

# Introduction

**H**ow should scientific evidence be evaluated? After reading a research article, one person may be fully convinced by the evidence that is offered; a second person may think that the same evidence might be true but regards it, on balance, to be equivocal and feels obliged to suspend judgment; and a third person may disdainfully dismiss it with scatological words of unmistakable meaning. Their different judgments may be informed by different views about what proof is. They may be influenced by their different beliefs about what evidence is needed to establish proof. They may be limited by the amount of knowledge that they have about the methods used to gather evidence in the search for truth. Finally, they may be affected by variation in their ability to think critically.

Regrettably, there is evidence that people reading the same research paper but beginning with opposing beliefs come away with even more polarized opinions than before they were exposed to the new evidence (Lord, Ross, & Lepper, 1979). This can happen because people misinterpret the evidence they have read, they are motivated to think in a certain way, or because of other cognitive malfunctions (McFadden & Lusk, 2015). This is a quality of human nature that is antithetical to the goals of science. It is what we attempt to overcome when we put on our critical thinking caps.

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*Critical Thinking About Research: Psychology and Related Fields, Second Edition*, by J. Meltzoff and H. Cooper

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We use the phrase *ability to think critically* as a positive quality, not as a pejorative reference to the characteristics of a mean-spirited faultfinder. The phrase refers to the skill of thinking about an issue, analyzing it, looking at it from all sides, and weighing whether there is sufficient evidence of good-enough quality to warrant making a reasoned judgment that is as free of personal bias as possible. The Critical Thinking Community (2016) defined it this way:

Critical thinking is self-directed, self-disciplined, self-monitored, and self-corrective thinking. It presupposes assent to rigorous standards of excellence and mindful command of their use. It entails effective communication and problem-solving abilities, as well as a commitment to overcome our native egocentrism and sociocentrism. (p. 1)

Texts and curricula are available to teach critical thinking in general (e.g., Moore & Parker, 2015). Our purpose here is a bit more restricted. We focus on critical thinking in the context of evaluating scientific research. We hope (a) to exhort you to adopt a critical mental set when reading research literature; (b) to try to increase your understanding of the principles and methods of research that are used to produce evidence; (c) to alert you to booby traps that can compromise the research and cloud the evidence; and (d) to provide you with materials that can be used for practice, with the goal of improving and honing your critical reading skills when you are exposed to research in the sciences, especially psychology and related fields (education, law, economics, health, nursing).

This two-part book is about how to evaluate scientific evidence. Part I provides an overview of the methods and principles that you need to know about when you critique or evaluate the trustworthiness of research. Part II presents fictional journal articles that provide you with practice in applying the principles outlined in Part I. The book is certainly not a statistics text, and it assumes that you have some familiarity with basic statistical methods. It is not intended to be your only text to prepare you to design and to carry out research. The focus is on reading and critiquing research. The two activities, producing and consuming research, are in no way contradictory, but a person who is adept at critiquing research is not necessarily skilled at thinking up research questions or conducting research any more than a drama critic is necessarily a good playwright. Books on research methods aim to give people who are preparing to do research an insider's view of how to go about designing a study and planning and conducting statistical analyses of data.

This is not a stand-alone methods book for aspiring and practicing researchers, although they can certainly use it to hone their skills as they think about how to proceed. It is intended to assist you in reading and assessing research. A reader who may not be familiar with the intricacies of *research design* (and who may not be aware of all the pitfalls to avoid) should know enough to recognize procedures that have gone awry or to know when plans have not worked out optimally. We review the application of research principles and alert you to things that interfere with valid research. Our objective is to help you bring an inquiring and informed mind to the evaluation of research.

Our presentation of the ways an experiment can flounder, and the emphasis we place on scrutinizing and critiquing research, is in no way intended as an indictment of the research process or as an expression of any reservations whatsoever about its value as a method of seeking the truth. In fact, we know that the perfect study has never been done. All research has strengths and flaws. Your task as a critical reader is to identify these and judge the value of the research for making an informed judgment of its utility in drawing the conclusions the authors intended.

We hope to encourage a form of interactive reading that we believe is central to the process of critical evaluation of research literature, as opposed to the almost reverential acceptance (or rejection) of the printed word. You must be able to bring a skeptical, inquiring, searching, probing attitude to the task; to spot things that do not look quite right; and to recognize how a weakness in one phase of the design or execution of a study can severely compromise the study at a later phase. The “tests” take the form of questions that you, the critical reader, ask of the written research report.

## **Why Psychologists and Professionals in Related Fields Need to be Critical Thinkers**

Psychologists may spend their time in one of three ways: (a) doing research to generate knowledge, (b) transmitting knowledge to others by teaching or by directing the research of others, or (c) applying psychological knowledge in the form of clinical or consulting services. These can be done singly or in any combination. A parallel set of options is available to specialists in other behavioral or social sciences, in education, in law, in medicine and the health sciences, and in the service of organizational improvement. There is variation between and within fields in how much time is spent educating and training students for the functions of generating knowledge, disseminating it, or applying it.

One thing shared by people in psychology and all related fields and specialties, no matter what career direction they choose, is that they all must be consumers of research. The bedrock of psychology and related fields consists of theories and data from research that support or refute the theories. All who profess to know a field, and those who want to keep abreast of advances, are necessarily consumers of research. It stands to reason that they must be able to evaluate research critically. Having a good grasp of the scientific method and the principles of research design, and knowing what to look for, are invaluable in this pursuit.

Psychologists who graduate from research-oriented doctoral programs have the advantage in this regard because research knowledge is a vital part of their education and the dissertation requirement gives them hands-on experience in research. Nevertheless, virtually all programs that do not require a research dissertation strive to teach students to think critically and to read empirical work intelligently. Nobody who is considered an expert or specialist likes to be the bearer of misinformation. Throughout the history of psychology and related fields, untested fads, half-baked ideas, and outright quackery have led astray theories, policies, and practices. Many

professionals with weak skills for critically evaluating research have become enthusiastic advocates of unsubstantiated claims. Other professionals have had the wherewithal to resist and have retained their skeptical reserve until solid research data were furnished.

What is necessary, then, is first to learn how to critique research and then to make a habit of sifting all incoming offerings through a sieve whose openings are small enough to permit only the trustworthy evidence to fall through. This two-part book is written to further that goal. We present the principles of research design that you need to know about to critique research (Part I), followed by intentionally flawed, but realistic, fictitious materials on which to practice your critiquing skills (Part II).

## Overview of the Chapters

Part I consists of 11 chapters. Chapter 1 deals with the methods of seeking knowledge about our world, the rules of scientific evidence, and what constitutes scientific proof. It discusses how to read critically and presents an outline to serve as a guide for critiquing research. Chapter 2 focuses on the questions and *hypotheses*, or predictions, that motivate research and discusses faulty reasoning about causation. Chapter 3 reviews the critical appraisal of research strategies and the selection of variables. The selection and composition of the research participants, or *sample*, methods of sampling, and the consequences of faulty sampling are covered in Chapter 4. Chapter 5 gets to the heart of research design in a discussion of the variables that should be under the control of the researcher and methods of controlling them. Chapter 6 presents the major *experimental* and *quasi-experimental designs* that are available, and discusses the flaws that you should recognize in some of them. It also gives examples of some of the important threats to the trustworthiness of a study. Chapter 7 discusses the selection of *independent variables*<sup>1</sup> and *dependent variables* (or outcomes) to help you appraise whether the selected techniques were appropriate and used properly in a particular research study. Chapter 8 provides an orientation to the assessment of statistical analyses, graphic analysis, and the drawing of inferences and conclusions. Chapter 9 looks at how data are interpreted and statistics translated to information. It also covers issues to consider when evaluating the completeness and transparency of a report of research. Chapter 10 introduces a different kind of research, the *research synthesis*, or *meta-analysis*, in which the goal of the researchers is not to collect new data but to accumulate and interpret the studies on a topic that have already been conducted. Ethical considerations in research, the subject of Chapter 11, are discussed to alert you to deviations from ethical standards. All the chapters in Part I are written from the perspective of readers looking in on the research report from the outside, with

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<sup>1</sup>Most often, we use the term *independent variable* to designate a variable that is being manipulated in an experiment, and therefore is viewed as a cause. The term *predictor* is used in a nonexperimental study, when the variable is measured. *Outcome* or *criterion variable* is used in a study of a treatment or intervention. We will try to use these terms in this manner through the text.

the emphasis on critically evaluating research rather than conducting research on their own.

Part II consists of 17 realistic but short and entirely fictitious simulations of journal articles. The articles have flaws built into them that range from the blatant to the subtle. The collection is essentially a workbook that is based on the principles in Part I and is intended to be used by you to practice your critiquing skills. The frontispiece by the great 18th-century artist, Hogarth, was one of the things that instigated the idea to write this book. The legend at the bottom of the print says, "Whoever makes a design without the knowledge of perspective will be liable to such absurdities as are shown in this frontispiece." So it is with research. Lack of understanding of the principles of research design can lead a researcher to the kinds of errors that are illustrated in the fictitious articles and can prevent you from realizing that there is anything wrong.

The articles in Part II range across a variety of content areas (e.g., clinical psychology, general psychology, psychology and the law, education, sociology) and research methods, but the predominant emphasis is on psychological experiments. Each fictitious article is accompanied by a critique of its built-in flaws. Critical issues are cross-referenced to the chapter in Part I that addresses them, so that if you want a fuller explanation you will know where to find it.

The kinds of statistical analyses in the articles range from simple descriptive statistics to univariate *analyses of variance* with *categorical variables*. Studies that use the techniques listed in the fictitious articles are abundant, and the articles mirror those that can be found in the literature. The articles do not feature highly advanced statistical techniques, so that the book will be useful for the greatest number of people.

These critiquing exercises are meant primarily for the use of students in psychology and related fields, whether they be advanced undergraduates or beginning graduate students. Psychologists whose graduate school experience is well behind them, and who have not themselves been engaged in research, can profit from these as well.

Because the principles of research design and the approaches to critiquing research are not restricted to psychologists or psychological research, students and professionals in other behavioral and social sciences also should find these materials and exercises useful. This book may be helpful to medical researchers, consumers of medical research, educators and education administrators, and members of the business and legal profession who deal increasingly with the evaluation of evidence and opinions that are offered by scientific expert witnesses. With so many scientific specialties, cross talk among them is necessary to function intelligently. Your understanding of research in another field may be circumscribed by a lack of technical knowledge, but you should still be able to read and understand research in a related field.

In this age of science, the media continuously expose nonscientists to science reports from all fields. The ordinary person is served a rich diet of science every day. The portions, unfortunately, take the form of sound bites that must be swallowed whole or of summaries that lack all the details. Efforts to facilitate public engagement with science are plentiful and growing more so (e.g., Alan Alda Center for Communicating Science, 2016; Center for Engagement With Science and Technology, 2016). In psychology, the call for practices to be evidence based is taking hold throughout

the profession (e.g., American Psychological Association Presidential Task Force on Evidence-Based Practice, 2006). Educated nonscientists who want to learn more about research design and how to read research critically could profit from reading in Part I, perhaps skipping sections that appear to be too technical and specialized. As information consumers, they could derive benefit from testing their critical reading skills on the exercises in Part II.

## Who Will Find This Book Useful?

Readers who are advanced undergraduate or graduate students may read this book as part of a course's materials, or can use it to assess their own level and needs. Those who have already had considerable training in research design should select any sections of Part I that will fill the gaps. You should evaluate the articles in Part II on your own before reading the accompanying critiques. Concepts that are relevant to the article are cross-referenced with Part I; you should consult Part I for further clarification.

Professional psychologists who have not done any research or who have done some research in the past but have been away from it for a long while may choose to look through the contents of Part I and start to read wherever they see a need for a refresher or wherever something strikes their interest. Those who evaluate the articles in Part II independently and find that they have missed many of the central points in the critiques may benefit from reading Part I more thoroughly.

Readers who believe that they already have a good understanding of research questions, hypotheses, and sampling but that they could use a booster on design options and methods of control might want to read Chapters 5 and 6. Those who are comfortable with various aspects of design but have questions about independent variables and dependent measures could start with Chapter 7. In either case, you should try to sharpen your reading skills by critiquing the articles in Part II.

Knowledgeable and experienced researchers who already know far more than is covered in Part I may begin with Part II and read the fictitious articles for fun, for challenge, and for mental calisthenics.