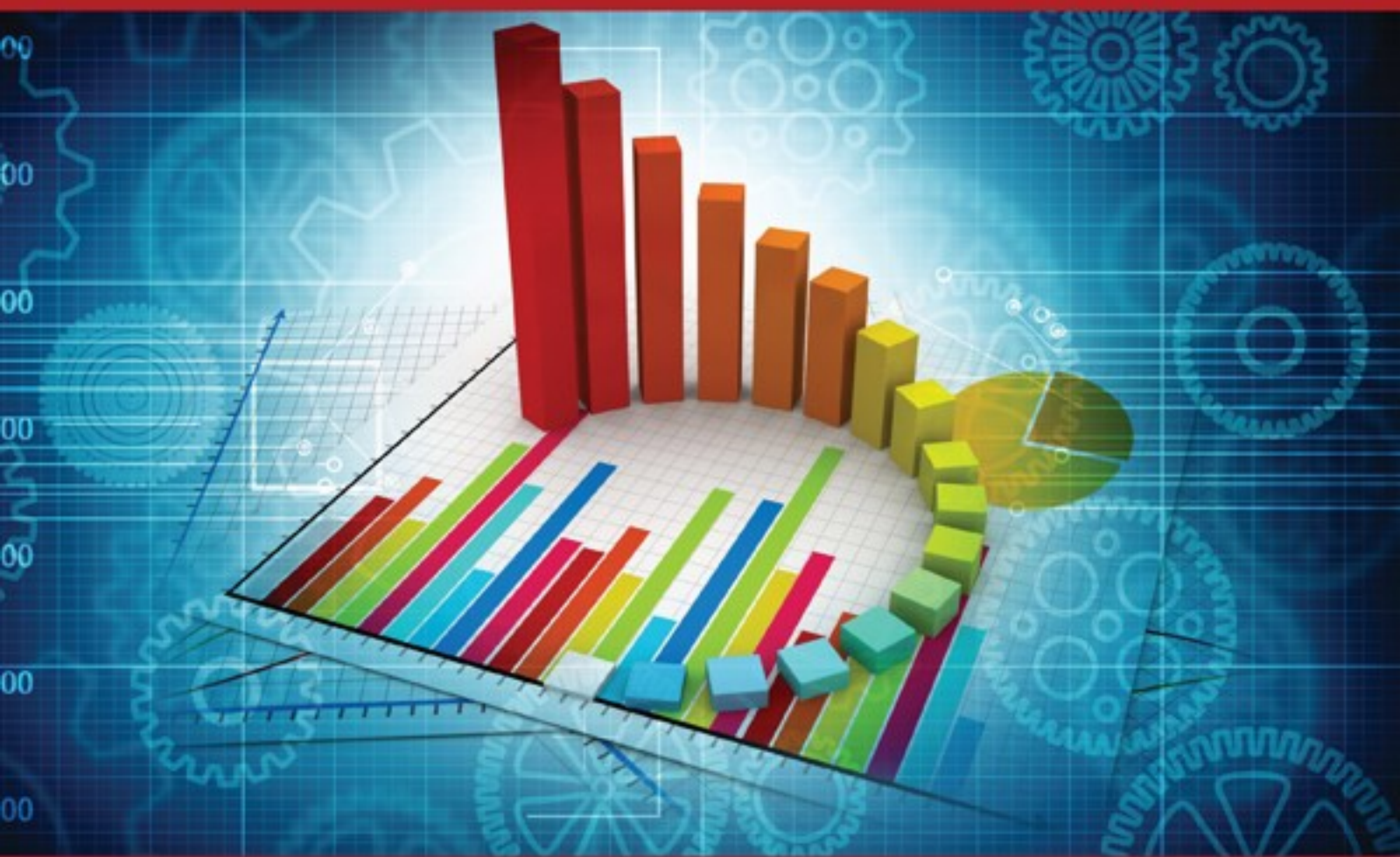
Research Design in Clinical Psychology

FIFTH EDITION



ALAN E. KAZDIN

Pearson

Research Design in Clinical Psychology

FIFTH EDITION

Alan E. Kazdin
Yale University

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Dedicated to Nicole and Michelle

Brief Contents

Contents

Preface

The purpose of this text is to describe and explain research methods in clinical psychology but the issues and methods are relevant to other areas as well, such as counseling, educational, health, and school psychology, psychiatry, social work, and nursing. The topics within each of these areas span theory, research, and application. Consequently, many of the methodological challenges are shared. The text elaborates the methods of conducting research and the broad range of designs and practices for developing a sound knowledge base. The intended audiences are individuals who design and conduct research and who read research and wish to discern what can and cannot be concluded based on how that research was conducted.

Research in clinical psychology and other disciplines I have mentioned span well controlled laboratory settings as well as applications in clinic, community, and field settings where less control is allowed and the slings and arrows of everyday experience can interfere with drawing clear inferences. An in-depth understanding of methodology is of great importance because of the range of influences in clinical and applied research that can obscure the results. These influences cannot be used as an excuse for poorly designed research. On the contrary, the subject matter and the diverse ways in which research is conducted require a grasp of the underpinnings and nuances of design so that special arrangements, novel control conditions, and methods of statistical evaluation can be deployed to maximize clarity of our findings. Methodology, including the underlying tenets and specific practices, permit the combination of rigor and ingenuity as a defense against the multitude of influences that can obscure the relations among variables.

Clinical psychology encompasses a variety of topics including the study of personality, assessment and prediction of psychological functioning and positive adjustment, etiology, course, and outcome of various forms of psychopathology and their cognitive, social, and cultural neuroscience underpinnings, and the impact of interventions (treatment, prevention, education, and rehabilitation). Many issues of contemporary life have added to the range of research topics, as witnessed by the strong role that psychology plays in research on health, interpersonal violence, crime, trauma, homelessness, and substance use and abuse. Also, family life and demographic characteristics of the population have changed (e.g., increases in teenage mothers, single-parent families, blended families, and same-sex parenting; shift in population with more elderly who are physically active). Each of these and other changes has spawned rich areas of study directly related to understanding mental and physical health. Cultural and ethnic issues increasingly are recognized to play a central role in understanding variation in core psychological processes as well as adaptive and maladaptive functioning. These changes have made the substantive focus of psychological research in general very rich. Substantive foci and findings are very much intertwined to research methods and challenges to address these questions in an evolving society.

Methodology

Methodology as a broad overarching topic is divided in this text into five areas:

- Research Design,
- Assessment,
- Data Evaluation and Interpretation,
- Ethics and Scientific Integrity, and
- Communication of Research Findings.

These areas help organize many issues as they emerge in the planning and executing research from the developing the research idea, selecting methods, procedures, and assessment devices, analyzing and interpreting the data, and preparing the written report of the results. While there is an obvious sequence in planning and executing research, ethical issues in the treatment of participants and scientific integrity pervade all facets of methodology and before, during, and after a study is conducted. At each stage of research, underlying principles, options strategies, and guidelines are presented. Connections are made as well to convey how one facet of a study we have discussed (e.g., research design, assessment) influences another (e.g., ethical issues, communication of findings).

Many methods are covered as for example illustrated with major design options (e.g., true experiments, quasi-experiments, observational studies, single-case experiments for clinical use, qualitative research) and modalities of assessment (e.g., objective and projective measures, behavioral measures, neuroimaging). The goal is to convey the range of options so that one can move from hypotheses to design in different ways but also to consider strengths, weaknesses, and trade-offs in electing specific strategies.

Overall, methodology is addressed from multiple perspectives or levels of analysis. First, methodology is a way of thinking, problem solving, and approaching substantive questions. This focus emphasizes the commitment

to overarching principles that guide science and how we describe and explain data. Second and related, there are many specific concepts that direct our attention of what to consider and what facets of a study are likely to emerge as problems that interfere with obtaining clear information from our data collection. These concepts help us move from general abstractions of developing a research idea to considering the many conditions that form a study. Once these specific concepts are known, it is possible to evaluate virtually any scientific study. Also, the specific concepts we raise direct our attention to and anticipate a range of well-known biases and pitfalls.

Third, and as expected, methodology includes scores of specific practices from sampling, assigning subjects, matching, selecting data analyses, handling missing data, and so on. The text covers these in detail but in the process reflects back on underlying principles and specific concepts we are trying to address. It remains critical at each stage and with specific practices to keep in mind what we are trying to accomplish and why. That connection can open further options as to what we can do to strengthen the inferences we wish to draw from a study.

Finally, methodology is evolving within psychology and the sciences more generally. Of course, one can find stability in methodology. Random assignment of subjects to groups or conditions, when possible, is still wonderful. Yet, much of methodology continues to change. The standards for what constitutes a "good," "well controlled," and important study continue to evolve, the range of options for measurement, the use of technology and the Web in conducting studies and expanding beyond the usual range of participants, how participants in research subjects ought to be informed, treated, and protected, and what constitutes conflict of interest among investigators. The text covers many of the changes and the broader point that methodology is not at all static.

The text emphasizes the importance of methodological diversity in science and of course specifically psychological science. There are multiple methodologies in research and the focus, yield, and contributions of these vary. We usually learn in our training the importance of experiments based on groups, comparison of group differences, null hypothesis testing statistical evaluation, and so on. This is the emphasis of the present text because this is the dominant paradigm and students ought to master the strengths, methods, and weaknesses. There are other and methodologies and approaches; they are mentioned because they are important in their own right in relation to topics studied in clinical, counseling, educational, and other areas of psychology. Also, the methodologies convey and place into sharper focus many research practices we currently take for granted as the only paradigm for empirical science.

Methodological diversity is central to research for yet another reason. The methods we select among the many options available, how we frame the question, the groups we include, and the ways we decide to measure key constructs directly affect the answers we obtain. It is not the case that every answer to every question will change depending on our methods. Even so, it is important to understand that different answers can be readily achieved with different methodological tools and decisions. This is not a "problem." The different methods we use often reveal different facets of a phenomenon, a point illustrated as we present different methods.

Overview of the Text

Research includes several stages as an investigator moves from identifying the research question; translating that into a specific study; addressing potential sources of influence, which could obscure interpretation of the results, to obtaining, evaluating, and interpreting the data. Each of these and many intervening steps are points, and each decision has its own implications and trade-offs in terms of the final product. The principles of methodology tell us what we are trying to accomplish at the decision points and the procedures and practices help us concretely devise and implement the study.

The text describes and evaluates diverse research designs, methods of assessment, and many procedures and the rationale for their use. The goal is to be of concrete help to individuals who are designing studies and evaluating the studies that others have completed. This is not a recipe text with specific procedures and ingredients from which someone can simply select. Each practice serves a purpose, and it is important to understand what that is and what trade-offs there might be in selecting one practice versus another.

Chapter 1

This chapter provides an overview of the text and introduces the topic of research design as used in clinical psychology.

Chapters 2 & 3

Methodology includes arranging the circumstances of the study so as to minimize ambiguity in reaching conclusions. Many of the factors that can interfere with drawing clear conclusions from research can be readily identified. These factors are referred to as *threats to validity* and serve as the basis for why and how we conduct research—psychological research specifically but all scientific research more generally. Types of experimental validity and the factors that interfere with drawing conclusions serve as the basis for Chapters 2 and 3.

Chapter 4

The investigation begins with an idea that becomes translated into a specific question or statement. Yet, how does one develop an idea for research? Ideas come from many places. Chapter 4 discusses sources of ideas in different ways including the role of theory and types of research (e.g., basic, applied, and translational research). Also, the topics of what makes research interesting and important are discussed. Finally in this chapter is a guide for obtaining the research idea and then moving to the next steps to develop the study.

Chapter 5

The design or how conditions are arranged to test the hypothesis is an initial pivotal decision in moving from an idea to a study. Chapter 5 discusses different design options and arrangements including true-experiments and quasi-experiments and how they address the threats to validity. Also, group designs begin with deciding who will be the subjects or participants in research (e.g., college students, online sample from the Web, clinical population). This chapter considers different options and factors that guide participant selection and the critical role of diversity (e.g., ethnicity and culture) because of their influence on what is being studied.

Chapter 6

Control and comparison groups in a study obviously are pivotal and determine what can be concluded in a study. Different types of control groups, especially in the context of experiments and the evaluation of interventions, are presented. Each type of control or comparison condition is associated with the type of question the researcher wishes to ask but also may involve ethical and practical issues that guide the decision as well. Chapter 6 discusses several types of control and comparison groups and the considerations that dictate their use.

Chapter 7

A great deal of research is based on understanding variables that cannot be manipulated directly, as illustrated, for example, in the study of individuals with different characteristics (e.g., clinical disorders, experiences, and exposure to events—natural disasters such as hurricanes and human-made disasters such as war). Observational designs (case-control and cohort designs) in which individuals are selected and evaluated concurrently or longitudinally are presented in Chapter 7. These designs are quite powerful in identifying antecedents (e.g., risk factors to some outcome such as a mental or physical health problem, dropping out of school, criminality) and even possible causal relations. There are multiple design options, control procedures, and strategies to optimize the yield from designs in which variables of interest cannot be manipulated and controlled experimentally.

Chapter 8

Although experimental designs usually consist of group studies, causal inferences can be drawn from the study of individuals or a small number of individuals. Single-case experimental designs provide a methodology for drawing inferences that can be applied both to individuals and groups. The designs expand the range of circumstances in which can conduct evaluations, especially in circumstances where control groups are not available and one is interested in evaluating an intervention program. Chapter 8 presents special design and data-evaluation strategies that characterize single-case experimental research.

Chapter 9

The vast majority of research within psychology is within the quantitative tradition involving group designs, null hypothesis testing, assessment on standardized scales and inventories, and statistical evaluation in the form of null hypothesis testing. From a different tradition and approach, qualitative research methods alone but also in combination with quantitative research are enjoying increased use in psychology and social sciences more generally. Qualitative research is a scientifically rigorous approach and makes a special contribution to knowledge, usually by intensively studying a small number of subjects in depth. The goal is to capture the rich experience of individuals in special circumstances and to go well beyond the knowledge that can be obtained by questionnaires and fixed measures. Chapter 9 provides an overview of the qualitative research, conditions to which the designs are suited, and illustrations to convey the contribution to developing the knowledge base. Qualitative research, along with the prior chapter on single-case research, also places into perspective the dominant model of quantitative and hypothesis testing research and expands the range of options from those commonly used to address important research questions.

Chapter 10

The chapters now move from design strategies to measurement. Chapter 10 focuses on the underpinnings of assessment to establish key considerations in selecting measures for research and interpreting the measures that are presented in articles we read. Core topics of assessment are included such as various types of reliability and validity, the use of standardized versus nonstandardized measures, and assessment issues that can influence the conclusions one can reach from research. Useful strategies (e.g., selecting multiple measures, measures of different methods) and their rationale for improving research also are discussed.

Chapter 11

The varied options for measurement are discussed in Chapter 11. These options or assessment modalities include large families of measures such as objective, projective, observational, psychobiological measures, and other types as well. The chapter illustrates specific measures but is more concerned about conveying the different modalities and their strengths and limitations. In addition, the chapter encourages drawing from different types of measures in any one study to strengthen the conclusions that can be drawn.

Chapter 12

Special topics in assessment are covered in Chapter 12. The chapter begins by discussing ways on assessing or checking on the impact of experimental manipulations on the participant. These measures focus on whether the manipulation was perceived by or registered with the participants and are not primary outcomes or dependent variables. Assessment of the manipulation raises important issues to strengthen a study but also special considerations that can influence interpretation of the findings. Another topic in the chapter is measuring the practical or clinical significance of change that goes beyond the usual measures.

Chapters 13, 14, & 15

The next chapters turn to data evaluation. Null hypothesis and statistical testing serves as the dominant model in scientific research in social, natural, and biological sciences and of course including clinical psychology, counseling psychology, education, and other areas with basic and applied research questions. Mastery of the approach is essential. Chapter 13 evaluates the rationale of this approach and strategies to strengthen research within the tradition of null hypothesis testing. Common ways in which the results of research misinterpreted ("my results were almost significant; pretty please let me sort of say that they are significant") and failures to replicate the findings of others in light of statistical testing and binary decision making (significant or not) are also presented. Despite the dominance of null hypothesis testing, there is a long history continuing today firmly objecting to using the approach. Mastery of the approach requires knowing the objections and possible ways of addressing them. In addition, an alternative way of doing research (e.g., Bayesian analyses) is highlighted to convey another option from null hypothesis testing.

Data evaluation has many practical decision points related both to describe the sample and to draw inferences about the impact of the manipulation of interest. Chapter 14 discusses presentation of the data and using supplements to statistical significance testing (e.g., measures of strength of effect, confidence intervals) to elaborate the findings. Key decision points, multiple options, and sources of bias are highlighted in relation to such topics as handling missing data and deleting subjects from data analyses. Exploring one's data is also discussed to deepen one's understanding of findings but primarily as a guide to further hypotheses and studies. Chapter 15 focuses on interpretation of the findings of an investigation and common issues and pitfalls that emerge in moving from describing and analyzing the results to the interpreting of those results. This chapter also discusses so-called negative results, i.e., the absence of differences.

Chapters 16 & 17

Ethical issues and scientific integrity form the basis of Chapters 16 and 17, respectively. Although the topics overlap, I have treated them separately to permit their detailed treatment. For purposes of presentation, I have delineated ethical issues as the responsibilities of the investigator in relation to participants in research. The ethical issues chapter covers such key issues as deception, debriefing, invasion of privacy, informed consent and assent, withholding treatments, and presenting treatments of questionable effectiveness. Also, professional guidelines and codes along with federal regulations to guide protection of subjects are presented. Scientific integrity is delineated as the responsibilities of the investigator in relation to the research enterprise, science, and public trust. Issues that are covered include fraud, questionable practices that can distort findings, plagiarism, sharing of data, and conflict of interest, and jeopardizing the public trust. Here too there are professional guidelines and regulation to guide us. The chapters convey that ethical issues and scientific integrity are core features of research and emerge at the stage of developing the research proposal long before the first subject is run. In addition, ethics and scientific integrity are vibrant areas of activity in part because of greater public awareness of science and lapses in ethics or integrity but also because novel situations are emerging (e.g., "big data," findings that can be used for the public good or ill). These new situations raise the need for deliberation and new guidelines to ensure protection of subjects.

Chapter 18

Completion of a study often is followed by preparation of a written report to communicate one's results. Communication of the results is not an ancillary feature of research methodology. The thought and decision-making processes underlying the design of a study and the specific methods that were used have direct implications for the conclusions that can be drawn. Preparation of the report is the investigator's opportunity to convey the interrelation of the conceptual underpinnings of the study and how the methods permit inferences to be drawn about those underpinnings.

Chapter 18 discusses the written report and its preparation in relation to methodological issues presented in previous chapters. The special role that methodological issues and concerns play in the communication and publication of research is highlighted. Questions are provided to help guide the write-up of research on a section-by-section basis. Also, the journal review process and the different fates of manuscript will be of interest to those who develop research or read published articles.

Chapter 19

The text ends with closing comments that discuss the interplay of the five areas of methodology covered in prior chapters, namely, research design, assessment, data evaluation, ethical issues and scientific integrity, and communication of findings. The chapter conveys that substantive and conceptual issues and methodology are deeply intertwined. Methods used to study a phenomenon actually can contribute to the specific findings and conclusions. Consequently, the chapter underscores the importance of methodological diversity, i.e., the use of different methods (e.g., designs and measures) because different methods often elaborate different facets of a phenomenon of interest and produce different findings. The student who has completed and mastered the text will not need any simple, summary, nutshell rendition of how to develop and design the almost perfect study. Even so, at the very end of the chapter, there are simple guidelines for applying all that has been learned in a format that, hopefully, will assist any person designing his or her first study, or planning a project or grant.

New to the Edition

The revised edition of the text includes scores of additions and changes to reflect the evolving and dynamic nature of psychological science and methodology and ways of carrying out studies. Many such changes of this type addressed in this text, compared to prior editions, include greater attention to:

- How to develop a research idea and what makes a research study interesting and important;
- Use of technology and Web-based methods to conduct studies;
- Cultural and ethnic issues and how and why they are essential to integrate into research;
- Decision making in analyzing the results and points where bias often is introduced;
- Ethical issues and scientific integrity and their pervasive role in the research process from beginning to end;
- Publication bias, "negative" results, and current priorities related to replication; and
- Changes in the publication and communication of research that can affect both researchers and consumers of research.

I mentioned technology and its role in research design. Novel and emerging topics related to technology including secondary data analyses on a large scale, "big data," tracking individuals and connecting data (e.g., social network, GPS tracking of smart phones, monitoring purchases on the Internet), and the nature of publication of research (e.g., predatory journals, ghost authors) raise all sorts of new opportunities (e.g., assessment in real time, feedback to subjects in their everyday life) and problems. Several such topics have been expanded in the revised edition along with the many of the challenges (novel ethical issues, ways of reducing fraud).

Apart from additions, each chapter was revised and updated. An effort was made to retain classic references and references to leaders in statistics and methodology whose names ought to be known and recognized because of their roles in developing methods that we currently use. Also, many key topics of research were retained (e.g., moderators, mediators, and mechanisms) but updated in light of changes in research. Throughout the text examples are provided to illustrate key points. The examples draw from classic (old) but mostly new studies and from clinical and other areas of psychology.

For the illustrations of all components of methodology, I have drawn examples from natural, biological, and social sciences, in addition to psychological and clinical psychological research. The purpose in drawing from diverse fields is four-fold. First, psychology is recognized as a hub science, i.e., a field from which many other disciplines draw including education, medicine, law, economics, and public health. Our substantive findings as well as our methods routinely are drawn upon. This allows illustrations of what is important in methodology to connect with other areas of research. Many of the central issues and concerns specific to areas of this text (e.g., clinical, counseling, educational psychology) are common among many disciplines. Seeing a methodological issue or practice in different contexts can lead to better understanding as well as increase options for how we address the matter in our studies.

Second, disciplines often approach topics somewhat differently. For example, there are currently new and evolving guidelines regarding the use of placebos in medicine. The ethical issues and new guidelines developed to address them raise critical points in psychological research in relation to the various control and comparison groups we use (e.g., in evaluating the effects of psychotherapy or a community intervention to improve nutrition). In fact, guidelines and regulations often drawn for research in one area or discipline spill over into other areas as well. Seeing

emergent issues in other areas can deepen our understanding of many practices that are required in our research.

Third, psychologists (and scientists in general) increasingly are involved in collaborative arrangements with researchers from other disciplines. Indeed, many of the examples are drawn from just such instances. Thus methodologies from varied disciplines move back and forth to influence each other. Drawing examples from diverse disciplines helps to convey the methodological diversity, the range of options are available in research, and some of the advantages of collaborating to study phenomena of interest.

Finally, many fascinating examples from diverse areas can illustrate key points to bring methodology to life. For example, methodology is illustrated with examples on such topics as sports, sexual attraction, bullying in the schools, the effects of wine and religion on health, what stress can do to our immune system, cancer cures that could not be replicated, abstinence programs in the schools and their effects on sexual activity, racism and discrimination in research, interpersonal violence, and self-injury, so on. The purpose goes beyond the effort to make methodology engaging. Methodology is the core of key topics of our daily lives and is relevant. Stated another way, methodology is not merely a text on how to do or interpret studies. Methodology underlies the knowledge that we and others (e.g., policy makers, legislators) rely on to make decisions for ourselves, family members, or some group for which we have input or responsibility. Understanding the strengths and weaknesses of research and nuances are pivotal. Although there is an ivory tower feature of methodology, as scientists we are in the world and it is important to keep the relevance of what we do in mind as we design, complete, and write-up our research. Stated more dramatically but also accurately, methodology can be a matter of life and death and that point demands illustration and support. It is coming later in the text.

Although many examples draw on topics important to everyday lives that is not the only dimension on which current examples were selected. The range of research from laboratory to applied studies is addressed in separate ways. These include the role and importance of nonhuman animal studies and their contributions. Research projects designed to be a proof of concept, for example, convey how critical methodology is to see what can happen in principle. Also the range of translational research is discussed that include the extension of research from the laboratory to person or patient care ("bench-to-bedside" research) and from individual person care to community level intervention ("bedside-to-community" research).

This edition includes teaching aids for the reader and instructor. First, throughout the text, I have added tables to provide summaries and aids for the reader. When there are multiple points that require elaboration (e.g., how to increase power, types of relations among variables the investigator may wish to study), it is easy to lose sight of the key points. The tables are useful study guides once the individual entries have been elaborated. Second, at the end of each chapter there is a chapter summary to assist the reader in reviewing key concepts. Third, there is a list of readings included at the end of the text that directs the interested reader to more in-depth presentations of topics; this listing is organized by chapter. Finally, a Glossary is included at the end of the text to centralize and define briefly terms introduced throughout the chapters. Special terms italicized within the text are usually covered in the glossary as well. Although the text is not overabundant in terminology, there is value to providing a quick reference to terms and practices.

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Acknowledgments

Several persons have contributed to the thrust and focus of this text over the last several years. It is usually gracious for an author to convey to the reader that any errors that remain in the text after extensive input from others are his or her responsibility alone. That is not how I feel. For errors, short-sightedness, limitations, and non-brilliant ideas in this text, I hold most people in my life responsible! My early upbringing in the forest, in utero fast foods fed to me over which I had no control, a maladaptive polymorphism here and there, and crushing judgmental frowns by an influential high school teacher or two are just some of the influences that account for the lapses that the reader may find in my thinking. Also, my peer group in the other incubators in the maternity ward the few days after my birth were not exactly positive influences—many other infants were slackers (they slept most of the time); others seemed to whine (e.g., cry when they did not get fed or changed). In that environment, I did the best I could but the limitations cannot be eliminated. Who knows what of those influences entered this text.

As to the positive influences, I have been blessed with remarkable colleagues and students who through direct discussion or exemplary work have inspired me to think about methods, how important they are, and what they can accomplish at their best. Insofar as this revision excels and is helpful, interesting, or important, I am pleased to share the credit. A few mentors deserve especial credit for their influence and include Richard Bootzin, Donald Campbell, and Lee Sechrest. Long ago but also in an enduring way, they inspired my interest in methodology and its importance. Fast forward to now, graduate and undergraduate students at Yale University who have taken course on the topic of this text also have provided detailed input and comment. I am especially grateful to those few students who did not demand refunds for the text halfway into the course.

Finally, although many years have passed since my dissertation, I owe a special debt of gratitude to my dissertation committee. In addition to the laugh track they played after I summarized my study at my dissertation oral exam, committee members made subtle, nuanced comments that linger in their influence on me (e.g., "Alan, find another career." "Research isn't for everyone." "When we said, 'use a pretest,' we did not mean omit the posttest.") These pithy comments raised the prospect that understanding methodology may be rather important. (Not wanting to be identified with my study, all my committee members entered the Dissertation Committee Witness Protection Program immediately after my oral exam, and unfortunately cannot be identified by their original names. But, thank you "Cody," "Billie Sue," "Thaddeus," and most of all the chair of my committee, "Mygrane." I am grateful to you all wherever you are.)

Several sources of research support were provided during the period in which this text was written. I am pleased to acknowledge grants from the National Institute of Mental Health, The Humane Society of America, The Laura J. Niles Foundation, Yale University, and a generous donor who wishes to remain anonymous. Needless to say, the views expressed in this text do not reflect the views of any agency that has provided research support nor, for that matter, the agencies that have not provided support.

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About the Author

Alan E. Kazdin, PhD, is Sterling Professor of Psychology and Professor of Child Psychiatry at Yale University. Prior to coming to Yale, he was on the faculty of the Pennsylvania State University and the University of Pittsburgh School of Medicine. At Yale, he has been Chairman of the Psychology Department, Director of the Yale Child Study Center at the School of Medicine, and Director of Child Psychiatric Services at Yale-New Haven Hospital.

Kazdin's research has focused primarily on the treatment of aggressive and antisocial behavior in children (inpatient and outpatient) and parent, child, and contextual influences that contribute to child dysfunction and processes and outcome of child therapy. His work has been supported by the National Institute of Mental Health, the William T. Grant Foundation, the Robert Wood Johnson Foundation, Rivendell Foundation of America, Leon Lowenstein Foundation, the Humane Society of America, the Laura Niles Foundation, and Yale University. His work on parenting and childrearing has been featured on NPR, PBS, BBC, and CNN, and he has appeared on Good Morning America, ABC News, 20/20, and Dr. Phil.

Kazdin has been editor of various professional journals (*Journal of Consulting and Clinical Psychology*, *Psychological Assessment*, *Behavior Therapy*, *Clinical Psychology: Science and Practice Current Directions in Psychological Science*, and *Clinical Psychological Science*). He has received a number of professional awards, including the Outstanding Research Contribution by an Individual Award and Lifetime Achievement Awards (Association of Behavioral and Cognitive Therapies), Outstanding Lifetime Contributions to Psychology Award and Distinguished Scientific Award for the Applications of Psychology (American Psychological Association), and the James McKeen Cattell Award (Association for Psychological Science). In 2008, he was president of the American Psychological Association.

Kazdin's 700+ publications include 49 books that focus on methodology, interventions for children and adolescents, parenting and child rearing, cognitive-behavioral treatment, and interpersonal violence. Some of his recent books include:

Single-Case Research Designs: Methods for Clinical and Applied Settings (2nd ed.)

Methodological Issues and Strategies in Clinical Research (4th ed.)

Parent Management Training: Treatment for Oppositional, Aggressive, and Antisocial Behavior in Children and Adolescents

The Kazdin Method for Parenting the Defiant Child: With No Pills, No Therapy, No Contest of Wills (with Carlo Rotella)

Behavior Modification in Applied Settings (7th ed.)

Evidence-Based Psychotherapies for Children and Adolescents (2nd ed.) (with John R. Weisz)

Violence Against Women and Children: Volume I: Mapping the Terrain. Volume II Navigating Solutions (with Jacqueline W. White and Marry P. Koss)

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Chapter 1
Introduction

Learning Objectives

1.1 Justify the indispensability of science

1.2 Report some of the roadblocks in our study of science

1.3 Examine the methodologies that govern scientific research

1.4 Analyze some of the key concepts that guide scientific thinking and problem solving

1.5 Discuss the importance of Semmelweis's usage of a scientific way of thinking to solve a problem.

Science is the study of phenomena through systematic observation and evaluation. A body of knowledge in a given area is accumulated through agreed-upon methods about how to obtain and verify that knowledge. Science also is a special way of knowing. It relies on information from our experience and encounters with the world. Yet, it is a more formal way of understanding and evaluating that experience.

Key processes and characteristics of science are the use of:

- Generating theory or conceptual explanations of the phenomena of interest
- Proposing hypotheses to test these explanations
- Collecting data under conditions and special arrangements (e.g., experiments, natural situations)
- Evaluating the data to draw inferences about the hypotheses

The processes or steps do not need to flow in that order at all. We might systematically observe a relation that we did not expect. For example, women who immigrate to a country and have their children are more likely to have a child with autism than are women who are from the country (i.e., are already there) (Lehti et al., 2013). That finding has been replicated; so for the moment, let us assume this is reliable. That finding itself seems odd and not easy to explain. We now try to understand this.

- What about these mothers or families could explain the finding?
- Are less healthy moms the ones who migrate?
- Are they just as healthy but the stressors associated with migration (e.g., perhaps fleeing war zones) lead to many birth complications?
- Does migration temporarily lead to deficiencies in diet that somehow are involved?
- Are there new pathogens (bacteria, viruses) in the new country to which their immune systems have not accommodated?
- Where to begin?

The answer is developing a plausible explanation (theory) and now testing it. Age and income of the parents or complications in delivery of the child did not explain the effect. We turn to other possible explanations and also see if there is related research that could help. We know that low intake of folate (B9: a water-soluble B vitamin found in leafy green vegetables) increases risk of autism and that giving moms folate supplements decreases incidence of autism. Yet, diet is only one possibility, and we do not know from the immigrant study whether there were any dietary differences. We have our research tasks cut out for us but how wonderful it will be once we understand because then we can be the most helpful to prospective parents to reduce or eliminate the higher risk of autism. In that process, we are likely to learn about other disorders and the broader impact of parent practices before and during pregnancy and later child development. Perhaps armed with a fuller explanation, we can greatly reduce the rates of autism among mothers at risk. But this all began with an observed relation and that enters us into the key processes that characterize scientific research.

1.1: Why Do We Need Science at All?

1.1 Justify the indispensability of science

This is a good question. Four reasons can make the case for why we need science.

1.1.1: Rationale

Here are the four reasons that make the case for why we need science.

***First**, we need consistent methods for acquiring knowledge.*

There are many sciences, and it would be valuable, if not essential, to have the principles and practices consistent. We would not want the criteria for what "counts" as knowledge to vary as a function of quite different ways of going about obtaining that knowledge. This consistency is more important than ever because much of research on a given topic involves the collaboration of scientists from many different fields to address a question. They must speak the same language, share the same underlying values about how to obtain knowledge, and agree on procedures and practices (e.g., statistical evaluation, reporting data that do and do not support a particular hypothesis). Consistency also is critical within any given scientific discipline. For a given science (e.g., psychology), we would want consistency throughout the world in what the standards are for obtaining scientific knowledge—the accumulation of knowledge from all individuals in a given field requires this level of consistency. Science "says" essentially these are our goals (e.g., describe, understand, explain, intervene where needed, possible, and desirable) and these are our means (use of theory, methodology, guiding concepts, replication of results). Science is hardly a "game" because so many of the tasks we have are serious. Yet there are rules, and there are enormous benefits from following them among all sciences and scientists.

***Second**, science is needed to identify, detect, isolate, and reveal many of the extremely complex relations that exist in the world.*

Casual observation cannot identify the complexities that we study in science. Science uses special controlled arrangements to isolate influences that are otherwise difficult, if not impossible, to detect in everyday life. Also, science often relies on special methods of assessment that extend well beyond what our senses could reveal from normal observation. The complexities of our findings that require this special scrutiny that science provides are easily conveyed by examples from the natural and social sciences.

Consider questions and answers that scientific methods were needed to address:

- What is near the boundary of our universe? Well for starters, a galaxy (system of millions or more stars held by gravitational attraction) has been identified that is over 13 billion light years away.
- How did dinosaurs become extinct? Approximately 66 million years ago (give or take 300,000 years), a huge asteroid (15 kilometers or over 16,400 yards wide) crashed into the earth (near Yucatan, Mexico) and led to the extinction of more than half of all species on the planet, including the dinosaurs. The material blasted into the atmosphere would have led to a chain of events leading to a "global winter."
- Are male and female interactions and behaviors influenced by a woman's menstrual cycle? The place a woman is in her menstrual cycle apparently has effects on her behavior (e.g., selection of clothing, gait when walking, and the type of male that seems attractive, and how men respond to all of this). All of this is out of consciousness but conveys a dynamically changing interaction influenced in part by ovulation cycles.
- Exercise can greatly improve mental health, but how? Consider depression as one example. Exercise increases a protein in the brain (hippocampus) that helps the development of neuron and synapses (neurogenesis) and in the process reduces symptoms of clinical depression. These are the changes also made when antidepressant medication is used as the treatment.
- Do early harsh environments for children (e.g., exposure to violence, enduring stress, corporal punishment) have any long-term effects? Yes, they can have many including enduring impairment on the immune system (ability to ward off infection and inflammation), and that is considered to be the reason that such children have premature deaths from serious disease much later in adulthood.

This random-like sample of findings (each from a larger literature of multiple studies) is hardly the tip of the iceberg, and many findings you already know from your studies fit into the category, namely, they would be difficult or impossible to discern from casual observation. The complex findings required very special observation procedures under special arrangements and often using special math or statistics. The conclusions I list are not discernible by everyday observation. If you said, you knew all along there was a galaxy at the boundaries of our universe, what's the big deal? Or that of course exercise changes a specific protein in that area of the brain, you are among a very small group.

***Third**, whether the relations are complex or not, for many questions of interest, we need extensive information (a lot of data) to draw conclusions.*

How to obtain that information (assessment, sampling) requires very special procedures to yield trustworthy results. For example, how many individuals in community samples (i.e., in everyday life) experience some form of psychiatric disorder? To answer this, we need a large sample, a representative sample, and special procedures (e.g., use of measures known to be consistent with the information they provide and to reflect the phenomenon of interest). Approximately 25% of the population in the United States at any given point in time meet criteria for one or more psychiatric disorders (Kessler et al., 2009; Kessler & Wang, 2008). That kind of information cannot be obtained from casual observation or individual experience. (In fact, based on my informal assessment from a recent family reunion, I had the rate closer to 80%.) We need large data sets and systematically collected data to address questions, and science is needed to provide the information and in a trustworthy, transparent, and replicable way.

***Finally**, we need science to help surmount the limitations of our usual ways of perceiving the environment and extracting conclusion.*

There are many sources of subjectivity and bias along with limitations in our perceptions that interfere with obtaining more objective knowledge, i.e., information that is as free as possible from subjectivity and bias. How we perceive and think is wonderfully adaptive for handling everyday life and the enormous challenges presented to us (e.g., staying out of danger, finding mates and partners, rearing children, adapting to harsh and changing environments, meeting the biological needs of ourselves and family—it is endless). Our evolution spanning millions of years has sculpted, carved, sanded, and refined these skills, so I am not dismissing them here. Yet, those very adaptive features actually can interfere, limit, and distort information presented to us and do so by omission (our perception omits many facets of experience that we do not detect well) and by commission (we actively distort information on a routine basis).

1.2: Illustrations of Our Limitations in Accruing Knowledge

1.2 Report some of the roadblocks in our study of science

The goal of science is to build a reliable (consistent, replicable) body of knowledge about the natural world (physical, biological, psychological). Some limitations emerge that are merely part of being human that we need to address and surmount. Here is a brief sample, beginning with some you already know well.

1.2.1: Senses and Their Limits

Limitations of our senses including vision, hearing, and smell are familiar examples to convey how we are very selective in the facets of reality that we can detect. We consider what we see, hear, and smell to represent reality, i.e., how things are. In a way what we see, hear, and smell *are* reality. Yet, they are very selective. We do not see very much of the electromagnetic spectrum. We see what is called (and is amusingly self-centered) "the visible spectrum." Actually, it is not *the* visible spectrum but is *a* visible spectrum, because it is defined as that part of the spectrum that the human eye can see. We see wonderful things all of the time, people, colors, sky, sunset, and methodology texts, all the while knowing intellectually at least that we do not see it all. We do not see many parts of the spectrum (e.g., infrared, ultraviolet). Other animals (e.g., birds and bees and many other insects) see part of the spectrum we do not see that helps with their adaptation (e.g., identifying sex-dependent markings of potential mates that only are visible in ultraviolet light). The same holds true for sounds and smells; many nonhuman animals have senses that evaluate different parts of the world from those we can experience. Many animals can hear sounds that we do not hear (e.g., dogs, elephants, pigeons) and have a sensitivity to smell that vastly exceeds our own sense of smell (e.g., bears, sharks, moths, bees). More generally, many nonhuman animals trump our vision, hearing, and smell or have differences that are not better (more sensitive) or worse but just different (e.g., seeing different parts of the electromagnetic spectrum).

These examples are intended to make one point: as humans we see one part of the world and that is quite selective. The picture we have of what "is" omits piles of things that are. (As I write this paragraph, I am listening to a lovely tune on a dog whistle—I cannot really hear it of course, but the piece is written by Fido Johnson who has been called the Mozart of dog composers.) So one reason for science is to overcome some of the physical limitations of our normal processing of information. Much of what we want to know about and see cannot be seen by our ordinary capacities (our senses).

1.2.2: Cognitive Heuristics

Leaving aside physical limitations on seeing, smelling, and hearing the world, more persuasive arguments of the need for science come from many areas of cognitive psychology. These are more persuasive in the sense that when we look at experience well within our sight and capacities

of our senses we still may have enormous limitations in how we process that information. You already know the everyday expression, "seeing is believing;" psychological research has provided considerable support for the additional claim, "believing is seeing." We process the world in special ways and various cognitive processes have been well studied. These processes can and often do systematically distort and lead us to make claims and inferences that do not reflect reality, as revealed by less or unbiased means.

There are several characteristics of normal human functioning that reflect how we organize and process information. They are referred to as *cognitive heuristics* and are processes out of our awareness that serve as mental shortcuts or guides to help us negotiate many aspects of everyday experience (Kahneman, 2011; Pohl, 2012). The guides help us categorize, make decisions, and solve problems. The heuristics emerge as "bias" when we attempt to draw accurate relations based only on our own thoughts, impressions, and experience. There are several heuristics (as covered in the cited references).

Consider the *confirmatory bias* as an example of one cognitive heuristic. This heuristic reflects the role of our preconceptions or beliefs and how those influence the facets of reality we see, grasp, and identify. Specifically, we select, seek out, and remember "evidence" in the world that is consistent with and supports our view. That is, we do not consider and weigh all experience or the extent to which some things are or are not true based on the realities we encounter. Rather we unwittingly pluck out features of reality that support (confirm) our view. This is particularly pernicious in stereotypes, as one case in point. Thus, if one believes that one ethnic group behaves in this or that way, or that people from one country or region have a particular characteristic, we will see the evidence that is supportive—the supportive evidence is more salient in our mind and memory. Counter-evidence does not register as salient or if and when it does is dismissed as an exception.

1.2.3: Additional Information Regarding Cognitive Heuristics

Consider one of many lamentable stereotypes that has been part of our culture, namely that obese people are jolly, not based on research at all and even refutable. Furthermore, consider the following: you see eight pensive, mildly mournful obese individuals during your day and two other outgoing, smiling, and jolly obese individuals that same day. Our conclusion would not be (from casual observation) that a few obese people are jolly, or roughly 20% are. If one believes obese people tend to be jolly, the confirmatory biases would draw on the two as, "Aha, I knew it, no surprise here the group is jolly, but of course there are exceptions" or "those nonjolly ones probably just were having a bad day." You might even blurt out a cliché to even provide further confirmation by noting, "the exception proves the rule." The technical term for all of this processing is "normal," and other terms might apply too (e.g., stereotyping, prejudice, discrimination). Yet the coding of information is out of awareness completely but clearly guides our interpretation of reality. We need science in part to surmount such influences.

Of course it is quite a legitimate empirical (scientific) question to ask, for example, whether obese people are jolly, jollier than nonobese people, handle situations (e.g., pain, stress) with more positive outlooks, and so on. No single study could answer these, but it is interesting to note in passing that a gene associated with obesity also is related to depression. Obese individuals tend to have slightly lower rates of depression in light of a genetic influence that apparently influences both obesity and depression (Samaan et al., 2013). This finding is not the same as showing that obese individuals are walking around laughing and engage in inappropriately cheery behavior (e.g., at funerals). And we do not know what level of obesity (how much overweight, at what age, for how long) provides the limits of this finding. The point is that we cannot trust our perceptions in light of a confirmatory bias. And this is merely one form of cognitive bias in which our view, perceptions, and conclusions systematically depart from what the data in the world would show if the bias could be controlled in some way. There are many others that lead us to overestimate one possibility (e.g., being struck by lightning) or to underestimate others (e.g., being in a car accident while texting or talking on a phone while driving).

Cognitive heuristics are not the only set of influences that guide our perception. Our motivation and mood states can directly influence how and what we perceive of reality (Dunning & Balcetis, 2013). Both biological states (e.g., hunger, thirst) and psychological states (e.g., mood) can directly guide how reality is perceived. This is sometimes referred to as *motivated perception* or *wishful perceiving*. For example, when one feels threatened or angry, one is likely to see others as holding a weapon rather than a neutral object (Baumann & DeSteno, 2010). That is, the "reality" we perceive is influenced by us as a filter, and we are changing in biological and psychological states that have impact on what we see, hear, and recall.

1.2.4: Memory

Other examples illustrate how our normal processing of information influences and distorts. Consider a few facets of memory, a key topic within psychology. Memory refers to the ability to recall information and events,

although there are different kinds of memory and ways of studying them. As humans we believe (and are often confident) that our memory *records* reality but research very clearly shows that we *recode* reality (Roediger & McDermott, 2000). That is, more often than not we do not recall things as they have happened. And this has come up in many contexts.

***First**, as we consider stories of our past (e.g., childhood, high school years) little details and sometimes larger ones get filled in and become part of our remembered story.*

Our memory draws on information for experience of the external world, but these are filled in with internal processes (e.g., imagination, thought). As we recount the story, we cannot make the distinction between what in the story actually happened and what did not. *Reality monitoring* is the name for a memory function that differentiates memories that are based on external (the world) versus internal (one's own thoughts, perceptions) (Johnson, 2006). Thus, I can separate my imagined phone call from the Nobel committee (last night's dream) from reality (the phone call I actually received yesterday from my dry cleaner—pick up my shirts or they will be thrown out). Errors occur when that distinction is not made, and that is a function of several things including how vivid the imagined events are and how consistent they are with the external stimuli. We develop a story or scheme of an event or what happened and fill in details where and as needed, and when we recall the event cannot always distinguish the source. I have a vivid memory of something at home when I was 6 months or so old. This is a picture of where I was sitting, who entered the room, and so on. More likely, I was told related stories about this event many times and now subjectively I am certain I can recall this. I can recall this—but it is as likely as not, the event was registered on my memory by the stories and not by my direct recall of the event as it occurred, if it occurred at all.

***Second** and related, the notion of false memories has been in public as well as scientific literature.*

The interest emerged from the experiences of many clients in therapy who, over the course of treatment, newly recalled childhood experience of abuse that was brought out during the course of therapy. In fact, in several cases it looks as if the memories were actually induced by the very process of therapy. This does not mean of course that all, most, or any given recollection of abuse is false, but we know that some are and that is just enough. Research has moved to study false memories—can we induce them in stories, memory tasks, and laboratory studies (e.g., Brainerd & Reyna, 2005)? Yes, in experiments we can even implant them. And when people recall material in the experiment, often false memories (things that did not occur at all) in fact are recalled and mixed with those that have occurred.

***Finally**, consider recall used heavily by the courts in legal proceedings.*

In jury trials, the most persuasive type of evidence is eye-witness testimony. Juries are persuaded by a witness on the stand saying he or she saw the defendant do this or that and perhaps even identified the defendant out of a line-up as the perpetrator. The reliance of eye-witness testimony makes forensic psychologists want to jump out of their basement windows because there is now rather extensive research showing that this type of testimony is the most unreliable form of evidence and is responsible for sending more innocent victims to prison than any other form of evidence (Wells & Loftus, 2013). Well beyond our discussion are multiple findings that show that who is identified as the alleged criminal depends on how questions are presented to a witness, how the line-up of possible suspects is presented (one at a time, all together), the time between witnessing the event and recall, and so much more. Now rather extensive research not only has shown that eye-witness testimony is fairly unreliable, but also the many variables that influence what people recall and its accuracy. In short, coding and recalling experience, even when vivid and something in which we are very confident, may not represent what has happened. We need more reliable tools to codify current and past experience that surmounts some of our normal recall and other limitations.

1.2.5: General Comments

Several facets of perception, thoughts, and emotions influence how we characterize the world, although I mentioned only a small sample (e.g., only one cognitive heuristic although there are several; only a few areas of memory research including reality monitoring, false memories, and eye-witness testimony while omitting others). The point was just to convey that as humans we have limitations that can readily influence conclusions we reach. These limitations can have little impact (e.g., details regarding who was at a social event last month and who drank and ate what) or enormous impact (e.g., who goes to jail or receives the death penalty). Also, we negotiate life rather well, do not bump into buildings or each other when walking down the street, put on our clothing correctly most days, and say "hi" rather than "goodbye" when we first encounter a friend or colleague during the day. So we should not distrust our senses, cognition, and affect. Accumulating scientific knowledge is another story.

For developing a knowledge base of how the natural world is, the limitations I have illustrated convey how

essential it is to develop means to counter normal experience, perception, memory, and the like.

- The challenge is as follows: we know we have limitations in our perception and hence in our ability to acquire unbiased knowledge without some systematic set of aids.
- The paradox: we ourselves, with these imperfections, have the responsibility of developing those aids (methods) to surmount those limitations.

> *Methodology* is the broad label for principles, practices, and procedures we have devised to help overcome or minimize biases that can obscure our knowledge of what the world is like.

Methodology is invented by people and is hardly perfect or flawless. As a human endeavor, most human characteristics and imperfections (e.g., greed, fraud, distortion) are or can be involved along with so many of our ideal characteristics (e.g., search for true knowledge, cooperation, interest in helping others, understanding our place in the universe).

Think of science as a way of knowing filled with checks and balances. For example one check, arguably the most important, is repetition of findings by other investigators. This repetition of findings is referred to as *replication*. For example, if I find an amazing result and no other investigator can reproduce (replicate) that after many excellent tries, my finding is suspect. I am not necessarily suspected of anything odd, but the finding is not reliable. Perhaps the finding depended on something none of us knows about or occurred by chance, fluke, or a bias I did not detect or control. At this moment in our discussion, the reason does not matter. But we have to say that my finding is not to be taken as a reliable finding and we go on. Perhaps some people replicate my finding but others do not. This suggests there may be some other condition or circumstance (e.g., perhaps some characteristic of the participants? Perhaps how the experimental manipulation is conducted?) that influences whether the finding is obtained. More work is needed to reveal if that is true. Yes, if my study cannot be replicated, that is annoying at the moment, but we are committed to the process and the last thing any scientist wants is to squeeze in "false knowledge," i.e., findings that do not hold up across investigators, laboratories, and time.

We will say more about replication and all the things failure to replicate can mean but for now, methodology is the answer developed by humans to provide the best information we can, so that it can be believed, accumulated, relied on, and repeated.

- Methodology does not eliminate bias and problems, and so a great dose of humility about the process is just wise.
- Methodology is dynamic and constantly developing as we learn novel ways in which bias may enter, novel ways to control that, and better measures of everything we do to monitor how a study is conducted and to measure constructs we care about with greater precision.
- Methodology is evolving, improving, and correcting sources of bias or influences that can interfere with obtaining knowledge.
- Methodology can contribute enormously to our lives leaving aside the lofty goals of developing our knowledge base.

I believe you personally value, if not love, methodology or will someday, even though you may not know it yet. (Methodology is love at last sight rather than first sight.) One hopes that now or in the future you or one of your relatives will not require treatment (medical, psychological) for a seriously debilitating condition (e.g., cancer, stroke, major depression, posttraumatic stress disorder). Yet for these and many other conditions, there are evidence-based interventions that can really help. Those interventions were developed and evaluated with sound research methods using all sorts of principles, practices, and procedures we will discuss in this text. Rarely does casual observation provide the means of identifying effective interventions. Methodology allows us to obtain the needed knowledge and that knowledge often saves lives and makes lives better—our own personal lives and those whom we love and like. Do you like methodology now? Me too.

1.3: Methodology

1.3 Examine the methodologies that govern scientific research

The topic of this text is methodology of psychological science with particular emphasis on clinical psychology, counseling, education, and social sciences more generally where the goals often include basic as well as applied research. Basic research refers to our interest in understanding the underpinnings of various phenomena—what, why, when, and how something happens. We may need to study the phenomenon under highly controlled conditions (e.g., nonhuman animal laboratory studies). Applied research refers to our interest in translating our knowledge toward goals of everyday life and in applied settings. For example, we want to understand as much as we can about stress and its impact on functioning and basic research has elaborated all sorts of features (e.g., how stress affects aging, the immune system, onset of depression) but we are also interested when possible to apply that information to alleviate stress (e.g., in everyday

life, for special groups who are exposed to harsh environments, war and trauma).

1.3.1: Definition and Its Components

Methodology refers to the diverse principles, procedures, and practices that govern scientific research. Methodology will be used as an overarching term that includes several distinguishable components, as noted in Table 1.1.

Table 1.1: Five Components of Methodology

Component	Definition
Research Design	Refers to the experimental arrangement or plan used to examine the question or hypotheses of interest. There are many designs, which we will cover and see how they work to help reach valid inferences.
Assessment	Refers to the systematic measures that will be used to provide the data. There are many different types of measures, multiple measures within each type, and more importantly for our purposes considerations to guide how to select measures.
Data Evaluation	Refers to the methods that will be used to handle the data to characterize the sample, to describe performance on the measures, and to draw inferences related to the hypotheses. You may recognize this as familiar statistical significance testing, but data evaluation is much more than that and even sometimes less (no statistical tests are used with some research designs).
Ethical Issues and Scientific Integrity	Refer to a variety of responsibilities that the investigator has in the conduct of the study and can encompass all of the other components of methodology (e.g., design, data evaluation, and communication of findings). Ethical responsibilities are to research participants (e.g., their rights and protections) and adherence to professional standards of one's discipline (e.g., ethical codes). Scientific integrity includes responsibilities to the scientific community (e.g., transparency, accurately reporting findings) and also is part of professional standards and ethical codes.
Communication of Findings	Refers to how the findings will be communicated to others in many different venues (e.g., journal articles of empirical studies, review articles) including the media (dissemination of information to the public via TV, radio, and the Web). There are many issues that emerge related to core issues of science (e.g., transparency of methods), but also challenges as what and how we communicate might be very different for colleagues and for the press.

1.3.2: Using Methodology to Answer Critical Questions

We will take up each of these aspects of methodology and present them separately to ensure each is given its fair treatment. As a reader, you may be especially interested in learning the concrete facets of methodology to answer critical questions to conduct a study, such as:

- How do I select a research question?
- What participants or subjects should I use?
- How do I decide exactly what measures to include in the study?[1]

We will certainly address specific practices and procedures to be of help. Yet, it is critical to consider broader issues underlying those practices and guiding principles. The broader issues are not some academic challenge with little impact. Just the opposite, once the overarching principles or reasons for various practices are understood, investigators—you and me—often have more flexibility in selecting concrete practices for our study.

Consider, for example, random assignment of participants to experimental conditions in a study. All the participants come to the study and are assigned in random order to groups (e.g., group 1 receives some task to induce happiness; group 2 receives some task to a neutral or slightly negative emotion). Random assignment is a core tenet of experimentation. The practice of random assignment, i.e., how exactly one does that is important and covered later.

> Yet, why do we do random assignment, and does it serve the goal we have in mind? We will discuss that too, and once we do it is easier to see that random assignment is not always critical, not problem free, and often goals to which random assignment is directed can be served in other ways.

This is not a text taking positions on key practices like random assignment; it is a text designed to develop black-belt methodologists and as part to that to equip you with a wide range of methods to solve and address the questions of interest to you. When one designs a study or reads a study that has been completed by others, knowledge about the practices and procedures is important. Yet the principles and rationales underlying those practices are critically important as well.

1.4: A Way of Thinking and Problem Solving

1.4 Analyze some of the key concepts that guide scientific thinking and problem solving

Methodology refers to a *way of thinking* and problem solving, in addition to the more concrete features we will discuss later in the text. That way of thinking is how we approach understanding the world around us. There are guides we follow, and these are worth noting and illustrating here before we address them in greater detail later in the text.

1.4.1: The Role of Theory

In science we want to explain what things are, how they work, how they relate to other phenomena, how they come about, and so on.

Theory at the most general level refers to an explanation.

That is, what phenomena and variables relate to each other, how are they connected, and what implications can we draw from that? We want to describe, predict, and explain, and theory can tie this all together. It is helpful to distinguish the findings that are obtained in a study from the conclusions the investigator may reach. The distinction is important for understanding theory as well as methodology.

1.4.2: Findings and Conclusions

> The *findings* of a study refer to the results that are obtained.

This is the descriptive feature of the study or what was found. A statement of a finding might be that one group was better or worse than another.

> The *conclusions* refer to the explanation of the basis of the finding, and this is the interpretative and theory part.

For example, as a sample finding, we know that corporal punishment of a child in moderate-to-severe doses (more than once per week, used as a primary discipline, not injurious physically and not necessarily at the level of physical abuse) is related to (correlated with) greater aggression on the part of the child. Children who are physically hit a lot as part of their punishment at home tend to be much more aggressive at school (more fighting, bullying). That is the finding—merely descriptive and factual—even though it may not mean for all children, in all families, and in all cultures and countries.

As for conclusions, we now would like an explanation of why corporal punishment and aggression are related. But we do not need some casual explanation from everyday life (e.g., "The kids are rotten and need to know their place and if anything punishment probably tames them!). We need a little more, to say the least. Specifically, we want theory that explains the relation and allows us to generate hypotheses that will guide us to elaborate on the explanation, to test the theory, and to revise and expand as needed.

> *Why a theory?* Well, we want to understand in part to learn some of the roots of and paths to aggression and also possibly to intervene or to prevent aggression. It is too quick to just say, "stop hitting your kids and they will not be aggressive," even though there are many reasons we would like parents to stop hitting their children.

Among the explanations, maybe children who are more aggressive lead their parents to extremes of punishment. Instead of nagging, reprimands, and shouting, the parents eventually escalate in an effort to stop seemingly uncontrollable aggressive behavior. This theory suggests that aggression in the child may have actually caused aggression in the parent. Alternatively, since so many things (e.g., aggression, depression, suicide, low key temperament, sense of humor, conscientiousness, love of methodology) run in families, perhaps the parents' aggression and the child's aggression do not influence each other very much at all. Rather, maybe they share common genetic origin and aggressive behavior in the parent and child reflects that. We could generate more explanations, but the goal is not merely to generate explanations but to move to empirical tests of one or two that we have identified. In passing it is useful to note that three explanations: parent modeling of aggression leads to more aggression in the children, child behavior and provoke parent aggression, and that there are shared genetic influences all have some support but the first explanation appears to be the stronger influence (see Moffitt, 2005).

We generate explanations to draw implications. Those implications are hypotheses that elaborate what might be going on and help us move forward.

> *If exposure to parental aggression leads to aggressive behavior in the child, how could we ever test that?* Among the options, bring young children in the laboratory and have some children watch movies or video clips of aggressive behavior and other children watch movies or clips of social interaction that are not aggressive. Then give the children the opportunity to show aggression (e.g., in relation to a doll or press one of two responses indicating what they would in a particular situation presented on a video—hit the other person or walk away).

This is merely one little test of whether exposure in principle can increase aggression, even if temporary and restricted to a lab setting. Let us not get too far into the example and lose the larger point. We select an explanation that accounts for (ties together, connects) our original facts (findings) and use that explanation to obtain more findings. In the process, we revise our theory to account for new facts including predictions that were supported or not supported. In the end, we want as full an explanation as possible. I am simplifying but will elaborate a bit in an example below.

1.4.3: Additional Information Regarding Findings and Conclusions

In everyday life, "theory" sometimes emerges with a different meaning. If someone says, "Oh, that's just a theory" or that is "theoretical" that meaning often refers to something that is pure speculation, hardly proven, and just a tale. This emerges in the ongoing debates of "creationism" and "evolution." As an explanation of how human and nonhuman animals emerged, there are many weighty issues in that debate including different ways of knowing (by faith, by science). Even so, among the many issues is a different use and meaning of the word "theory." When scientists use that term "evolution" is not a "theory" in a speculative sense. Rather it is an explanation developed with data from multiple sciences

(e.g., fossil record from geology, tracking development within and among from molecular and genetic measures, and viewing evolutionary processes actually unfold in the lab [studies of thousands of generations of yeast] spanning decades).

Evolution explains these facts and makes useful predictions, many supported by further facts, and so on. Creationists would not be expected to use that notion of theory, but are more apt to say, this is speculative and not proven. That view is not simply wrong at all. Much in evolution as scientists use that term is NOT proven or clear. All the mechanisms through which species change are not known (but some are), and there is much speculation about how we got from there (first day earth counted as a planet) to here (billions of years later with millions of plant and animal species and music groups with the weirdest names). No theory explains all of that, so there is indeed speculation involved. Yet, we know a lot and can even monitor and alter "evolution" (change and adaptation of bacteria, for example, to watch evolutionary change in response to environmental forces) in a laboratory (e.g., Wiser, Ribeck, & Lenski, 2013). As a way to explain scores of findings, evolution as a theory is on solid ground that is not speculative. Yet, this does not directly address the full range of concerns and points of creationists.

For this text, for evaluating research, and for your possible professional careers in any of the sciences, theory is that explanation or model we develop to guide our next steps in science. We want to explain and understand, and merely piling up facts and correlations will not do that at all. So we know that depression increases the risk for heart attack and that heart attack increases the risk for depression, and that if one has a heart attack and depression they are at much greater risk (than if they had just one of those) of dying (e.g., Lichtman et al., 2008). My God, these "facts" or the findings scream out for understanding.

> *What could be going on here that explains these relations?* One theory might focus on diet. Perhaps depressed individuals have lard omelets, fried chicken nuggets, and chocolate cheese cake (just a little sliver or two) for breakfast each morning and that diet increases the likelihood of heart attack. Well, that could be tested easily.

We might do a survey of individuals matched in age, sex, and education, but who vary in depression, and ask about what they eat. But as explanations go, it already looks weak because it does not explain the other direction, heart attack leading to depression, unless you believe the same diet would lead to heart attack patients becoming morose. That is not likely, but you may have a good explanation (theory) for that. Findings often are intriguing and raise a puzzle to solve. Theory helps generate the ideas for research; methodology includes the strategies to help us obtain the answers.

1.4.4: Parsimony

As we select our theory or explanation, we are guided by parsimony as a critical concept and way of thinking in science. Parsimony is not that cute little curly green vegetable that almost no one eats and is used to garnish the main course when restaurants bring you your food. Rather, parsimony is an accepted principle or heuristic in science that guides our interpretations of data and phenomena of interest.

> *Parsimony refers to the practice of providing the simplest version or account of the data among alternatives that are available.*

This does not in any way mean that explanations are simple. Rather, this refers to the practice of not adding all sorts of complex constructs, views, relationships among variables, and explanations if an equally plausible account can be provided that is simpler. We add complexity to our explanations as needed. If there are two or more competing views that explain why individuals behave in a particular way, we adopt the simpler of the two until the more complex one is shown to be superior in some way.

Apart from parsimony, there are other names for the guideline and they convey the intended thrust. Among the other terms are:

- The principle of economy
- Principle of unnecessary plurality
- Principle of simplicity
- Occam's razor

Where was the name "Occam's razor" derived from?

The term emerged from William of Ockham (ca. 1285–1349), an English philosopher and Franciscan monk. He applied the notion that makes this principle sound more complex; he proposed that plurality (of concepts) should not be posited without necessity in the context. That is, he believed that we ought not to add more concepts (plurality) if they are not needed to explain a given phenomenon. Supposedly, his frequent and sharp invocation of the principle accounts for why the term "razor" was added to his (Latinized) name to form Occam's razor.

1.4.5: How Parsimony Relates to Methodology

Parsimony relates to methodology in concrete ways. When an investigation is completed, we ask how to explain the findings or lack of findings. New concepts and more complex concepts may be used than existing concepts that are simpler, already available, and useful in describing many findings beyond those of the investigator. The investigator