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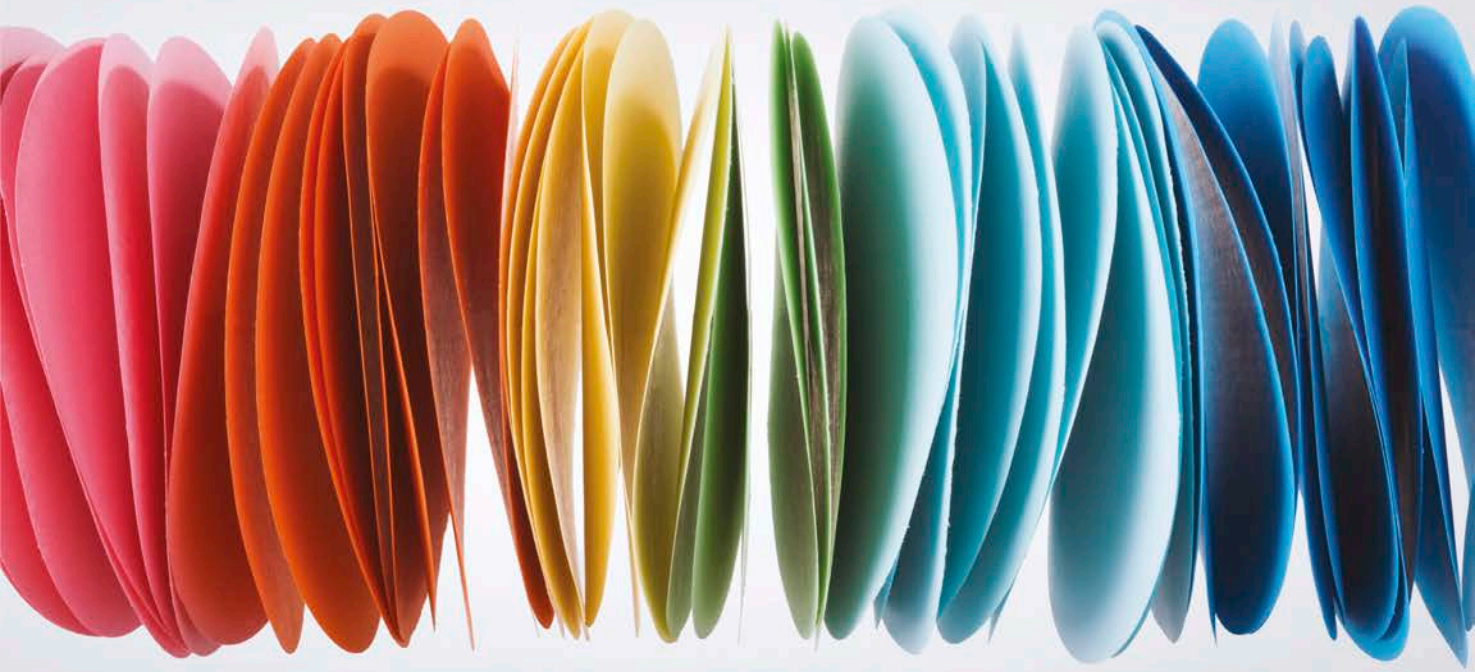
RESEARCH METHODS *for the* BEHAVIOURAL SCIENCES

EMEA Edition



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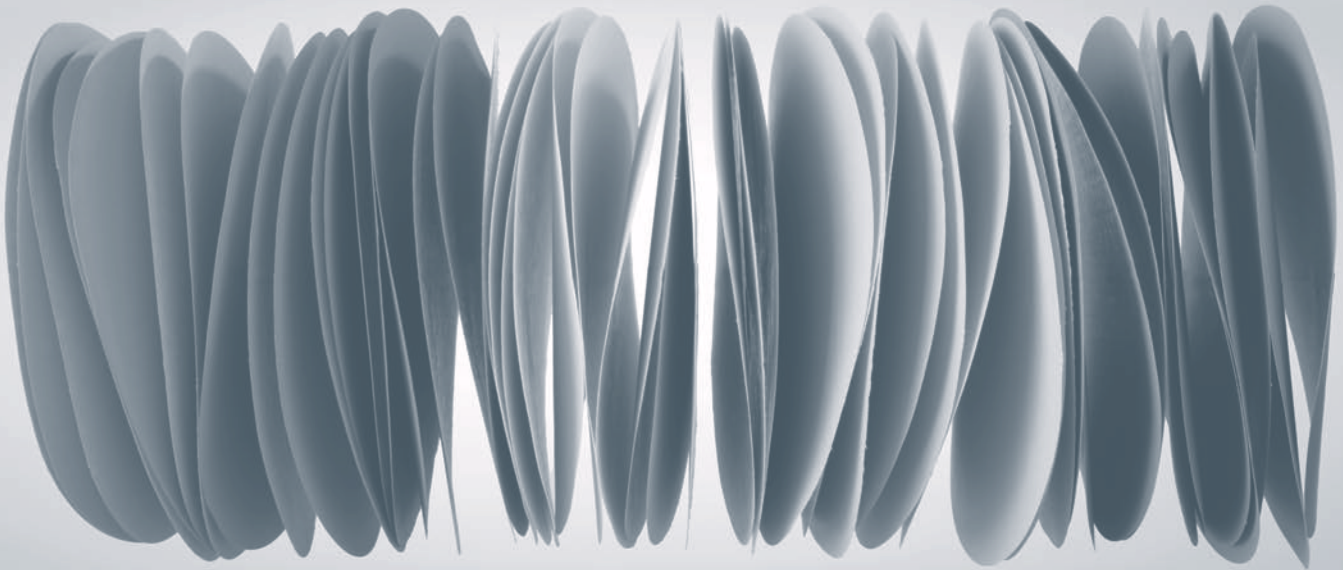

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PREFACE

Welcome to the first adaptation for Europe, the Middle East and Africa (EMEA) of Frederick Gravetter and Lori-Ann Forzano's textbook, *Research Methods for the Behavioral Sciences.* Understanding how research is done is fundamental to the study of the behavioural sciences because research is the means through which behavioural scientists create new knowledge. Therefore, this textbook aims to give students a thorough grounding in the different strategies and methods that are used to study behaviour, and thereby to equip students to understand and evaluate published research, and to conduct and draw conclusions from their own research studies. To that end, this EMEA Edition retains most of the structure and content that contributed to the success of previous editions of Gravetter and Forzano's textbook, while updating the content to reflect current practice in behavioural science research, and emphasizing that research is a global endeavour that takes place in different countries, languages and cultures.

Overview

Research Methods for the Behavioural Sciences, EMEA Edition, is intended for an undergraduate research methods course in psychology or any of the behavioural sciences. The book is organized around the framework of the research process – from developing a research question, through to analyzing data and communicating research. The chapters of the text have been organized into five sections. Chapters 1 and 2 focus on the earliest considerations in the research process, presenting an overview of the scientific method and describing how scientists develop a research hypothesis. Chapters 3–6 focus on the preliminary decisions in the research process, and include information on how to measure variables, maintaining ethical responsibility throughout the research process, selecting participants, and choosing a valid research strategy. Chapters 7–9 introduce the experimental research strategy and provide the details of between-subjects and within-subjects experimental designs. Chapters 10–14 present other (non-experimental) research strategies and their associated research designs, provide more detail on some of the most common methods that scientists use to measure behaviour, and describe research that focuses on a single individual (e.g., case studies). Chapters 15 and 16 focus on the final steps in the research process and include information on how to evaluate, interpret and communicate the results of the research process. Although the chapters are organized in a series that reflects an ordered process, the order of chapters can be varied to meet the requirements of different course instructors.

Pedagogy

This EMEA Edition retains the conversational style of writing of previous editions that emphasizes discussion and explanation of topics rather than a simple 'cookbook' presentation of facts. Each chapter includes many opportunities for students to interact with the material, rather than simply be passively exposed to the material (e.g., Learning Checks and end-of-chapter Exercises). Each chapter is organized around a list of Learning Objectives, and includes a Chapter Outline, Chapter Overview, and Chapter Summary – all of which are designed to help students impose a structure on the material that they are learning. Margin Notes, Definition Boxes, Tables, Figures, Key Word lists and the Glossary at the end of the book are all used to provide emphasis or concise summaries for key ideas. Boxes, which are separate from the regular text, provide additional information to illustrate a point – often one that is pertinent to the content of several chapters.

New to this EMEA edition

Previous edition users should know that we have tried to maintain the hallmark features of the textbook, though the content has been revised, and the structure of Chapters 13 and 14 has been re-organized.

In keeping with the brief to adapt the book for students in Europe, the Middle East and Africa, there are many new or alternative examples of research studies that extend the focus of the text beyond its original North American audience. Additionally, material has been added to several chapters that discusses cross-cultural and global perspectives on research. The prevalence of illustrative examples and idioms that are specific to the North American context has been reduced.

Other changes serve to update the content of the book: reflecting research as it is done now (e.g., increased reliance on online data collection) and current best-practice recommendations for behavioural science research. This includes new subsections of material and information boxes in several chapters that describe and explain Open Science practices, together with accounts of the questionable research practices that provided the impetus for this movement. There is increased emphasis on the importance of estimating the size of an effect, and the text in several chapters has been revised to eliminate the implication that small samples are often sufficient for a research study.

Finally, numerous small revisions have been made to improve the clarity, depth or precision of explanations. This includes revising descriptions of testing for statistical significance to improve the technical precision of the book. See below for a brief description of the other main revisions, which are described chapter by chapter.

Other revisions by chapter

Chapter 1 (Introduction, Acquiring Knowledge and the Scientific Method). To improve clarity, the subsection on *the rational method* has been revised. To simplify presentation, the material on the method of faith has been removed because this can be regarded as a special case of the method of authority. Some discussion of the 'grey area' between quantitative and qualitative research has been added.

Chapter 2 (Research Ideas and Hypotheses). Additional information had been added on advanced search functions in database searches. The terms *falsifiable hypothesis* and *falsifiability* (and some associated terminology) are introduced.

Chapter 3 (Defining and Measuring Variables). A subsection on *measurement across cultures* has been added, which discusses some of the features of research conducted in different languages.

Chapter 4 (Ethics in Research). In the discussion of ethical principles and guidelines, the terminology and examples have been revised to reflect practice beyond North America; for example, adding details of the *Code of Human Research Ethics* of the *British Psychological Society*. The implications for research of recent European Union legislation for data protection are identified. The section on *Ethical Issues and Non-human Subjects in Research* has been reduced substantially. This was done because the information was specific to US regulation, and because few undergraduates will have the opportunity to conduct such research, and those that do will need more specialist guidance than can be provided in a general introductory text. As a means to motivate understanding of current recommendations for research (e.g., Open Science) a subsection on *questionable research practices* has been added.

Chapter 5 (Selecting Research Participants). The discussion of sample size now includes greater emphasis on the problems associated with small samples (e.g., low statistical power).

Chapter 6 (Research Strategies and Validity). The detailed discussion of Rosenthal and Rosnow's (1975) study of research volunteer characteristics has been substantially reduced, and has been replaced by discussion of cross-cultural and cross-country issues around who participates in research. Some additional signposting has been added to orientate readers to the more in-depth consideration of research strategies and validity that occurs in subsequent chapters of the book.

Chapter 7 (The Experimental Research Strategy). The Box 7.1 'Statistical Significance' has been revised to improve its technical precision. The term *treatment-as-usual* is introduced (as a common form of control

condition in clinical research). The discussion of manipulation checks has been lengthened, and a new subsection has been added on *instructional manipulation checks, catch trials and other checks of attention.*

Chapter 8 (Experimental Designs: Between-Subjects Design). The terms *randomized controlled trial (RCT)* and *intention-to-treat analysis* are defined and discussed. The goal of estimating the size of a treatment effect is discussed (as complementary to the goal of establishing the existence of a treatment effect).

Chapter 9 (Experimental Designs: Within-Subjects Design). The discussion of within-subjects designs that run conditions concurrently (e.g., inter-mixing multiple trials from different conditions) has been lengthened because this is a common type of study with many advantages. The discussion of counterbalancing has been expanded to emphasize that counterbalancing the order of conditions is only one of several useful applications of this technique.

Chapter 10 (The Non-Experimental and Quasi-Experimental Strategies). Additional examples of research studies have been added to illustrate key points, such as how researchers examine the effect of language (e.g., Arabic vs. Italian) on cognition. A subsection has been added on studies that combine longitudinal designs with other research designs.

Chapter 11 (Factorial Designs). The term *moderation* is introduced and explained. A box has been added on the appropriate analysis of interactions to determine whether a 'differences in differences' exists; this includes explanation and some discussion of Nieuwenhuis, Forstmann and Wagenmakers (2011).

Chapter 12 (The Correlational Research Strategy). The role of correlational research in generating and testing hypotheses is now discussed in greater depth. Additional examples to illustrate these and other points have been added.

Chapter 13 (Modes and Methods of Measurement). Previously, this chapter was titled *The Descriptive Research Strategy*. However, much of this chapter in the previous edition related to methods for measuring behaviour that are used with any kind of research strategy or research design. Chapter 13 has therefore been re-structured to make that its primary focus, as reflected in the new chapter title. Consequently, the short section titled *An Introduction to Descriptive Research* has been removed, and the section tilted *The Case Study Design* has been moved to Chapter 14. A new section on *behavioural tasks* has been added, which uses examples of cognitive (e.g., reaction time) tasks to illustrate how behavioural tasks are used in research studies. Some new examples have been added to illustrate observational methods. The section titled *Surveys and Other Self-Report Methods* now emphasizes survey methods as a generic tool for measuring behaviour, rather than presenting it as a type of research design. This material has also been updated to better reflect that, in this digital era, online data collection is very common. Reflecting this, there are new subsections on *diary methods* and *the experience sampling method*. Given these revisions and its new focus, Chapter 13 can be used in various ways. For example, it can be used alongside Chapters 3 or 6 to provide greater detail on issues relating to the measurement of behaviour. Alternatively, course instructors can use Chapter 13 to discuss specific implementations of different research strategies and designs (Chapters 7-12).

Chapter 14 (Case Study and Single-Case Experimental Research Designs). With the addition of content that was previously in Chapter 13, this chapter now focuses on various kinds of single-case research – both experimental and non-experimental – as reflected in the revised chapter title. Additional examples have been added to better reflect the range of research topics and research questions that are examined via case studies, as well as the variety of goals of this type of research. This includes several examples from neuropsychology with new discussion of case-control comparisons and the logic of examining dissociations, as well as case study examples from different behavioural sciences. The coverage of single-case experimental designs has been slimmed down: the coverage of complex phase-change designs and multiple baseline designs has been greatly reduced; textbook users can now access this material from the previous edition via the new companion website.

Chapter 15 (Statistical Evaluation of Data). This chapter has had numerous small revisions to improve the technical precision of descriptions of significance testing (e.g., removing conflations of the alpha-level and *p*-value for a statistical test) and to increase the emphasis on the importance of estimating the

size of an effect (e.g., more detail on confidence intervals). New material on *p*-hacking and the steps taken to address it add to the text's emphasis on current best-practice recommendations for data collection, analysis and reporting. Appendix A and Online Appendix D, which are referenced from Chapter 15, have been updated in line with the revisions to Chapter 15.

Chapter 16 (Writing an APA-Style Research Report). The information about APA style has been updated from that for the sixth edition of the APA *Publication Manual* to that for the *Publication Manual of the American Psychological Association*, *Seventh Edition* (2020). The advice on writing a research report has been extended to include APA guidance on a *Student Paper* (to add to previous coverage of preparing a *Professional Paper* for submission to a journal). There is greater consideration on the principles of successful communication, which includes greater acknowledgement of appropriate variation in the style and format of research reports, and slightly less emphasis on formatting 'rules' for manuscript preparation. Appendix B (a *Sample Research Report*) has been edited so that it fits better with the revised Chapter 16 for which it provides integral examples.

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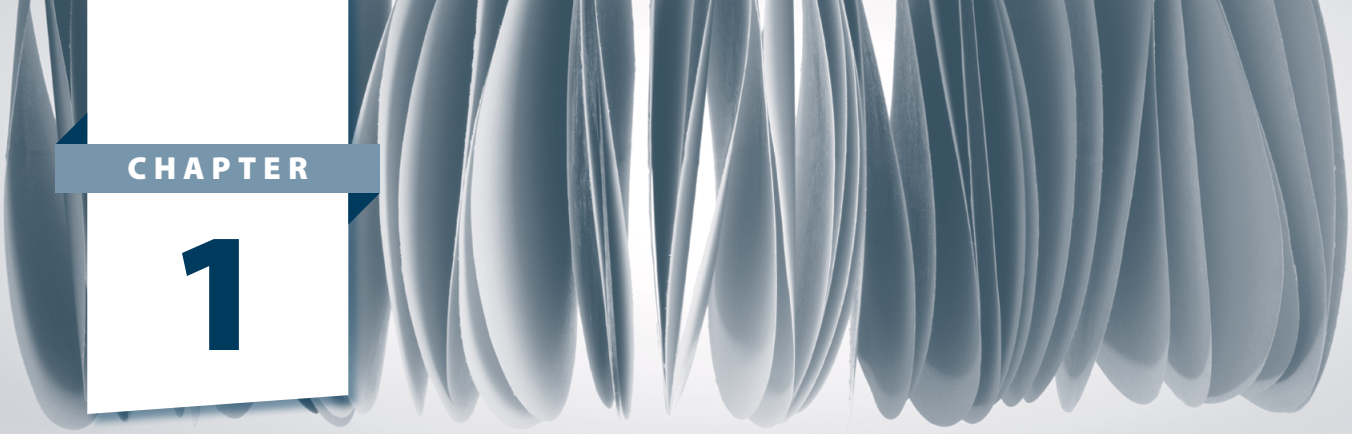


CHAPTER

1

Introduction, Acquiring Knowledge and the Scientific Method

CHAPTER CONTENTS

CHAPTER LEARNING OBJECTIVES

LO1 Compare and contrast the non-scientific methods for knowing or acquiring knowledge (tenacity, intuition, authority, the rational method and the empirical method). Identify an example and explain the limitations of each method.

LO2 Identify and describe the steps of the scientific method.

LO3 Define *induction* and *deduction* and explain the role of each in the scientific method.

LO4 Distinguish between a hypothesis and a prediction.

LO5 Explain what it means to say that the scientific method is empirical, public and objective.

LO6 Distinguish between science and pseudoscience.

LO7 Distinguish between qualitative and quantitative research and recognize examples of each.

LO8 Identify and describe the steps in the research process.

CHAPTER OVERVIEW

In this chapter, we introduce the topic of this textbook: research methodology. Research methods are intended to provide scientists with effective procedures for gathering information and answering questions. We begin by discussing the many ways of acquiring knowledge or finding answers to questions,

including the scientific method. Next, we provide a thorough discussion of the scientific method. The chapter ends with an outline of the research process or the way the scientific method is applied to answer a particular question. The research process provides the framework for the rest of the textbook.

1.1

Methods of Knowing and Acquiring Knowledge

LEARNING OBJECTIVE

LO1 Compare and contrast the non-scientific methods for knowing or acquiring knowledge (tenacity, intuition, authority, the rational method and the empirical method). Identify an example and explain the limitations of each method.

Consider the following questions.

Does multitasking make you more efficient with your time?

Does having more friends make you less vulnerable to depression?

Are children of divorced parents less likely to be satisfied with their romantic relationships?

Are girls more likely to cyberbully than boys?

Does eating cake for breakfast make dieters more likely to stick to their diets later in the day?

Are adolescents who play violent video games more aggressive than adolescents who do not play violent video games?

Does playing brain games in adulthood make it less likely you will develop Alzheimer's?

Terms printed in boldface are defined in the glossary. Some terms, identified as key words, are also defined in the text.

If you find these questions interesting, then you may also be interested in learning how to find the answers. Although there are many different ways to find answers to questions like these, in this book we focus on the method used by behavioural scientists: the scientific method. The scientific method is considered basic, standard practice in the world of science. Students in the behavioural sciences (e.g., psychology, sociology, experimental economics or criminal justice) should understand how this process works and have some appreciation of its strengths and weaknesses. Before we begin, however, you should realize that the methods used in scientific research are not the only ones available for answering questions, and they are not necessarily the most efficient. There are many different ways of knowing or finding answers to questions. In general, the different ways that people know, or the methods that people use to discover answers, are referred to as **methods of acquiring knowledge**.

DEFINITION

Methods of acquiring knowledge are ways in which a person can know things or discover answers to questions.

The rest of this chapter examines several established methods of knowing and acquiring knowledge. We begin with five non-scientific approaches: the method of tenacity, the method of intuition, the method of authority, the rational method and the method of empiricism. We conclude with a more

detailed discussion of the scientific method. As you will see, the scientific method combines elements from each of the other methods to produce a general question-answering technique that avoids some of the limitations or pitfalls of using just one of the other methods. Although the scientific method tends to be more complicated and more time consuming than the other methods, the goal is to obtain better-quality answers or at least a higher level of confidence in the answers. Finally, we warn that the scientific method outlines a general strategy for answering questions; the specific details of applying the scientific method to particular problems form the content of the remainder of the book.

The method of tenacity

The **method of tenacity** involves holding on to ideas and beliefs simply because they are accepted facts: habit leads us to continue believing something we have previously accepted as true. Often this is referred to as belief perseverance. For example, you may have heard the clichés, 'You cannot teach an old dog new tricks' and 'Opposites attract'. These statements have been presented over and over again, and they have been accepted as true. In general, the more frequently we are exposed to statements, the more we tend to believe them. Advertisers successfully exploit this, repeating their slogans over and over, hoping consumers will accept them as true (and subsequently buy their products). A very catchy fast-food jingle exclaiming, 'I'm lovin' it' hopes we do just that and buy more burgers from them.

DEFINITION

In the **method of tenacity**, an idea or belief is held on to because it has previously been accepted as true.

One problem with the method of tenacity is that the information acquired might not be accurate. With regard to the statement about old dogs not being able to learn new tricks, the elderly can and do learn (O'Hara, Brooks, Friedman, Schroder, Morgan & Kraemer, 2007). With regard to the statement that opposites attract, research shows that people are attracted to people who are like them (Klohnen & Luo, 2003). Another pitfall of the method of tenacity is that there is no method for correcting erroneous ideas. Even in the face of evidence to the contrary, a belief that is widely accepted can be very difficult to change.

The method of intuition

In the **method of intuition**, information is accepted as true because it 'feels right'. With intuition, a person relies on hunches and 'instinct' to answer questions. Whenever we say we know something because we have a 'gut feeling' about it, we are using the method of intuition. For many questions, this method is the quickest way to obtain answers. When we have no information at all and cannot refer to supporting data or use rational justification, we often resort to intuition. For example, intuition provides answers when we are making personal choices such as: What should I have for dinner? Should I go out tonight or stay in? The ultimate decision is often determined by what I 'feel like' doing. Many ethical decisions or moral questions are resolved by the method of intuition. For example, we regard something as wrong because it does not 'feel' right. Some intuitions are probably based on the subtle cues that we pick up from the people around us. Although we can't explain exactly how we know that a friend is having a bad day, something about the way she moves or speaks suggests to us that it is true. The predictions and descriptions given by psychics are thought to derive from this aspect of intuition. Intuition may also reflect an accumulation of experience that allows us to spot familiar patterns. For example, when faced with familiar problems or decisions, we can act or decide quickly based on what we did the last time we were in a similar situation. The problem with the method of intuition is that it has no mechanism for separating accurate from inaccurate knowledge.

DEFINITION

In the **method of intuition**, information is accepted on the basis of a hunch or 'gut feeling'.

The method of authority

In the **method of authority**, a person finds answers by seeking out an authority on the subject. This can mean consulting an expert directly or going to a library or a website to read the works of an expert. In either case, you are relying on the assumed expertise of another person. Whenever you 'google it' or consult books, articles, people, television or the internet to find answers, you use the method of authority. Some examples of people who are often regarded as experts are: physicians, scientists, psychologists, economists, professors, stockbrokers, religious leaders and lawyers.

DEFINITION

In the **method of authority**, a person relies on information or answers from an expert in the subject area.

For many questions, the method of authority is an excellent starting point; often, it is the quickest and easiest way to obtain answers. Much of your formal education is based on the notion that answers can be obtained from experts (teachers and textbooks). However, the method of authority has some pitfalls. It does not always provide accurate information. For example, authorities can be biased. We have all seen examples of conflicting testimony by 'expert witnesses' in criminal trials. Sources are often biased in favour of a particular point of view or orientation. For example, the supporters of different political parties often have very different answers to the same questions, as do the members of different schools of thought in academic disciplines.

An additional limitation of this method is that we often assume that expertise in one area can be generalized to other topics. For example, advertisers often use the endorsements of well-known personalities to sell their products. When a famous athlete appears on television telling you what soup is more nutritious, should you assume that being an outstanding football player makes him an expert on nutrition? The advertisers would like you to accept his recommendation on authority. Similarly, when Linus Pauling, a chemist who won the Nobel Prize for his work on the chemical bond, claimed that vitamin C could cure the common cold, many people accepted his word on authority. His claim is still widely believed, even though numerous scientific studies have failed to find such an effect.

Another pitfall of the method of authority is that people often accept an expert's statement without question. This acceptance can mean that people do not check the accuracy of their sources or even consider looking for a second opinion. As a result, false information is sometimes taken as truth. In some situations, the authority is accepted without question because the information appears to make sense, so there is no obvious reason to question it. We would all like to believe it when the doctor says, 'That mole doesn't look cancerous', but we might be better protected by getting a second opinion.

As a final pitfall of the method of authority, realize that not all 'experts' are experts. There are a lot of supposed 'experts' out there. Turn on the television to any daytime talk show. During the first 45 minutes of the show, in front of millions of viewers, people haggle with one another: women complain about their husbands, estranged parents and teenagers reunite, or two women fight over the same boyfriend. Then, in the final 15 minutes, the 'expert' comes out to discuss the situations and everyone's feelings. These 'experts' are often people who lack the credentials, the experience or the training to make the claims they are making. Being called an expert does not make someone an expert.

In conclusion, we should point out that there are ways to increase confidence in the information you obtain by the method of authority. First, you can evaluate the source of the information. Is the authority really an expert, and is the information really within the authority's area of expertise? Also, is the information an objective fact, or is it simply a subjective opinion? For example, does the expert provide evidence in support of their opinion? Second, you can evaluate the information itself. Does it agree with other information that you already know? Were sound methods used to generate the evidence that supports the expert's opinion? If you have any reason to doubt the information obtained from an authority, the best move is to get a second opinion. If two independent authorities provide the same answer, you can be more confident that the answer is correct. For example, when you obtain information from an internet site, you should be cautious about accepting the information at face value. Do you have previous experience with the site? Is it known to be reputable? If there is any doubt, it pays to check to see that other sites are providing the same information.

The methods of tenacity, intuition and authority are satisfactory for answering some questions, especially if you need an answer quickly and there are no serious consequences for accepting a wrong answer. For example, these techniques are usually fine for answering questions about which shoes to wear or what vegetable to have with dinner. However, it should be clear that there are situations for which these uncritical techniques are not going to be sufficient. In particular, if the question concerns a major financial decision or if the answer could significantly change your life, you should not accept information as true unless it passes some critical test or meets some minimum standard of accuracy. The next two methods of acquiring knowledge (and the scientific method) are designed to place more demands on the information and answers they produce.

The rational method

The **rational method**, also known as **rationalism**, involves seeking answers by logical reasoning. This method begins with a set of premises (statements that we assume to be true) and uses logic (deduction) to reach a conclusion or get an answer to a question. A simple example of reasoning that might be used is as follows:

> All information in this textbook is correct.
>
> This textbook states that *The Belmont Report* was published in 1979.
>
> Therefore, it is correct information that the *The Belmont Report* was published in 1979.

In this **argument**, the first two sentences are **premise statements**. The final sentence is a logical conclusion based on the premises. If the premise statements are, in fact, true and the logic is sound, then the conclusion is guaranteed to be correct. Thus, the answers obtained by the rational method must satisfy the standards established by the rules of logic before they are accepted as true.

Notice that the rational method begins after the premise statements have been presented. In the previous argument, for example, we are not trying to determine whether all information in this textbook is correct; we simply accept this statement as true. Similarly, we are not concerned with verifying that there was a report with this name or when it was published, or – indeed – whether it is even mentioned in this textbook. We take this premise 'on trust'. Specifically, the rational method does not require observations or gathering information. Instead, you should think of the rational method as mentally manipulating premise statements to determine whether they can be combined to produce a logical conclusion.

DEFINITIONS

The **rational method**, or **rationalism**, seeks answers by the use of logical reasoning.

An **argument** is a set of premise statements that are logically combined to yield a conclusion.

In logical reasoning, **premise statements** describe facts or assumptions that are presumed to be true.

The preceding example (textbook and report) can be used to demonstrate a limitation of the rational method: the conclusion is not necessarily true unless *both* of the premise statements are true, even in a valid logical argument. Regarding the first premise in our example, while we have taken great effort to avoid inaccuracies in this textbook, it is unlikely that we have always succeeded in this. Or consider a modified version of the second premise in which stated that: 'This textbook states that the moon is made of cheese' or that '… all martwheasals are chucklebons'. By rational deduction from the premises, it would necessarily follow that 'the moon is made of cheese' or 'all martwheasals are chucklebons' is correct information. In general, the truth of any logical conclusion is founded on the truth of the premise statements. If any basic assumption or premise is incorrect, then we cannot have any confidence in the truth of the logical conclusion.

A practical limitation of employing the rational method is that people are not consistently good at logical reasoning. For example, people will often accept a logically incorrect conclusion as being correct if that conclusion is consistent with their existing knowledge or beliefs (Markovits & Nantel, 1989). For example, consider this:

Premise 1: All flowers have petals.

Premise 2: Roses have petals.

Conclusion: Roses are flowers.

This conclusion does *not* follow as a logical necessity from these premises (because the premises do not exclude the possibility that there are non-flower objects that have petals). Similarly, people will often reject a logically correct conclusion if the conclusion seems implausible given what they already know about the world. For example, the following conclusion *does* follow logically from these premises below, though people often believe that it does not:

Premise 1: All things that are smoked are good for the health.

Premise 2: Cigarettes are smoked.

Conclusion: Cigarettes are good for the health.

In summary, the rational method is the practice of employing reason as a source of knowledge, whereby conclusions are tested by ensuring that they conform to the rules of logic. As you will see in Section 1.2, the rational method is a critical component of the scientific method. In the next section, we examine a different approach, in which we rely entirely on direct observation to obtain evidence to establish the truth.

The empirical method

The **empirical method**, also known as **empiricism**, attempts to answer questions by direct observation or personal experience. This method is a product of the empirical viewpoint in philosophy, which holds that all knowledge is acquired through the senses. Note that when we make observations, we use the senses of seeing, hearing, tasting and so on.

DEFINITION

The **empirical method**, or **empiricism**, uses observation or direct sensory experience to obtain knowledge.

Most of you know, for example, that children tend to be shorter than adults, that it is typically warmer in the summer than in the winter, and that a kilogram of steak costs more than a kilogram of minced beef. You know these facts from personal experience and from observations you have made.

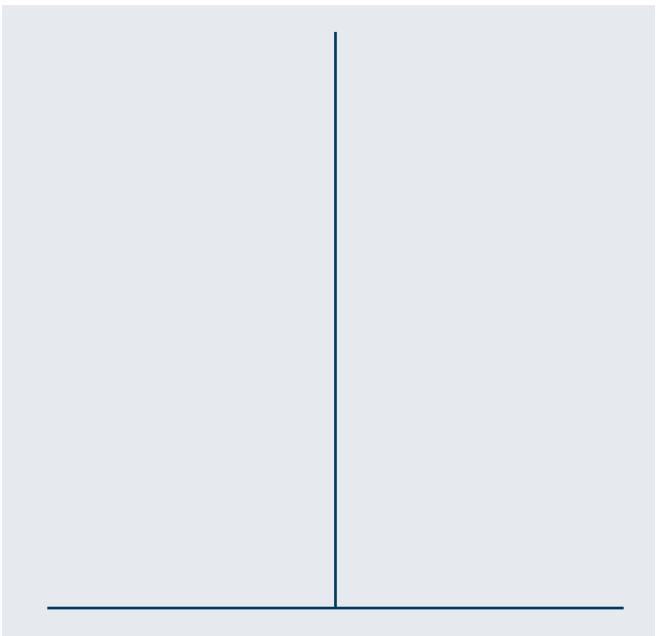
Many facts or answers are available simply by observing the world around you: that is, you can use the empirical method. For example, you can check the oil level in your car by simply looking at the dipstick. You could find out the weight of each student in your class just by having each person step on a scale. In many instances, the empirical method provides an easy, direct way to answer questions. However, this method of inquiry also has some limitations.

It is tempting to place great confidence in our own observations. Everyday expressions, such as 'I will believe it when I see it with my own eyes', reveal the faith we place in our own experience. However, we cannot necessarily believe everything we see, or hear and feel. Actually, it is fairly common for people to misperceive or misinterpret the world around them. Figure 1.1 illustrates this point with the horizontal–vertical illusion. Most people perceive the vertical line to be longer than the horizontal line. Actually, they are exactly the same length. (You might want to measure them to convince yourself.) This illustration is a classic example of how direct sensory experience can deceive us.

Although direct experience seems to be a simple way to obtain answers, your perceptions can be drastically altered by prior knowledge, expectations, feelings or beliefs. As a result, two observers can witness exactly the same event and yet 'see' two completely different things. For most students, the following example provides a convincing demonstration that sensory experience can be changed by knowledge or beliefs.

> Suppose you are presented with two plates of snack food, and you are asked to sample each and then state your preference. One plate contains regular potato chips and the second contains crispy, brown noodles that taste delicious. Based simply on your experience (taste), you have a strong preference for the noodles. Now suppose that you are told that the 'noodles' are actually fried worms. Would you still prefer them to the chips? The problem here is that your sensory experience of good taste (the method of empiricism) is in conflict with your long-held beliefs that people do not eat worms (method of tenacity).

FIGURE 1.1



The Horizontal–Vertical Illusion

To most people, the vertical line appears to be longer, even though both lines are exactly the same length.

It also is possible to make accurate observations but then misinterpret what you see. For years, people watched the day-to-day cycle of the sun rising in the east and setting in the west. These observations led to the obvious conclusion that the sun must travel in a huge circle around the earth.

Finally, the empirical method is usually time consuming and sometimes dangerous. When faced with a problem, for example, you could use the empirical method to try several possible solutions, or you could use the rational method and simply think about each possibility and how it might work. Often, it is faster and easier to think through a problem than to jump in with a trial-and-error approach. Also, it might be safer to use the rational method or the method of authority rather than experience something for yourself. For example, if I wanted to determine whether the mushrooms in my backyard are safe or poisonous, I would rather ask an expert than try the empirical method.

In summary, the empirical method is the practice of employing direct observation as a source of knowledge. In the empirical method, evidence or observations with one's senses are required for verification of information. Note that the observations can be casual and unplanned, such as when you are simply aware of the world around you. At the other end of the continuum, observations can be systematic and purposeful. As you will see in the next section, the planned and systematic application of the empirical method is a critical component of the scientific method.

Summary

As you have seen so far, the scientific method is not the only way to know the answers or find the answers to questions. The methods of tenacity, intuition, authority, rationalism and empiricism are different ways of acquiring knowledge. Table 1.1 provides a summary of these five methods. We should point out that different people can use different methods to answer the same question and can arrive at different, or sometimes the same, answers. For example, if you wanted to know the weight of one of your classmates, you might have them step on a scale (empirical method), simply ask how much they weigh (method of authority), or compare their physical size to your own and calculate an estimated weight relative to how much you weigh (rational method).

TABLE 1.1 Summary of Non-Scientific Methods of Acquiring Knowledge

Method	Way of knowing or finding answer
Tenacity	From habit or persistence
Intuition	From a hunch or feeling
Authority	From an expert
Rationalism	From reasoning; a logical conclusion
Empiricism	From direct sensory observation

LEARNING CHECK

1. **Which method of knowing is being used by a student who believes that his performance on tests is influenced by wearing a lucky hat?**
   a. The method of empiricism
   b. The rational method
   c. The method of tenacity
   d. The method of authority

2. Which method of knowing is used when you find the address and phone number of a restaurant by googling the name of the restaurant?
   a. Method of empiricism
   b. Rational method
   c. Method of authority
   d. Scientific method

3. Last year Tim and his friend Jack were both too short to ride the roller coaster at a theme park. Jack went to the park this year and was tall enough to ride. Tim knows that he is taller than Jack, so he knows that he will be able to ride the roller coaster as well. Which method of knowing is Tim using?
   a. Method of empiricism
   b. Rational method
   c. Method of authority
   d. Scientific method

4. A restaurant chef tried replacing rice with pasta in one of her recipes to see what would happen. Which method of acquiring knowledge is she using?
   a. Method of empiricism
   b. Rational method
   c. Method of authority
   d. Scientific method

Answers appear at the end of the chapter.

1.2

The Scientific Method

LEARNING OBJECTIVES

- **LO2** Identify and describe the steps of the scientific method.
- **LO3** Define *induction* and *deduction* and explain the role of each in the scientific method.
- **LO4** Distinguish between a hypothesis and a prediction.
- **LO5** Explain what it means to say that the scientific method is empirical, public and objective.
- **LO6** Distinguish between science and pseudoscience.

The **scientific method** is an approach to acquiring knowledge that involves formulating specific questions and then systematically finding answers. The scientific method contains many elements of the methods previously discussed. By combining several different methods of acquiring knowledge, we hope to avoid the pitfalls of any individual method when used by itself. The scientific method is a carefully developed system for asking and answering questions so that the answers we discover are as trustworthy as possible. In the following section, we describe the series of steps that define the scientific method. To help illustrate the steps of the scientific method, we will use a research study investigating the common response of swearing in response to a painful stimulus (Stephens, Atkins & Kingston, 2009).

The steps of the scientific method

Step 1: Observe behaviour or other phenomena

The scientific method often begins with observation (i.e., using the empirical method). Often these are casual or informal observations. For example, the authors of the swearing study observed (themselves or others) swearing in response to pain. Based on their observations, they began to wonder whether swearing