to answer some elusive questions about people by making use of careful, albeit typically indirect, observations.

A FEW QUICK TIPS FOR USING THIS TEXT

Now that you know why we chose the subtitle for this text, we'd like to draw your attention to a few key features of the text—so that you can use it as wisely and efficiently as possible. Just as we have done in this chapter, we begin most chapters of the text with a story or anecdote that serves as a simile for getting a grasp of that particular chapter. A **simile** is a saying or description in which the communicator explicitly uses one concept to help people understand or appreciate another—typically by using words such as "like" or "as." A nice example of a simile is "This textbook is like an oasis in an intellectual desert." A not-so-nice example is "This textbook is like an anchor that is tied to my neck, while I struggle to remain afloat in a sea of despair." Incidentally, we are making such a big deal about similes for two reasons. The first reason is that in addition to opening most chapters with a simile, we also make liberal use of similes throughout the book—to make the point that many important methodological concepts have parallels in real life. The second reason we emphasize the word "simile" is that doing so allows us to define the word and thereby remind you of another important feature of this book that students sometimes overlook. Recall that when we introduce important terms, we always print them in **bold font** (as we did with the decidedly non-methodological word "simile"). We include a glossary of these terms at the end of the text, and we urge you to consult this glossary if you forget the meaning of an important term. At this point, the only other important thing you should know about this book is that we close each chapter with a brief summary to reinforce basic concepts and help you focus on the key themes of the chapter. In other words, we hope that each chapter summary will feel more like an oasis than an anchor.

PREAMBLE FOR CHAPTER 1

In this first chapter, we set the stage for the chapters that follow by familiarizing you, in both formal and informal ways, with the nature of the scientific method. We consider this a very important goal. By specifying the basic underpinnings of science, we hope to prepare you to think about psychology as an enterprise that is just as scientific as physics or chemistry. By showing how the basic underpinnings of science are reasonable and intuitive, we also hope to introduce you to the idea that you can translate your common sense—things that you know tacitly or implicitly—into formal knowledge of scientific research methods. Believe it or not, we introduce you to the basic principles of science by doing something that strongly resembles a palm reading.

Imagine that you now have in your hands the world's first custom-designed textbook. We wrote this particular version of the book with you and you alone in mind, tailoring the content and presentation to your own unique personality. As ridiculous as this may sound, try to keep an open mind while you read our professional evaluation of your personality:

> You feel good when other people like and admire you. However, you sometimes have a tendency to be self-critical. You have some personality weaknesses, but you are generally able to compensate for them. Though you try not to appear this way to others, you tend to be worrisome and insecure on the inside. You have a great deal of unused energy that you have not turned to your advantage. At times you have serious doubts about whether you have made the right decision or done the right thing. You prefer a certain amount of change and variety and become dissatisfied when hemmed in by restrictions and limitations. You pride yourself on being an independent thinker and do not accept other opinions without satisfactory proof. You have found it unwise to be too frank in revealing yourself to others. At times you are introverted, wary, and reserved; at other times you are extroverted, affable, and highly sociable. Though you have weaknesses that sometimes bother you, you have many talents and are above average at many things. Where character is concerned, two of your biggest strengths are your ability to get along with others and your self-insight. You have a clear and balanced sense of your strengths and weaknesses. Most of all, you rarely deceive yourself; you are in touch with the real you.

"I was hoping you could tell me something mildly favorable—yet vague enough to be believable."

You should now be having at least two reactions to this description. First, you should find it surprisingly accurate. Second, you should be curious to know *how* it could be so accurate. To address the second reaction first, what you have just read is a **Barnum description**, aptly named after the famous circus promoter P. T. Barnum. Like many psychics and astrologers, Barnum knew that most people readily confuse statements that are true of *people in general* with statements that are true of *them in particular* (see Forer, 1949; McKelvie, 1990). When Bui (1997) gave a description very much like this to undergraduates at UCLA, she found that the typical student reported that it was highly accurate. When asked how well this personality profile described them on a 9-point scale whose upper endpoint was labeled *extremely well*, the large majority of students responded with 7s, 8s, or 9s. (The mean was 7.5, and the most common response was 8.)

To appreciate how truly *un*informative a Barnum description really is, consider how you would have felt about the description if it had been a little more obvious that it describes virtually everybody: "You dislike being publicly humiliated, and you enjoy it when important people tell you that you are wonderful. You strongly prefer typing with your hands over typing with your feet. You hate waiting in long lines, having root canals, contracting serious illnesses, and getting into motor vehicle accidents. . . ."

But what do Barnum descriptions have to do with psychological research methods? For starters, your curiosity about the apparent accuracy of our original Barnum description is an example of your general curiosity about human nature. Nothing, absolutely nothing, is more interesting to people than people, and this has probably been true for as long as people have existed. For finishers, Barnum descriptions are also good reminders of the difference between intuitive and scientific ways of understanding behavior. More specifically, Barnum descriptions are not scientific. Instead, they closely resemble some of the earliest ways that human beings explained human behavior. To appreciate fully the kinds of explanations for human behavior that psychologists currently offer, one should place them in historical context. From this perspective, the story of how people's explanations for human behavior have changed over time is a story of great progress. It is also a testament to the power of systematic research methods to uncover truths that would be difficult if not impossible to uncover through intuition or casual observation. We hope that we will not sound overly enamored of scientific research methods if we say that the 100 or so years in which people have conducted systematic research on human behavior have taught us more than we learned in the hundreds of centuries that preceded the last 100 years.

A BRIEF HISTORY OF HUMAN KNOWLEDGE

Metaphysical Systems

The earliest explanations for human behavior (and for the physical world as well) appear to have been **metaphysical** or supernatural explanations. Metaphysical explanations are explanations that violate what scientists now consider to be established physical laws, primarily by attributing behavior or experiences to nonphysical forces, such as spirits or deities. The earliest category of metaphysical explanations for human behavior was probably **animism**, the belief that natural phenomena are alive and influence behavior. The common members of many prehistoric bands of hunter-gatherers, along with the distinguished members of many ancient civilizations, appear to have endorsed a wide variety of animistic beliefs. For example, a common belief among many ancient people was that possessing parts of certain animals (e.g., a buffalo's hide, an eagle's feathers) would endow the owner with some of the psychological properties of the animal in question. Similarly, among ancient people almost everywhere, natural phenomena, such as the wind, sun, and rain, were often assumed to have wills or temperaments. Even early scientists and philosophers sometimes explained natural phenomena in animistic terms. For example, Plato apparently believed that the universe was literally alive and had a soul at its center. According to at least some interpretations, Aristotle argued that gravity reflects the desire of physical objects to return to "mother earth" (Rensberger, 1986).

More subtle versions of animistic thinking appeared in Aristotle's analysis of human personality. In his *Physiognomics*, Aristotle heartily endorses the idea that people who possess the *physical* attributes of certain animals possess the habits and dispositions of those same animals. According to Aristotle, just as people with thick necks were strong in character and fierce tempered (like bulls), people with long, thin necks were backward and cowardly, like deer. Similarly, it seemed self-evident to Aristotle that "men with small *ears* have the disposition of monkeys" and that "those with large ears [have] the disposition of asses." And speaking of asses, Aristotle did not limit his analysis to facial features. He also argued that "*Buttocks* pointed and bony are a mark of strong character" and that curved toes and nails "on the evidence of birds with curved claws" are a sign of disrespect or rudeness (Aristotle, in Barnes, 1984). (Though we hate to quibble with Aristotle, we should note that we have never met a disrespectful sparrow.)

Animistic explanations such as these seem naive by today's standards, but the natural appeal of animistic and anthropomorphic explanations has not completely disappeared from modern thought. Any car lover who has ever assumed that his reliable old Dodge Dart will not be as good to its new owner as it was to him, any cat lover who has ever assumed that his tabby genuinely loves and admires him, and any PC lover who has ever commented that her aging laptop "is still thinking" about a command (or that her out-of-date software program "is temperamental") has engaged in highly animistic ways of thinking. In fact, researchers who appreciate our predisposition to infer that machines have wishes and dispositions have begun to capitalize on this predisposition to create user-friendly robots that can get people to trust them (e.g., see Brazeal, 2003). Furthermore, the specific knowledge of what physical, social, and emotional cues we use to make automatic inferences about the likeability or trustworthiness of a robot may play a role, for example, in how effectively robots can be used as tutors (Desteno, 2011, personal communication).

A second very old category of metaphysical explanations shares many of the features of animism but is still a potent force in the lives of millions of people everywhere. This second category of metaphysical explanations includes **mythology and religion**. In the United States, about 65 percent of adults say that religion is an important part of their daily lives. In less affluent countries, this figure is considerably higher. In both Sri Lanka and Bangladesh, for example, fully 99 percent of adults say that religion is an important part of their daily lives (Crabtree, 2010).

Mythological and religious systems make the assumption that deities (who exist in a spiritual rather than physical plane) play an important role in human behavior. Religious explanations for behavior are typically much more sophisticated and comprehensive than animistic explanations, but they share the basic assumption that nonphysical, even magical, forces determine much of what people do. We include religious systems in this historical sequence not because they are right or wrong relative to scientific explanations, but because they are different. Religious systems are built on a different set of assumptions than those upon which scientific systems are built (though scientists, too, make plenty of assumptions). As you will see later, religious and scientific systems of thought are also built upon very different sources of evidence. For now, it may be instructive to remember that, in addition to being an important part of the lives of people everywhere, religions are also systems of understanding and explaining human behavior.

A third very old category of metaphysical systems is **astrology**. Astrology appears to have been first practiced by the ancient Egyptians, who, like modern advocates of horoscopes, made the assumption that human behavior is determined by the activity of celestial bodies. An interesting aspect of astrology is that, despite its demotion to a form of entertainment for many, it does adopt some scientific practices in trying to explain human behavior. For example, serious astrologers are very focused on accuracy and precision in measurement. They believe that to give a person the most accurate astrological reading possible, it is necessary to know the exact year, month, day, and time of day of that person's birth, along with the exact latitude and longitude of the person's birth location (Candlish, 1990). Thus, according to *some* of the criteria of good science, astrologers are scientific in the same way astrophysicists are. Of course, according to many other criteria, they are the perfect model of decidedly *un*scientific ways of thinking. We will return to this topic later. For now, suffice it to say that metaphysical systems, such as animism, mythology, and astrology, were eventually abandoned by scientists in favor of explanations based on an entirely different approach to knowledge.

Philosophy

One of the earliest systems of thought to compete with metaphysical systems was **philosophy**. As it is practiced today, philosophy refers to the study of knowledge, behavior, and the nature of reality by making use of logic, intuition, and empirical observations. However, early philosophers often borrowed concepts from less scientific ways of thinking. Many early European philosophers worked hard to make sure that their ideas were consistent with the Bible or with the works of Aristotle or Plato—both of whom, as you may recall, endorsed some highly animistic beliefs. As late as the 17th century, the brilliant philosopher Descartes, who almost single-handedly transformed thinking about human behavior into a scientific enterprise, accepted the argument that nerves were hollow tubes through which "animal spirits" flowed to the brain. As philosophy matured, however, its practitioners increasingly came to rely on logic and empirical observation. Among contemporary philosophers, arguing for an idea or opinion solely on the basis of authority is considered a sign of weakness.

The focus on logic among philosophers had its roots in early Greek philosophers, such as Plato and Aristotle, and it has never really fallen out of favor. In contrast, the focus on empirical observation, though championed by Aristotle himself, never really caught on until the concept got a big jump-start from Descartes in the 1600s. After Descartes, the value of making empirical observations grew in popularity during the days of British empiricists, such as Locke, Hume, and Hartley. This principle reached its philosophical heyday after August Comte convinced most 19th-century philosophers that a comprehensive theory of knowledge and human behavior should follow the principle of **positivism** (Schultz, 1981). That is, it should be based only on observations that can be made with absolute certainty. By the middle of the 19th century, the concept of **empiricism**—the idea that the best way to learn about the world is to make observations—not only took a firm hold in philosophy but also became one of the core assumptions of the scientific method. Because psychology emerged as an independent field of study in the mid- to late 19th century and because it emerged partly in the wake of philosophy, it should come as no surprise that psychologists, especially experimental psychologists, place a great deal of stock in systematic observation. Before we discuss psychology, however, it is useful to remind ourselves that psychology owes only about half of its genealogy to philosophy. Psychology also grew out of physiology and the physical sciences.

Physiology and the Physical Sciences

Although philosophers believe in empirical observation, very few philosophers gather data to test their theories and hypotheses. Psychology probably owes its current emphasis on systematic observation to its roots in the physical sciences, especially **physiology**. Physiology is the study of the functions of and interrelations between different parts of the brain and body. Physiologists study topics as diverse as how voluntary and involuntary muscle tissues differ and whether different areas of the brain can perform the same basic cognitive or emotional functions. Virtually everything we know about physiology has been discovered using the experimental method. Before William Harvey's landmark experiments on the circulation of blood in 1628, scientists had little or no idea that blood is pumped throughout the body by the heart. Similarly, the tenacious belief that nerves were Lilliputian (i.e., tiny) pipelines for animal spirits was put to rest once and for all by means of the **experimental method**. A few simple experiments conducted by biologists like Luigi Galvani and Alessandro Volta demonstrated that an electrical rather than a spiritual charge must be applied to a frog's nerves to produce muscle movements. Finally, only when researchers began to experimentally destroy certain parts of the brains of animals were they able to determine that different areas of the brain performed different physical and psychological tasks. For example, Marshall Hall's experiments with decapitated animals in the early 1800s provided some of the first convincing evidence that reflex movements are determined by the spinal cord and not the brain. (We said that experimental physiology was enlightening, not that it was always beautiful to behold.) What a super genius like Descartes could never quite resolve in a lifetime of careful speculation, a regular genius like Volta all but proved with a battery and a single, freshly severed frog leg (see Asimov, 1964). And what Volta left unfinished, subsequent generations of smart folks with a little training in experimental physiology proved beyond the slightest doubt (Schultz, 1981).

We are making two distinct points. The first point is that the experimental method is a powerful way to answer research questions—whether they are physical questions about quantum mechanics or social psychological questions about Quattro mechanics. The second point is that experimental psychologists owe a great deal of what is good about their discipline to the traditions and methods developed and refined by physiologists and other physical scientists.

Now that we have paid some tribute to the metaphysicians, philosophers, and physiologists who preceded scientific psychology, let's take a brief look at the development of scientific psychology. Although it would be a mistake to equate science with experimentation (many scientific studies are not experiments), most historians of psychology would probably agree that psychology first became a science when psychologists first began to conduct experiments. Thus, we begin with an account of when psychologists first seized upon the experimental method.

Experimental Psychology

Most historians of psychology agree that experimental psychology was invented in Germany sometime around the mid- to late 1800s. The only point of disagreement is whether the German scientist who invented it was named Fechner, von Helmholtz, Weber, or Wundt.[1] Although most people have bestowed this honor on Wundt, one could easily make an argument for almost any of these visionary researchers. To a greater or lesser extent, they all studied perceptual and sensory processes in the mid- to late 1800s, and they all made use of experimental methods. However, Wundt was the most psychologically minded one in the bunch. His desire to break consciousness down into its component parts as well as his heavy emphasis on experimental methods reflected his extensive training in physiology. On the other hand, Wundt was also quite interested in higher-order mental processes. In fact, in one of his earliest and most important works (the *Beitrage*, published in 1862), he expressed a keen interest in creating a field he called *social psychology*, and he eventually published a ten-volume book entitled *Folk Psychology* between 1900 and 1920. Surprisingly, however, Wundt felt that the experimental method that was so crucial to understanding basic psychological experience was ill-suited to the study of complex cognitive and social processes. Of course, a major theme of this text is that nothing could be further from the truth.

In the past 140 years or so, **psychology** has become both decidedly experimental *and* decidedly scientific. In fact, like many other researchers, we define psychology as the scientific study of human behavior. That brief definition warrants an entire textbook on research methods because of the single word "scientific." In a nutshell, this book is about how to go about the business of psychology scientifically. Your brief foray into the history of how people have understood their physical and social worlds should have given you some appreciation for how scientific approaches to understanding human behavior differ from other approaches. To gain a fuller appreciation of what it means to study human behavior scientifically, it is probably useful to give some additional thought to exactly how scientists go about their business. The first thing to know about scientists is that, like pastors, politicians, and pastry chefs, scientists make some very important assumptions. Knowing what scientists take for granted can help make us better methodologists because many of the specific principles that are dear to the hearts of methodologists can be derived from the general principles that almost all scientists take for granted. Fundamental principles that are more or less accepted on faith are often referred to as **canons**. At least four such fundamental principles appear to be accepted by almost all scientists.

THE FOUR CANONS OF SCIENCE

Determinism

One hallmark of scientific thinking is the assumption of **determinism**. This is the doctrine that the universe is orderly—the idea that all events have meaningful, systematic causes. Even animistic and astrological systems of thought are partly deterministic. Astrologers appear to believe that something about the motions and positions of celestial bodies causes people to behave in certain predictable ways. They can't (or won't) tell us exactly what it is about Neptune's rising or Venus's falling that caused Serena to have bad luck last Wednesday, but it is presumably *something* systematic. Otherwise, why not assign people to astrological signs at random? Whereas there may be some deterministic slippage in astrological systems, there is no room for such slippage in science.[2] Some psychologists have even argued that people (and perhaps many other animals) are predisposed to think in causal terms. Whether or not we are predisposed to do so, plenty of evidence suggests that we are wont to do so. As an example of the power and utility of causal thinking, consider the following problem (adapted from Tversky & Kahneman, 1982):

A cab was involved in a hit-and-run accident at night. Two cab companies, the Green and the Blue, operate in the city. You are given the following data:

1. Eighty-five percent of the cabs in the city are Green and 15 percent are Blue.
2. A witness identified the cab as Blue.

The court tested the reliability of the witness under the same circumstances that existed on the night of the accident and concluded that the witness correctly identified each one of the two colors 80 percent of the time and failed 20 percent of the time. What is the probability that the cab involved in the accident was Blue? If you are like most people, your intuitions are telling you that it is about .80, which corresponds very well to the reliability of the witness. In numerous studies, this is exactly what Tversky and Kahneman (1982) found. The median (middle) and modal (most common) answer for a large group of participants was .80.

Now, if you can somehow cleanse your cognitive palate, consider a slightly different version of the same problem. In this version, you learn exactly what you learned above, except that the information about the cab companies is a little different. Specifically, replace statement (1) in the original problem with the following statement:

1b. Although the two companies are roughly equal in size, 85 percent of cab accidents in the city involve Green cabs, and 15 percent involve Blue cabs.

Now think again about the accident, the reliability of the witness, and the probability that the cab involved in the accident was Blue. What is this probability?

Although the correct answer hasn't changed, your intuitions about the answer may have. When Tversky and Kahneman gave this logically equivalent version of the problem to a different group of participants, the median answer changed to .60, which indicates that participants in this second group were making at least partial use of information about *base rates.* Base-rate information is information about the proportion of things in a target population—in this case, either the proportion of Green and Blue cabs in the city or the proportion of Green and Blue cabs involved in accidents.

The main point of the cab problem is that people find it easier to think in terms of causality than not. Thus, when you were provided with both base-rate information and some kind of subjectively useful competing information (in this case, a witness's report), you probably did not make very good use of the base-rate information. However, if you revised your answer downward once you realized that most accidents in this city are *caused* by Green cabs, you improved the accuracy of your judgment by being more sensitive than usual to base-rate information when it was expressed in causal terms (see Tversky & Kahneman, 1980, for additional evidence along these lines). The correct answer to the cab problem, by the way, is .41. In light of the facts that (a) Green cabs are 5.67 times as likely to be involved in accidents as are Blue cabs and (b) the witness's judgment was pretty poor (only 30 percent better than the chance performance level of 50 percent), you should have adjusted your answer *quite a bit* in the direction of Green cabs (see Tversky & Kahneman, 1982, for a more detailed explanation). The fact that most people come a lot closer to the correct answer when the base-rate information is framed in causal terms attests to the tendency that people prefer to think and are possibly predisposed to think in causal terms.

Further evidence that people may be predisposed to think in causal terms comes from research that deals more directly with how people perceive covariation. Consider the information about glorks and zarks presented in Table 1.1. Based on the information in this table, decide which of the two groups, zarks or glorks, you find more likable. Please make this judgment before you read any further! If you are like most people, you probably found the glorks at least a little more likable than the zarks. If you did in fact conclude that you'd prefer to invite a glork rather than a zark to your next dinner party, you probably fell prey to a common judgmental bias known as the **illusory correlation** (Hamilton & Gifford, 1976). In a number of judgment situations very much like this one, Hamilton and his colleagues found that people falsely infer a connection or correlation between group membership and the likelihood of engaging

Table 1.1 Prosocial and Antisocial Behavior of Zarks and Glorks

Group:	Who Harmed the Nems?	Who Helped the Nems?
Zarks:	T, a zark, harmed the nems.	E, a zark, helped the nems.
		N, a zark, helped the nems.
Glorks:	R, a glork, harmed the nems.	A, a glork, helped the nems.
	O, a glork, harmed the nems.	S, a glork, helped the nems.
		L, a glork, helped the nems.
		P, a glork, helped the nems.

in nice versus nasty behavior. More specifically, they typically judge small groups like the zarks to be less likable than large groups like the glorks.

If you were careful enough to resist the illusory correlation, consider the simple and highly concrete information that you see in Figure 1.1. Which of these obnoxious guys grabbed your attention? It's probably the same one that you're more likely to remember in ten minutes. The combination of statistical minority status and noteworthy (i.e., statistically unusual) behavior is very hard to resist.

The perceived correlation between group membership and likeability is referred to as illusory because in the preceding examples (and in many others like them), there is no connection between group membership and behavior. In the case of glorks and zarks, both groups are exactly twice as likely to help the nems as they are to harm them. There just happen to be twice as many glorks as zarks. If we consulted Tversky and Kahneman to help us describe this situation, they would probably remind us (a) that base rates for helping are twice as high as they are for harming, (b) that base rates for glorks are twice as high as they are for zarks, and (c) that in this case, there is no need to adjust anything for base rates—except perhaps in the sense that, in light of base rates, there is no reason to be impressed by the fact that four different glorks helped the nems. Helping is simply popular; glorks are simply populous.

Presumably, the fact that people often perceive connections where none truly exist plays an important role in the development and maintenance of stereotypes (see Hamilton & Rose, 1980). Did you notice, for example, that in most people's eyes, the statistical minority group (the much maligned zarks) was judged more harshly

Figure 1.1 Minority and majority faces. Which face will you remember best in a few minutes?

than the statistical majority? The well-established finding that people often perceive connections between things that aren't really connected also suggests that people may be a little too ready to see the world in terms of causes. If this is true, people do not appear to be alone in this tendency. Behaviorists who condition animals such as rats and pigeons have identified an animal analogue of this judgmental bias. More specifically, B. F. Skinner demonstrated that if you place an animal in a box and drop reinforcements in a food tray at random intervals (irrespective of what the animal is doing), the animal will often behave as if there is a contingency (i.e., a causal connection) between some behavior it may have spontaneously emitted during the "training" session and the delivery of the reinforcement. For example, if a pigeon happened to be standing on one foot prior to the (random) delivery of a food pellet, the pigeon might engage in this behavior several times again. Of course, if the pigeon does this long enough, another pellet will eventually be dropped into the food tray. The exact behavior that is "falsely conditioned" in this way will differ from one pigeon to the next, but conditioning will often occur nonetheless. Skinner (1948) referred to this false conditioning process as **superstitious conditioning**. At the risk of anthropomorphizing, the pigeon appears to have formed an illusory correlation between the arbitrarily produced behavior and the arbitrarily delivered food pellet. If pigeons could invite people to dinner parties, they too might prefer the company of glorks.[3]

The principle of determinism has a close corollary. This is the idea that science is about **theories**. A theory is simply a statement about the causal relation between two or more variables. It is typically stated in abstract terms, and it usually has some degree of empirical support (though many people would quibble with this final part of the definition). Theories wouldn't be very useful in the absence of determinism, because in the absence of determinism, orderly, systematic causes wouldn't exist. Although many people think of psychology as a "soft" science that may not be as theoretical as "hard" sciences, like physics or biology, theories play exactly the same role in psychology that they play in physics or biology. They identify abstract, hypothetical constructs that presumably tell us something about how the world operates. From this perspective, psychological constructs such as "relative deprivation" or "selective attention" are just as scientific as physical and biological constructs such as "relativity" or "natural selection" (see Hedges, 1987).

Just as laypeople tend to think deterministically, they also tend to think theoretically. Most people have well-elaborated "theories" about things as diverse as police officers, baseball games, and golden retrievers. Moreover, much like scientists, people often learn these theories from their ancestors, and they are often reluctant to part with them. Social psychologists have a host of terms for these naive (untrained) causal theories; they include terms such as causal schema, script, stereotype, self-concept, and working model. In fact, when Fritz Heider (1958) wanted to summarize the way in which common people understand their social worlds, he referred to people as "naive scientists." By this he meant that people have little or no formal training in explaining the social world but go about doing so in much the same way that scientists typically go about explaining the physical world.

In this regard, it could be argued that scientists are just as likely as laypeople to make assumptions about how the world works. Most scientists would probably like to think of themselves as completely fair and impartial, and in a sense, when practiced properly, science pursues fair and impartial answers to questions. But there is an important difference between a system that seeks impartiality and a system that is free of assumptions. Many scientists and philosophers have argued, in fact, that no form of knowledge can exist in the absence of assumptions. If one assumption is chief among those endorsed by scientists, it is probably the assumption that the universe is chock full of orderly causes (that are just waiting to be discovered by scientists who think themselves impartial). Scientists accept this canon largely on faith, in much the same way that a rabbi accepts the Torah largely on faith. To be anti-Torah in any serious way would probably mean being something other than a rabbi. Similarly, to be devoutly anti-deterministic would probably mean being something other than a scientist. However, being enamored of determinism isn't the only thing that makes a person a scientist. You probably need to believe in at least three other things if you want to be a card-carrying scientist.

Empiricism

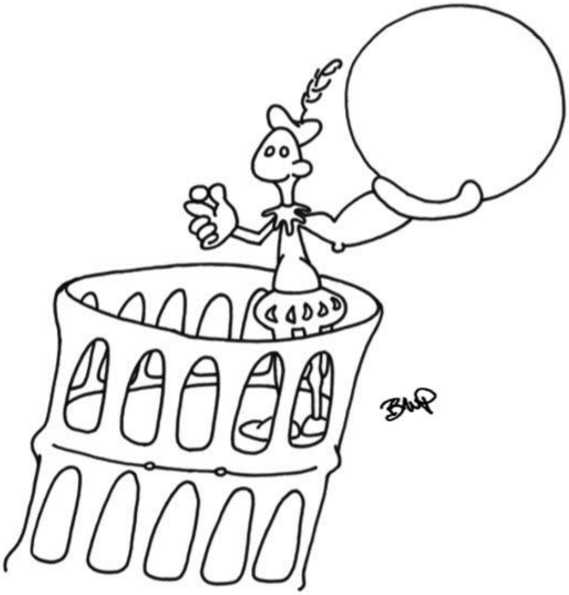
Scientists not only assume that the universe obeys orderly principles; they also assume that there are good and bad ways of *figuring out* these orderly principles. The best method, according to scientists, is to follow the canon of empiricism—that is, to make *observations.* Of course, you are already familiar with the concept of empiricism because, as we noted earlier, it is one of the favorite tools of modern philosophers. It is an even more highly favored tool of scientists, and psychologists are no exception. Like astrophysicists and psychophysicists, psychologists assume that the best way to find out how the world works is to make observations. It may seem patently obvious to you that making observations is a great way to find things out, but this is a relatively modern assumption—even among philosophers and scientists.

This point should be brought home for you anytime you hear someone use the phrase "I got it straight from the horse's mouth." What people typically appear to mean by this is "I got it straight from the source" (often an expert source)—meaning that they are reporting firsthand rather than secondhand information. Like many other common phrases, this one has been around for so long that it has come to take on a subtly different meaning from the one originally intended. Apparently, the phrase originated when a group of philosophers were debating the number of teeth that a horse should have (see Rensberger, 1986). We don't know exactly how many teeth a horse should have, and apparently the philosophers didn't either. If we may take a little creative license to re-enact this discussion, a biologically inclined philosopher may have argued that, as a member of the family *Equidae,* a horse should, like a quagga or a zebra, have exactly 34 teeth. A more theologically inclined philosopher may have retorted that, as a scripturally unclean, non-cloven-hoofed grazer, the horse should have fewer teeth than a cow and should therefore have somewhere in the neighborhood of 28 teeth. Of course, we have no idea *exactly* what logical or intuitive arguments the philosophers debated, but the point is that the debate was extremely long and extremely speculative. Eventually, one of the philosophers put an abrupt end to the debate by posing a simple but profound solution. He suggested that if everyone really wanted to know how many teeth a horse has, they should just go out, find a horse, look it in the mouth, and count its teeth (unless, perhaps, it proved to be a gift horse, but that's a different story). In other words, he suggested that *making an observation* is a good way to find things out about the world.

What horses think about while philosophers count teeth.

This second canon of science is probably the least controversial of the four. After all, throughout human history, there have been plenty of empiricists. As we noted earlier, one of the things that distinguished Aristotle from many of his contemporaries was his emphasis on systematic observation. Similarly, Galileo's biggest claim to fame is a legendary experiment in which he simultaneously dropped a heavy and a light cannonball from the Leaning Tower of Pisa. As the famous story goes, the two balls obligingly fell at precisely the same rate, invalidating the Aristotelian theory that the rate at which objects fall is directly proportional to their weight. This is an excellent example of Galileo's extreme faith in empiricism. However, this example has a serious problem. The problem is that Galileo *never performed* this celebrated experiment (see Asimov, 1964; Glenn, 1996; Rensberger, 1986). Moreover, the reason he never did so is quite interesting. Galileo *did* place a great deal of faith in empiricism. However, he apparently placed an even greater deal of faith in himself (or to be more precise, in his powers of reasoning). Galileo solved this gravitational puzzle logically, and then he *challenged his detractors* to perform the crucial experiment.

Galileo's logic took the form of a thought experiment that went something like this: Imagine that we held a heavy object directly underneath a light object and simultaneously dropped the two objects. According to Aristotle, the heavy object should outpace the light object in its descent toward the earth, leaving it behind. Fair enough. Now imagine that we reversed the situation by holding the light object directly *underneath* the heavy object before releasing them. According to Aristotle, the light object should actually slow the heavy object down! To Galileo this seemed ridiculous. By combining arguments such as these with some additional arguments about wind resistance, Galileo convinced himself that if one could eliminate the



problem of wind resistance, all objects would fall at the same rate. Apparently, Galileo convinced his detractors as well. When he challenged them to prove him wrong by performing the much-acclaimed experiment with cannonballs, they declined the invitation. The point is that Galileo was so confident of his prediction that he challenged *others* to test it empirically.

Because empiricism has become one of the guiding assumptions of modern science, you shouldn't be too surprised to learn that many other famous scientists have placed a great deal of faith in it. However, you might be at least a little surprised to learn that many laypeople and at least a few famous religious thinkers have also placed a great deal of stock in empiricism. For example, when someone says "the proof of the pudding is in the eating" or tells someone else to "put up or shut up," this person is expressing an intuitive appreciation of empiricism. Similarly, when the much-maligned "doubting Thomas" said that he could not truly believe that Jesus had risen from the dead unless he could be allowed, among other things, to place his finger in the holes in Jesus' hands, he was identifying himself as an empiricist. Of course, this hasn't done much for Thomas's popularity with followers of Christianity. For at least one famous Christian, however, preaching the merits of empiricism never caused much of a ruckus. When the apostle Paul wrote "faith without works is dead," part of what he appears to have been saying is that works count for something special because works, unlike faith, are readily observable. If Paul had been addressing a group of cooks rather than a group of disciples, he might have said that the proof of the pudding is in the eating. If he had been addressing a group of athletes or gamblers, he might have reminded them that talk is cheap and asked them to put up or shut up.

Parsimony

A third basic assumption of most scientific schools of thought is a sort of scientific tiebreaker. It is a pragmatic recommendation about the kind of theory or explanation that a good scientist should prefer. Virtually all scientists agree that if we are faced with two competing theories that do an equally good job of handling a set of empirical observations, we should prefer the simpler or more *parsimonious* of the two. As the word "parsimony" is commonly used by nonscientists, it refers to extreme stinginess or frugality. This is good to remember because the canon of **parsimony** says that we should be extremely frugal in developing (or choosing between) theories—by steering away from unnecessary concepts. Mechanics and engineers would probably appreciate parsimony because it is a sort of theoretical analogue of the mechanical idea that it is preferable to make machines that have the smallest possible number of moving parts (because this leaves fewer parts to break down).

Because people often confuse science with closely related fields like technology and higher mathematics, parsimony is probably the canon that is least consistent with most laypeople's intuitions about science. When people see a "scientific" figure or diagram that resembles the wiring schematic for a telephone dispatch system—full of circles, boxes, arrows, and cryptic labels—they tend to think "How scientific! I wish I could understand it!" The point of parsimony is that if something is good science you *should* be able to understand it. If forced to choose between two pretty good theories that both explain the results of your experiment, choose the one that your great-aunt Josephine will understand better. Unless your great-aunt Josephine is a retired electrical engineer, it will almost never be the one that looks like a wiring diagram. Arnold Buss (1988) has appropriately labeled the tendency for psychologists to be intrigued by models with lots of boxes and arrows "boxology." And he has noted that boxology is very *un*scientific—because it is very unparsimonious.

One of the first people to make a potent argument for parsimony was the medieval English philosopher William of Occam, and for this reason, the principle of parsimony is sometimes referred to as "Occam's razor." To paraphrase Occam, the principle of parsimony states that it is intellectually inappropriate to make more assumptions than you absolutely have to (Duffy, 1993). In the late 1800s, another famous Englishman, the animal psychologist C. Lloyd Morgan, made a very similar point. Morgan argued that we should avoid making too many assumptions when we try to understand the behavior of animals. He is best known for the version of this point that he emphasized in his debates with the famous animal psychologist George Romanes. Morgan was very frustrated with Romanes's elaborate (and typically anthropomorphic) explanations for animal behavior. For example, Romanes (1882) frequently assumed that animals possess complex ideas, engage in reasoning by analogy, and make use of the "logic of feelings" in pretty much the same way that human beings do (see Figure 1.2). Morgan's recommendation to animal psychologists was that whenever one can explain animal behavior in terms of simple mental activities, such as conditioned associations, it is inappropriate to explain these behaviors in terms of higher mental functioning. In the early days of scientific psychology, behaviorists such as John B. Watson and B. F. Skinner took "Lloyd Morgan's Canon" a step further by assuming that we should strive to explain human as well as animal behavior using a small set of relatively simple principles. From this perspective, Watson and Skinner were even bigger fans of parsimony than the two men whose names have become virtually synonymous with this basic tenet of science.[4]

At the risk of undermining our basic argument about the canon of parsimony, it is worth noting that it may not *always* be parsimonious to explain human and animal

Figure 1.2 At the time this photo was taken, Devon was a two-year-old housecat. In this series of photos, Devon is opening a door to get to some tuna the first author placed on the other side (and his housemate, Tasha, is capitalizing on his efforts). The animal psychologist George Romanes (1882, pp. 421–422) observed a cat very much like Devon and described the cat's behavior as follows: "Cats . . . have a very definite idea as to the mechanical properties of a door . . . First the animal must have observed that the door is opened by the hand grasping the handle and moving the latch. Next, she must reason . . . If a hand can do it, why not a paw?. . . . the pushing with the hind feet after depressing the latch must be due to adaptive reasoning." How parsimonious is this explanation?

behavior using different theories. In the case of explaining how a housecat opens a door, for example, we agree that it is inappropriate to assume that a cat's thoughts and feelings about doors are as complex as a carpenter's. But what if you were trying to explain why chimpanzees do some of the amazing things they do? For example, like people, chimpanzees easily learn to recognize themselves in mirrors. Chimpanzees also make and use tools, and they appear to engage in strategic deception as well as strategic cooperation. For instance, the Dutch primatologist DeWaal (1996) once observed an amorous but low-ranking male chimpanzee display his erect penis to a desirable female (to protect the chimp's identity we'll call him C. H.). C. H. expressed his affection for this beautiful female chimp by simply facing her, sitting upright, and spreading his legs. However, when the alpha male in this troop wandered by, C. H. quickly and strategically placed his hand over his penis—and casually looked away. Is it more parsimonious to explain this behavioral sequence using the principles of operant conditioning or to describe it using words such as fear, jealousy, and deception? Considering the fact that chimpanzees share about 98 percent of their genetic information with human beings (Diamond, 1992), DeWaal suggests that it would sometimes be more parsimonious to explain similar behaviors in human beings and chimpanzees using a single theory rather than two completely different theories. This controversial example should illustrate that whereas there is a great deal of consensus concerning the basic canons of science, there is somewhat less consensus regarding exactly how and when to apply these canons.

A final perspective on parsimony is to consider it an extension of the idea that science is a very theoretical enterprise. One of the most important things a good scientific theory does in the first place is to simplify and organize a great number of otherwise disparate observations—by tying them together into some kind of coherent causal story. A good theory about why people fall in love, for example, can simplify and organize a great number of otherwise unrelated observations about romantic attraction. The idea behind parsimony is that as long as we are at the business of simplifying and organizing, we might as well *keep* at it until we have made things as simple as possible. When it comes to scientific journeys, most scientists believe in traveling light.

Testability

The final and perhaps the most important canon of science is the assumption that scientific theories should be testable (confirmable or disconfirmable) using currently available research techniques. The canon of **testability** is closely related to the canon of empiricism because the techniques that scientists typically use to test their theories are *empirical* techniques. It is hard to be a believer in empiricism without also being a believer in testability (and even harder to be a believer in testability without also being a believer in empiricism). After all, empirical tests of an idea often reveal that the idea is not as correct as its proponents had originally assumed. In addition to being closely related to the canon of empiricism, the concept of testability is even more closely associated with the more specific philosophy of **falsifiability**. The idea behind falsifiability is that scientists should go a step beyond putting their theories to some kind of test by actively seeking out tests that could prove their theories *wrong* (see Abramson, 1992). During the period of tremendous scientific advancement that occurred in the early to middle part of the 20th century, Karl Popper became very famous for espousing this idea.

During his youth, Popper had been an ardent devotee of Marxism, but as he thought about how Marxism compared with some alternate schools of thought, he began to realize that most Marxists accepted Marxist doctrines uncritically—going about their lives as if all the predictions of Marxism were self-evident truths. His feeling was that if he were to devote himself to a school of thought, it would have to be one that could survive some kind of critical test.

In the early portion of his book *Unended Quest*, Popper (1974/1990) described his conversion to a philosophical and scientific school of thought known as **logical positivism**. Logical positivists believe that science and philosophy should be based solely on things that can be observed with absolute certainty. Many of them also believe that the way to go about testing scientific theories and hypotheses is to actively try to disconfirm them. Popper (1974/1990) described a crucial step in his conversion to this critical school of thought by explaining his delight at the way Einstein wrote about his general theory of relativity:

> But what impressed me most was Einstein's own clear statement that he would regard his theory as untenable if it should fail in certain tests. Thus he wrote, for example: "If the red-shift of spectral lines due to the gravitational potential should not exist, then the general theory of relativity will be untenable." . . . This, I felt, was the true scientific attitude.

Among psychologists, concepts such as testability and falsifiability are extremely important because many early psychological theories (e.g., the work of Freud and other psychoanalysts) were difficult to put to any kind of objective test. Prominent behaviorists such as E. C. Tolman and Clark Hull improved this state of affairs when they followed the example of many physicists and popularized the idea of operationism or **operational definitions**. Operational definitions are definitions of theoretical constructs that are stated in terms of concrete, observable procedures. It is a thorn in the flesh of psychologists that much of what we wish to understand (e.g., hunger, fear, attention, prejudice, etc.) is not directly observable. Operational definitions solve this problem by connecting unobservable traits or experiences to things that *can* be observed. For example, researchers such as Tolman and Hull operationally defined hunger in terms of hours of food deprivation or proportion of normal body weight after extended food deprivation

(Schultz, 1981). Unlike the nebulous experience of hunger, things like time and weight can be readily observed or measured. Of course, there is no way to know with absolute certainty that a rat (or a person) that hasn't eaten in two days is experiencing hunger, but it is an extremely reasonable assumption. More important, it is an assumption that makes theories involving internal states such as hunger the objects of empirical investigation.

Operational definitions also lend themselves well to precise quantification. An elephant that hasn't eaten in 48 hours should be somewhat hungrier than one that hasn't eaten for 36 and should be much, much hungrier than an elephant that has just eaten. It would be highly presumptuous to assume that an elephant that hasn't eaten for 48 hours is *twice* as hungry as an elephant that hasn't eaten for 24 hours, but if we plot hours of food deprivation against a quantitative, operationally defined measure of learning (e.g., the number of wrong turns taken prior to reaching a goal box in an enormous maze), we can begin to say something precise about how hunger relates to learning in elephants. And if we are in the business of theory testing, we might be able to say that a particular theory of hunger and learning is in need of revision.

Operational definitions are so much a part of scientific ways of thinking that most modern scientists probably take them for granted. However, if we define both science and operational definitions pretty loosely, it could be argued that operational definitions have been around as long as science has. A case in point has to do with an operational definition of intelligence that was (somewhat begrudgingly) adopted by the Greek philosopher-scientist Thales. Thales was one of the first people recorded in history to address questions about the basic nature of the universe without falling back on magical or metaphysical explanations. Although Thales cared little for money, he apparently cared a great deal about being viewed as intelligent. After becoming legendary for his intellect, Thales was apparently insulted by jealous critics who asked him (if we may translate loosely from the Greek), "If you're so smart, why ain't you rich?" In short, Thales found himself oppressed by a questionable operational definition of intelligence that he himself probably did not endorse. Though he may have cared little about money, Thales apparently cared enough about his reputation for being smart that he decided to play by the rules of his critics. Thales happened to have an excellent understanding of weather, and according to Asimov (1964), he responded to his jealous critics by buying up olive presses in a year in which his meteorological observations told him it would be an excellent year for olives. During that year's bountiful olive harvest, Thales charged bountiful rates for the use of his olive presses. Thales thus became an instant olive oil baron and having met the critics' operational definition of intelligence, went back to his genteel life as an intellect.

The fact that psychologists must rely so heavily on operational definitions points to an uncomfortable fact about our discipline. We cannot ever directly observe internal psychological states such as hunger, anger, or frustration. This does not mean, however, that psychology is not a science. After all, astronomers cannot directly observe black holes, and physicists cannot directly observe the tiniest subatomic particles. Like psychological scientists, physical scientists appreciate the fact that operational definitions make the unobservable observable. To some degree, laypeople also appreciate this fact. Long before Tolman and Hull were imploring their fellow psychologists to convert the unobservable into the observable, rabbis and referees were doing much the same thing—and for much the same reason. They wanted observable answers to important but elusive questions having to do with things like the will of God or the relative skill of two soccer teams. In the case of religious figures, ancient Jewish prophets, when faced with difficult decisions about the will of God, used to place "prayer cloths" on the ground around dusk and consult these cloths the next morning to ascertain what they assumed were God's wishes. Most frequently, the presence or absence of dew on the cloth would be taken to indicate which of two potential courses of action was to be taken. Of course, prophets who made use of such prayer cloths were making some pretty big assumptions about the connection between dew and their chosen deity, but the issue is not that they did or didn't make good decisions this way. It is that even people with no training in scientific methods can appreciate the logic of operational definitions.

Most sports and games provide more familiar examples of operational definitions. In fact, to our knowledge, there is no such thing as a competitive sport or game that does not make use of operational definitions. In basketball, for example, the operational definition of scoring a basket is propelling the ball from a legal position on the court so that it falls downward through a metal hoop that is suspended ten feet in the air on some kind of backboard. Nothing else players do, no matter how spectacularly athletic, will score a basket for their team. Of course, the ability to do this while following all the other rules of the game is one good, solid indicator of the abstract, hypothetical construct most people call basketball-playing ability. To appreciate the utility of operational definitions, imagine trying to play a complex game like basketball, football, or chess *without* operational definitions. It is hard to know how winners and losers would be decided, and it is quite possible that there would never *be* any losers. If we asked the members of opposing baseball teams to introspect on their skills and decide who should be declared victorious, we strongly suspect that both teams would typically decide that they were superior. Operational definitions play a similar role in science. If we simply asked proponents of a theory what they think of their theory's chances of being correct, we would find that very few theories ever got disconfirmed.

Because operational definitions are so important, it is useful to consider some concrete examples. Table 1.2 summarizes at least two distinct ways in which psychologists might operationally define constructs as varied as cognitive load and interpersonal attraction. Whereas no one way of operationalizing any of these constructs is perfect, they all share the positive trait of making abstract hypothetical concepts measurable (and thus testable). To flesh out one of these examples in more detail, consider the two operational definitions of "memory." The first definition, the number of words from a list that a participant can recall after a delay, is very intuitive. If we want to know how well you learned the words in a list, we can simply ask you to recall the words and count up the number of words you listed correctly. However, unless you happen to know a lot about memory, the second definition, the specific word a participant makes when presented with a word fragment such as "ele______," may not make much sense. How could you test people's memory by asking them to complete a word fragment?

Let's begin by considering how *you* completed this word fragment. What was the very first word that came to mind for you? If you made the word "elephant," we suspect it is because you were exposed to this word a few minutes ago—when you were reading about operational definitions of hunger. If we hadn't mentioned elephants in this example (or if you had just taken the *elevator* from your *elementary* calculus class on the *eleventh* floor), we suspect that you'd be way more likely to have made a different word.

As it turns out, word fragment tasks are excellent measures of certain kinds of memory. When a person cannot recall a specific word but this word nonetheless influences how the person completes a word fragment task (or some other cognitive task), memory researchers would say that the person has an implicit (i.e., unconscious)

Table 1.2 Some Abstract Psychological Concepts and Some Potential Operational Definitions for Them

Concept	Operational Definition
Depression	Total number of symptoms a person reports having experienced (e.g., fatigue, difficulty concentrating, loss of appetite, sleep disturbance) in a structured interview A person's true–false responses to an anonymous, 20-item pencil-and-paper survey (e.g., "During the past four weeks, I have had serious thoughts of harming myself.")
Cognitive load	Whether participants are given five seconds or 50 seconds to estimate the answer to a problem Whether participants are instructed to keep a running total of a series of one-digit numbers that appear in the center of a computer screen (while they are listening to a story)
Attraction	How close participants sit next to a confederate who is always seated at the end of a row of chairs Whether a person is married to someone
Memory	The number of words from a list a participant can recall after a delay The specific word a participant makes when presented with a word fragment such as "ele__________"

memory for the word (Schacter, 1996). To frame this a little differently, everyone knows that people can sometimes *recognize* words that they cannot *recall.* Measures of recognition memory (e.g., "Did you see the word 'apple'?") are often more sensitive than measures of recall memory (e.g., "List all the words you can remember."). Memory researchers happen to know that word fragment measures are sometimes even more sensitive than measures of recognition. Having a cool operational definition can sometimes allow researchers to learn things they never could have learned without it. Judging from research using measures of implicit memory, we have learned that people sometimes "know" things that they themselves do not realize.

Speaking of memory, you may recall that we said operational definitions are important because they make theories testable or disconfirmable. What, exactly, makes a theory disconfirmable? In addition to operational definitions, things like clear and parsimonious statements of what the theory predicts can make a theory disconfirmable. One additional thing to keep in mind is that testability and disconfirmability refer as much to the attitude of a theory's proponents as they do to the nature of a theory itself. For example, very few voters would consider conducting an experiment to decide whether to become a Republican or a Democrat. Similarly, if Zeke tells you that there is no kind of empirical evidence that could persuade him to change his opinion of shellfish or Zen Buddhism, you can be pretty sure that he did not arrive at his opinions scientifically. Thus, the cornerstone of the scientific perspective is openness to criticism and revision. In fact, Popper has argued that openness to criticism and revision rather than the use of any specific methods or procedures is what makes a field of study scientific (Popper, 1974/1990). The degree to which a belief system is open to revision is an important determinant of the kinds of evidence or support that advocates of the belief system are typically most interested in scrutinizing. For example, scientists place very little stock in authority, but popes and presidents typically consider authority to be the bottom line. To gain a final bit of perspective on how scientific belief systems differ from other common belief systems, it is useful to consider four different kinds of support for beliefs and see how advocates of the different belief systems typically view each kind of support.

FOUR WAYS OF KNOWING ABOUT THE WORLD

One of the best ways to learn about a person's thinking style is to ask a difficult question and then ask the person to explain how he or she arrived at the answer. For example, consider the proposal that there is a gravitational attraction between the tip of your left thumbnail and the planet Pluto. Is there? Use any reasonable method that is currently at your disposal, but do not read any further until you have come up with an answer.

If you guessed that there is no such attraction, you might have come to this conclusion in several different ways. First of all, your **intuition** may have simply told you that such an idea seems far-fetched. Second, you may have tried to make use of **logic**, reasoning that if the tip of your left thumbnail were attracted to things as bizarre and distant as the planet Pluto, then you'd have some noticeable difficulties keeping it in your possession. Though it is less likely, you may have also consulted some sort of **authority** figure. If your roommate, the physics major, was handy when you were reading this question, you may have simply asked him or her for the answer to the question. Finally, although it would have been desirable to do so, it is extremely unlikely that you made any kind of empirical **observation** to test this idea because doing so would be virtually impossible. The correct answer, by the way, is that there is indeed a gravitational attraction between the tip of your left thumbnail and the planet Pluto. The universal law of gravitation states (and empirical research has thus far confirmed) that there is a gravitational attraction between all the matter in the universe. One reason you are at little risk of having a tiny piece of your thumbnail wrenched from your thumb in a meteoric descent toward Pluto is that gravitational attraction falls off as a squared function of the distance between the objects in question. As long as you stay close to Earth and far away from other celestial bodies, you will save a lot of money on manicures.

As far as we can tell, the four methods of "knowing" you may have consulted when trying to answer this question—namely, authority, intuition, logic, and observation—come pretty close to exhausting all the basic ways in which people decide what they believe. Although each of these ways of knowing plays a role in almost all kinds of belief systems, the relative emphasis placed on each varies dramatically from one belief system to the next. Consider authority. Authority refers to status or prestige, typically based on things like expertise or legitimately acquired power. Laypeople appear to place a great deal of emphasis on authority or expertise when making day-to-day decisions. In fact, the tendency to do so is prevalent enough that it has been labeled the *expertise heuristic* by researchers who study attitudes and persuasion (e.g., see Chaiken, Liberman, & Eagly, 1989; Hovland & Weiss, 1951; Petty & Cacioppo, 1986; Smith & Mackie, 2007). Whereas scientists and philosophers claim to place little stock in authority, believers in virtually all governments or religions consider authority (e.g., the president, the Buddha, the Torah, the Constitution) the final word on many important beliefs and decisions.

Governments and religions are also similar in that both systems appear to consider intuition an important way of understanding the world. The U.S. Declaration of Independence makes the bold, intuitively appealing statement, "We hold these truths to be self-evident . . ." As another example, most religions and governments take the intuitively appealing position that people are free to make all their own choices in life. Many philosophical and scientific views call this intuitive claim into question because it is potentially at odds with the canon of determinism (see Skinner, 1971).

Debates about topics like freedom versus determinism, which have taken on great importance among philosophers and scientists, are not nearly so important to ministers and prime ministers. One reason this is true is that religious and political thinkers place great faith in intuition. In contrast, scientists and philosophers place greater faith in logic and may become deeply troubled by logical paradoxes. Politicians are more likely to put paradoxes to a vote. Ministers are more likely to leave them in the hands of a higher power.

Although the typical scientist and the typical philosopher might both prefer logical rather than intuitive solutions to a debate, scientists and philosophers differ somewhat in the relative emphasis they place on logic. To the typical philosopher, logic is likely to take preeminence even over observation as the touchstone against which all other things are judged. Philosophers as a group devote an enormous amount of their intellectual efforts to discerning the correct and incorrect rules of reasoning (Copi, 1978). Philosophers seem to have learned that they cannot always believe their eyes. To the typical scientist, logic can be incontrovertible, but it can also be impenetrable—and thus take a back seat to observation as the primary mode of figuring out the world. Whereas the philosopher finds comfort in the use of contrapositives, the scientist finds more comfort in the use of counterbalancing. Scientists prefer experimentation over argumentation.

The relative importance of authority, intuition, logic, and observation for religion, government, philosophy, and science is shown in Table 1.3. Although it is possible to quibble with the exact rankings, a gross analysis of the table should clarify an important distinction between scientific and nonscientific belief systems. Scientists and nonscientists prefer different ways of knowing about the world.

Three additional notes are in order about the four ways of knowing. The first note is that there is no guarantee that one way of knowing will be superior to others across all possible situations. Observation compels scientists to create particle accelerators; intuition compels people to create families, sculptures, and governments.

Table 1.3 Relative Importance of Different Ways of Knowing to Different Belief Systems

Religion	Government	Philosophy	Science
authority	authority	logic	observation
intuition	intuition	observation	logic
logic	logic	intuition	intuition
observation	observation	authority	authority

Note: Rank orderings are from (1) most to (4) least important.

If the Declaration of Independence had been written by political scientists rather than politicians (e.g., "Recent research in public policy suggests a number of useful generalizations about self-governance. . . ."), we suspect that it would have generated a bit less enthusiasm among colonists struggling with their allegiances to the British Crown.

The second note is that Table 1.3 describes the ways in which science is *supposed* to be carried out. Because scientists are human beings, they sometimes fall back on other ways of knowing that do not represent the ideals of the discipline. For instance, because scientists often share the same powerful intuitions as laypeople, they sometimes rely on their intuitions when they should not. As an example, clinical psychologists once believed that they could make solid inferences about a person's character or mental health by using the "Draw-A-Person" test. Patients who drew figures that had large eyes, for example, were thought to be paranoid or delusional. As it turns out, this is not the case. Thus, when clinicians were kept blind to a person's diagnostic status, they could not rely on a person's responses to the Draw-A-Person test to determine who did or did not suffer from schizophrenia. In the case of this particular projective test, scientists and laypeople alike shared some powerful intuitions about how the features in a drawing might reflect the psychopathology of the artist. These intuitions led at least a few clinically inclined researchers down some blind alleys. In other words, intuition probably plays a slightly bigger role in the day-to-day business of science than it ideally should. At times, scientists also rely more heavily on authority than they would probably like to admit. When ideas are proposed by well-known researchers or published in highly prestigious journals, they are usually accepted more readily than they might be otherwise. Thus, a young researcher who writes a paper challenging the validity of Dr. Bogg's Draw-A-Person test might have trouble getting this piece into a high-prestige journal. When his criticism subsequently appears in a lower-prestige journal, other researchers might at first infer that the criticism in the article is not valid. Although inappropriate reliance on intuition or authority sometimes gets scientists in trouble, scientists hold the view that facts eventually will win out. Thus, bad ideas should have a relatively short "shelf life" in the literature.

The third additional note about the ways of knowing is that different ways of knowing summarized here are convenient simplifications. In fact, true genius often consists of finding the balance between different ways of understanding the world. For instance, Thomas Jefferson was a scientist as well as a politician, and his scientific side often influenced his political arguments. Unlike many of his contemporaries, for example, Jefferson argued that systems of government, like scientific theories, should change with the times on the basis of new evidence. When asked, in 1816, whether the Virginia constitution should be revised, Jefferson remarked:

> I am certainly not an advocate for frequent and untried changes in laws and constitutions. . . . But I know also, that laws and institutions must go hand in hand with the progress of the human mind. As that becomes more developed, more enlightened, as new discoveries are made, new truths disclosed, and

manners and opinions change with the change of circumstances, institutions must advance also, and keep pace with the times. We might as well require a man to wear still the coat which fitted him when a boy, as civilized society to remain ever under the regimen of their barbarous ancestors.

(Letter to Samuel Kercheval, July 12, 1816)

Good thinkers rarely limit themselves to a single way of understanding the world. As a very different example, when Galileo finally got around to doing some empirical studies of gravity, he was plagued by the inaccuracies of the current technology of measurement. Instead of waiting a couple of hundred years for the invention of a good stopwatch, he slowed things down by studying the behavior of bodies *rolling down inclined planes* (Asimov, 1964; Harré, 1981). By doing so, Galileo was able to demonstrate quite convincingly that heavy and light objects "fell" at the same rate. In addition, he was able to show something more subtle and perhaps more important. Things don't simply fall at a constant rate: they constantly accelerate. Of course, accepting Galileo's conclusions requires us to make some logical inferences about the compatibility of rolling and falling, but this is exactly the point. Galileo was not simply a good logician or a good observer. One of his unique talents was his ability to blend logic and observation into a seamless set of arguments that could knock someone's socks off (and predict how quickly they would fall to the floor).

To further your appreciation of the four ways of knowing, we draw your attention to Appendix 1. Hands-On Activity 1, Galileo's Dice, presents a class exercise that can help you better understand the distinctions between these approaches to knowledge and their relative strengths and weaknesses.

SUMMARY

Human beings attempt to understand the physical and psychological world in many ways. Throughout history humans have tried to understand their world by such means as animism, mythology, and philosophy. By comparing these different ways of understanding the world, we can see how psychology evolved out of such disciplines as philosophy and physiology. The four canons of science, that is the four basic assumptions about the world that virtually all scientists take as a given, are determinism, empiricism, parsimony, and testability. The four distinct "ways of knowing," that is, four ways of trying to figure out what the world is like, are intuition, logic, authority, and observation. Whereas political and religious systems place great emphasis on authority and intuition as ways of knowing, scientific systems place more stock in logic and observation. This explains, for instance, why scientific beliefs are revised much more frequently than religious beliefs. Although the basic rules of science are highly stable, this stable system of methods and procedures facilitates the revision of beliefs based on new observations and discoveries.

STUDY QUESTIONS

What are positivism and empiricism? Why would a typical research psychologist (i.e., a scientist) view these philosophical traditions as progress away from metaphysical ways of knowing?

Raphael has a theory that adults who grew up as first-born children are more likely to be outgoing than those who grew up as later-born children. To test his theory, he gives a questionnaire to 200 students at his college and asks them to report (a) whether they were first-born children or later-born children and (b) the degree to which they consider themselves outgoing. Is Raphael's approach to acquiring knowledge scientific? In answering this question, consider each of the four canons of science and evaluate how Raphael's approach measures up on each of these dimensions. Can you think of any ways for Raphael to make his birth-order analysis more scientific?

Gloria has a theory that people who are born between July 23rd and August 22nd (i.e., "Leos") are more likely to be outgoing than people who are born at other times of the year. In support of her theory, she notes (a) that most of the Leos she knows are outgoing and (b) that she is very good at correctly guessing the astrological sign of Leos when she meets them. Is Gloria's approach to knowledge acquisition scientific? In answering this question, consider each of the four canons of science and evaluate how Gloria's approach measures up on each of these dimensions. Can you think of any ways for Gloria to make her astrological analysis more scientific?

Although one of the tenets of science is that theories should be based on observable events (empiricism), most of the constructs that psychologists study are not visible to the naked eye. For instance, we can't directly observe a person's true attitudes, beliefs, or thoughts. How, then, can psychology be considered scientific? In answering this question, carefully consider the role of logic, theory testing, and operational definitions. (*Note:* Your answer to this question will become more sophisticated after you read Chapter 2.)

NOTES

For a more detailed discussion of this issue, see Schultz (1981, pp. 56–57). Schultz notes, for example, that Wundt was the only one in this distinguished group to set himself the explicit task of founding a new discipline.

Actually, proponents of chaos theory might argue that the universe isn't completely deterministic. For an interesting discussion of this topic, see Stewart (1989).

The best evidence that people may be predisposed to think in ways that reflect some kind of belief in systematic causes comes from developmental studies of infants (for example, see Spelke, 1991). Even evidence that very young infants possess certain kinds of causal knowledge, however, is open to multiple interpretations (see Baillargeon, 1994). For our purposes, suffice it to say that scientists are not alone in their assumption that the world operates on the basis of systematic, predictable causes.

Of course, an even more important reason why Watson and Skinner didn't like to speculate about higher-order mental processes is their belief that these processes are impossible to observe. (They did not, however, argue that they don't exist.) In other words, behaviorists like Watson and Skinner were big fans of empiricism. Although we are big fans of behaviorism, we feel that the devotion of many behaviorists to empiricism may have been misguided. Physicists cannot *directly* observe black holes, subatomic particles, or radio waves, but they can test theories about them empirically by making indirect observations—that is, by examining the consequences of these hypothetical entities for things that we *can* observe.

2

HOW DO WE FIND OUT?

> ***If a man will begin with certainties, he shall end in doubts; but if he will be content to begin with doubts, he shall end in certainties.***
>
> **—Francis Bacon (1605/1893, p. 65)**

When the first author's oldest nephew, Shaun, was three years old, the first author asked him a few questions about cars, driving, and traffic laws. Because Shaun had always been fascinated with cars and driving, he demonstrated an impressive knowledge of cars. For example, at the tender age of three, Shaun knew that a Chevy Camaro was a *lot* cooler than a typical sedan. He also seemed to have a keen appreciation of his parents' driving behavior. Consider his answers to the following questions about traffic lights. "What do you do at a *red* light?" "Stop," he answered casually. "What about a *green* light?" "Go!" he answered with a bit more emotion. "And what about a *yellow* light?" "Go *faster!*" he responded enthusiastically. Shaun's third answer illustrates the difference between descriptive and prescriptive laws (i.e., the difference between what people *ought to do* and what people *actually do*). We think this story serves as a fitting introduction to this chapter, which focuses heavily on psychological laws and scientific discovery. In a sense, Shaun's lack of preconceived notions about what was right and wrong meant that he provided an empirical, scientific answer ("Here is what people do.") to what his uncle had intended as a legal question ("What are people *supposed* to do?"). The fact that Shaun had no preconceived notion of the rules of the road is also relevant to this chapter because, as we will see, scientists and laypeople alike often have preconceived notions about the best way to discover what is true. Moreover, these preconceived notions sometimes get in the way of accurate scientific discoveries. Perhaps anthropologists from a distant planet would learn more about human driving behavior by interviewing small children than they would learn by interviewing adults. Better yet, of course, they could use records from those annoying cameras that sometimes take your picture when you are blowing a red light.

In this chapter, we build on the foundation laid in Chapter 1 by discussing the process of scientific discovery. The chapter is broken into three sections. In the first section, we discuss the logic of scientific discovery. We begin by arguing that the primary goal of any science is to establish laws of nature, and we distinguish laws from theories and hypotheses. We then examine the role of observation and reasoning in science, and in so doing, we distinguish between inductive and deductive approaches to scientific thinking. Next, we identify three distinct approaches to scientific hypothesis testing and discuss some of the ways in which each approach is compatible or incompatible with the basic goals of science. In the second section, we discuss the art of scientific discovery. We review a set of inductive and deductive techniques that will help you generate exciting ideas that merit the kind of attention to methodological detail that you will learn about in subsequent chapters. In the final section of the chapter, we discuss the ethics of scientific discovery. As we show, exciting and insightful ideas are of no use unless you can find an ethical way of testing these ideas.

THE LOGIC OF SCIENTIFIC DISCOVERY

Laws, Theories, and Hypotheses

If you are a psychology major, you probably take it as a given that psychology is a science. However, you probably won't be surprised to learn that many *non*-psychologists (including some scientists) assume that it is impossible to study human behavior scientifically. Some people even react with annoyance or indignation when they learn about psychologists' latest efforts to understand important phenomena, such as love, morality, or altruism. To some people, it is disturbing to imagine that wonderful things like love are subject to orderly laws. As the poet e. e. cummings put it, "He who pays any attention to the syntax of things will never wholly kiss you." By this, he seemed to mean that it is easy to ruin a wonderful experience by overanalyzing it. We couldn't agree more with this opinion. In fact, we agree with it because scientific research has confirmed it! For example, taste testers who think too much about the basis of their preferences while sampling jellies have a lot of trouble telling the difference between really succulent and really sucky jellies (Wilson & Schooler, 1991; see also Albrechtsen, Meissner, & Susa, 2009; Dijksterhuis, 2004). However, this does *not* mean that we shouldn't seek scientific explanations for important experiences, such as love, altruism, and the taste of strawberry jelly. It just means that we shouldn't allow what we learn about the nature and causes of these important experiences to get in the way of the enjoyment these experiences can bring us. In principle, psycholinguists (i.e., syntax experts) can enjoy kissing just as much as poets and artists can. We don't have to be afraid of knowledge.

Of course, critics come in many shapes and sizes, and some critics argue that although it would be highly *desirable* to understand things like infatuation or gustation,