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WILLIAM J. RAY

5th
EDITION

FIFTH EDITION

METHODS TOWARD
A SCIENCE OF BEHAVIOR
AND EXPERIENCE

WILLIAM J. RAY

The Pennsylvania State University



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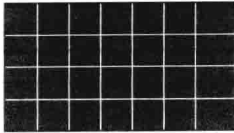
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*To Ken King,
who originally helped this book
come into being,
as he moves into a new life path;
and to Jude, Adam, Lauren,
Jen, David, and Kate,
who give meaning to this book*



PREFACE

We live in a time when books on science and on the nature of ourselves and our world are setting sales records. For many of us, science offers an exciting understanding of reality. Society also looks to science for answers to difficult questions. Given a wide range of problems, such as AIDS, diminishing energy resources, crime, and the effect of psychological processes on health and disease, scientists are asked to present solutions and help shape policy. However, despite this great interest in science, the experimental course remains the one that some students dread and put off until the last minute. This reluctance seemed strange to me because many of my colleagues are excited about what they do in psychology, and they approach research with a real desire to know. Students' dread of the experimental course led me to think that, in teaching psychological research, we as faculty have neglected to communicate to our students a complete understanding of science, including our own experience in psychology and, especially, our reasons for attempting a science of behavior and experience in the first place. Thus, one of my goals in writing this book was to introduce students to the basics of doing science and to the spirit that motivates many scientists. A second goal was to help students make the transition from viewing themselves as an outside observer of science to one who participates in the scientific process.

Students' and colleagues' responses to the first four editions of this book have been persuasive in suggesting that these initial goals are being accomplished—that is, it is possible to produce a highly readable book that students are able to learn from and to imbue them with a greater understanding of the techniques of science, as well as the experience of doing science. As I have moved through the various editions of this book, I have seen psychology change in its approach and subject matter. Just as psychology, in its theories and approaches, has become more sophisticated, so have the students. In response to this shift, new information and a slightly different tone of presentation have been incorporated into the last three editions. This book began with Dick Ravizza as a co-author, and the first edition reflected, as have the later ones, important discussions between him and me about the nature of science, the nature of psychology, and at times, the nature of life. Since that time, these discussions have been continued with colleagues, students, reviewers, and almost anyone else who would listen and talk about these issues. For this reason, the plural *we* has been retained throughout all editions of this book. The ever-changing constituency of this “we,” some of whom are acknowledged at the end of this preface, continues to suggest clarifi-

cations, new information, and additional changes that contribute to the overall quality of this book.

■ About the Fifth Edition

Every chapter in this edition has been revised. In particular, I have included an important new information resource—the World Wide Web—and offer links to relevant psychological sites. I have also incorporated changes prompted by the publication of the fourth edition of the *APA Publication Manual* and by changes to the APA Code of Ethics. As with every edition, examples and research studies have been updated and clarifications added to help students in their learning. I hope the book continues to reflect the fact that scientists both work hard and have fun in their pursuit of knowledge and understanding. Also, I have seen a shift in the teaching of this course, with a growing number of colleges and universities presenting the methods course in a large lecture format. In response to this, I have followed the suggestions of faculty and students to clarify the presentation of some of the more important or difficult concepts through illustration and extended discussion. Let me now briefly describe the goals and directions that I have continued in this fifth edition.

■ Philosophy of Science

One idea we try to convey from the very beginning is the relationship of science and philosophy. I do this not only through the introduction of propositional logic in Chapter 2, but through a discussion of individuals who have shaped our ideas about science. For example, in the first two chapters, students are introduced to Newton's rules of reasoning, as well as to the views of Karl Popper and Thomas Kuhn on how science works. I also show students how some approaches to science, such as the use of strong inference and the development of a research program, have allowed certain fields to move at an accelerated rate. Likewise, I show that science cannot be performed without reference to values; this point is brought out not only in the discussion of the ecology of the experimental situation in Chapter 10 and the discussion of ethics in Chapter 14, but throughout the text.

However useful, abstractions alone do not teach students about science as it is practiced, much less how to practice science themselves; thus, I also emphasize the concrete. In this edition, I attempt to involve the student earlier in the process of experimentation. For example, in Chapter 3, I include detailed information on how to use major library reference works, such as *Psychological Abstracts*, *Index Medicus*, *Science Citation Index*, and *Social Science Citation Index*. I also include information about the more popular computer databases, as well as the Internet and the World Wide Web. In the discussion of descriptive statistics in Chapter 4, I teach students how to read and plot graphs. In Chapter 15, I teach students how to write up an experiment and include a checklist they can use for

writing an article and presenting a research proposal. Because of my desire to make science concrete, I have included interviews with psychologists on how they first obtained the ideas for their studies. These interviews are followed by a discussion of how to turn an idea into a testable hypothesis.

■ The Logic of Making Testable Hypotheses

Most students grasp the idea of asking testable questions, but often they are uncertain of what exactly they are testing in research. To help clarify this point, I have presented the process of hypothesis testing both conceptually and practically. In Chapter 5, I present a conceptual understanding of inferential statistics and probability. I likewise stress the process of making decisions and the importance of logically ruling out alternative hypotheses. Although this process begins in the first chapter and continues throughout the book, Chapter 2 emphasizes the use of logic and drawing conclusions.

■ Discussion of Various Designs, Including Correlational Designs

An understanding of the logic of experimental design, including the concept of control as well as the process of making inferences, remains the heart of the present edition. However, I have also expanded the discussion of procedures to employ when the experimental situation does not allow for traditional experimental designs. For example, in the present edition, I have expanded the coverage of correlational designs to reflect the ways in which such areas as behavioral medicine and developmental and social psychology rely on such approaches. I have likewise expanded the discussion of single-subject designs; Chapter 12 is devoted to this topic. As in the previous edition, information on quasi-experimental approaches and naturalistic observation is also included. An entire chapter (Chapter 13) covers questionnaires, survey research, and sampling; this provides students with a basic understanding of how to construct questionnaires and of the logic involved in sampling procedures.

■ Clarification of Important Concepts

To help faculty teach this course and students understand the material better, I have made a special effort to define and illustrate what I know are general problem areas for students. Also, I have presented material at the end of each chapter that not only summarizes the main points in the chapter, but also includes questions to test students' comprehension and discussion questions and projects for better integration of the material. Included in this section are designs for the students to criticize and conclusions to evaluate. My talks with faculty across the country have led me to pay special attention to certain topics. For example, the concept of interaction effect is not only illustrated with research examples, but

numerous possible outcomes are graphically represented. Because many students find it difficult to understand interaction effects, I have added even more actual examples from the literature. I also carefully guide students through the interpretation of interaction effects and explain why an interaction effect must be interpreted before a main effect. These discussions are aided by the explanation of the concept behind the F -ratio. Beginning in Chapter 6 and continuing throughout the rest of the text, the logic of the F -ratio is used in discussions of experimental control and variation. Emphasizing the factors that influence either the numerator or the denominator of the F -ratio enables students to grasp conceptually what factors will influence their acceptance or rejection of the null hypothesis. In this book, I also give special attention to two other problem areas for students: the meaning of causation in science and the use of the terms *error* and *chance* in relation to experimentation.

■ New Directions

I used the title *Methods Toward a Science of Behavior and Experience* to convey a sense not only of where experimental psychology has been, but of where it might be going. I expand on this idea in Chapter 16, in which I discuss the potential for a scientific psychology. I point out that psychology was once almost a battleground in which those who were interested in behavior vied with those interested in experience. But today, with scientific studies of such topics as attention, emotion, awareness, animal cognition, and especially consciousness, I see a new group of scientists who are interested in both behavior and experience, in others and in themselves.

■ Acknowledgments

This book evolved from discussions concerning our experience of science and the role it currently plays in psychology. At this time, I would like to acknowledge the many individuals who joined me in these discussions. In relation to the first edition, Dale Harris took the time to share his perspective on the history of the experimental movement in psychology. I appreciate the willingness of Jude Cassidy, Richard Carlson, Nora Newcombe, Carolyn Sherif, and Lance Shotland to relate how their ideas came about and how they began their important research programs. I also appreciate the help of our colleague Mel Mark for his careful reading of and critical suggestions regarding the chapters related to inferential statistics and survey research. In addition, I appreciate Judith Kroll's willingness to share with me her notes and ideas for helping women to find more of a home in science. Many colleagues at Penn State shared with me knowledge and experiences in doing science. Others told me about ways they use to teach experimental methods, as well as the values they wish to impart. For their time and thoughtful consideration, I am extremely appreciative.

I am grateful to the Literary Executor of the late Sir Ronald A. Fisher, F.R.S., to Dr. Frank Yates, F.R.S., and to Longman Group Ltd. London, for permission to reprint from their book *Statistical Tables for Biological, Agricultural, and Medical Research*, Sixth Edition, 1974.

Many colleagues around the country shared their experience of teaching and made this book richer in a variety of ways. I appreciate their careful reading of the earlier editions and their invaluable suggestions based on their experience with the book. In particular, I would like to acknowledge the reviewers of the first edition: Robert T. Brown, University of North Carolina, Wilmington; Dennis Cogan, Texas Tech University; Paul Eskildsen, San Francisco State University; Henry Gorman, Austin College; Les Herold, California State University, San Bernardino; Alan C. Kamil, University of Massachusetts; Nancy Kirkland, Trinity College; Elizabeth Lynn, San Diego State University; Henry Morlock, State University of New York, Plattsburgh; Howard B. Orenstein, Western Maryland College; Ronald Rossi, Lyndon State College; Mark S. Sanders, California State University, Northridge; Kathryn Schwarz, Scottsdale Community College; Keith Stanovich, Oakland University; Barbara Tabachnick, California State University, Northridge; W. Scott Terry, University of North Carolina, Charlotte; and Sheila Zipf, San Francisco State University. I would also like to thank the reviewers of the second edition: Earl Babbie, Chapman College; Elizabeth Capaldi, Purdue University; Elvis C. Jones, Frostburg State College; John M. Knight, Central State University; Judith E. Larkin, Canisius College; John J. Meryman, San Jose State University; Thomas O. Nelson, University of Washington; and Mark A. Sabol, Creighton University. And I express my gratitude to the reviewers of the third edition: Philip G. Benson, New Mexico State University; Alexis Collier, Ohio State University; Eric S. Knowles, University of Arkansas; Mark D. Pagel, Oxford University; Kirk H. Smith, Bowling Green State University; and Marty Wall, University of Toronto. Reviewers' comments for the fourth edition resulted in numerous major changes. Reviewers for that edition include Jonathan D. Brown, University of Washington; Clarke A. Burnham, University of Texas at Austin; Henry A. Cross, Colorado State University; Raymond T. Garza, University of California–Riverside; Mary Gauvain, Scripps College; Elizabeth L. Glisky, University of Arizona; Joellen T. Hartley, California State University–Long Beach; Alan C. Kamil, University of Nebraska–Lincoln; Philipp J. Kraemer, University of Kentucky; W. Trammell Neill, Adelphi University; Howard A. Rollins Jr., Emory University; and Barry S. Stein, Tennessee Technological University. Reviewing is something of a lost art, and I appreciate the consideration given this present edition by its reviewers, who include Deane Aikins, Pennsylvania State University; Steve Buck, University of Washington; Nancy Eldred, San Jose State University; Philip Freedman, University of Illinois; Michael Gaynor, Bloomsburg University; Elizabeth Glisky, University of Arizona; Judith Kroll, Pennsylvania State University; Mark Pitt, Ohio State University; Joseph F. Sturr, Syracuse University; and Jenny Wiley, Virginia Commonwealth University. I hope

the book has not suffered from my inability to implement all of their suggestions.

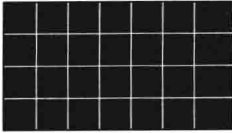
I found the production staff at Wadsworth and Brooks/Cole to be excellent and wish to thank them for their efforts. It is never easy to turn a manuscript into a finished product, and such efforts often go unnoticed. I appreciate my association with Ken King, the psychology editor at Wadsworth, for his initial commitment to this project and to quality publishing. I also appreciate my association with the sponsoring editor of the fourth and fifth editions, Jim Brace-Thompson at Brooks/Cole.

I would like to invite both students and faculty to send me their comments about the book or examples from their courses or the literature that have helped to clarify the material. You can write to me at the Department of Psychology, The Pennsylvania State University, University Park, PA 16802, or send an e-mail message to [WJR @ PSUVM.psu.edu](mailto:WJR@PSUVM.psu.edu). I will do my best to incorporate your suggestions into the next edition.

William J. Ray

One thing I have learned in a long life:
that all our science, measured against reality,
is primitive and childlike—and yet it is the
most precious thing we have.

ALBERT EINSTEIN



INTRODUCTION

You are about to begin a voyage of wonder and curiosity, of questioning and doubts. It is a voyage that human beings began many generations ago and that scientists like yourselves embark on every day—a voyage into the nature of ourselves and the world in which we live. This voyage has a particular focus: science. For some of you, science offers a new way to view the world. Learning about science, like learning about anything new, offers added perspective that can lead to a profound expansion of your own consciousness. For those of you already familiar with science, this book offers a deeper exploration of the science of behavior and experience. From the outset, it is important for you to realize that learning about science is an expansion of what you already are. Science is an option, an alternative that you are free to use as you explore and interact with our world. You choose how and when to use it. In fact, after taking this course, you may decide that you do not wish to view the world from a scientific perspective, and you may never use it again.

Some students hesitate to explore science because they believe it is cold, antihumanistic, and even antireligious. In other words, they believe it separates us from our beliefs, our faiths, our feelings, and ourselves. This is a serious, limiting misconception. Many of our colleagues in all fields of science are as open to humanistic and spiritual traditions as they are to science. We believe that science—a science of behavior and experience—will someday assist us in a profound examination of all our great humanistic and spiritual traditions. Helping us to more fully explore and understand our own potential may be science’s main function in the future evolution of human consciousness.

Our voyage into the science of behavior and experience begins by recognizing that we possess many childlike qualities—such as genuine laughter, spontaneous play, intimacy, curiosity, and creativity—that we hope will always remain part of us. These qualities form the foundation of mature human experience. Similarly, the scientific method we are about to examine is firmly rooted in the simple way that children explore their world. With this in mind, we start our exploration of science by seeing ourselves as children who wish to explore. The world that awaits the child includes not only the outside world, but also the child’s own psychological experience. Through this child, who is one aspect of ourselves, we approach the question of how we go about performing a science of behavior and experience. We will watch the child search for

knowledge and mature into three distinct aspects, which we can define as roles in our drama of psychological inquiry.

The first aspect or role is that of the scientist. This is the active role in our drama. Your task is to learn how the scientist goes about doing science. In this book, we will watch the child learn the role of the scientist. We will see that many activities of present-day, mature scientists are simply extensions of the way they approached the world as children. As you learn about this role, you will learn about the types of questions scientists ask, the types of answers they accept, and the way in which they approach and verify knowledge.

The second aspect or role is that of the research participant. This is the passive role in our drama. The research participant is the particular organism the scientist chooses to study. In fact, the various experiences and behaviors of the participant form the content of psychology. The paradox for scientists interested in the study of human behavior and experience is that, although the subject matter is “out there” in the individuals we study, because we are also human, it is at the same time “in here” in us. In a very real sense, as we study other people and animals, we also study ourselves.

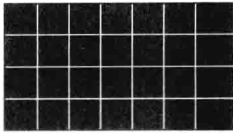
The third role is that of the witness. Although this role is not always recognized, in many ways it is the most important because it maintains a balance between the scientist and the research participant, the active and passive aspects of the scientific process. The witness, who is also us, stands back and watches the scientist do science and the research participant behave and experience the world. One task of the witness is to teach that both the scientist and the research participant are limited because each sees the world only from his or her own perspective.

As the witness teaches us that there is a broader perspective from which we can appreciate both viewpoints simultaneously, we begin to mature and realize the richness of the scientific process and the wonder of approaching knowledge of reality. In this vein, it is the task of the witness to remind us that the experience and understanding of life require more than just a description of miles of blood vessels, reinforcement schedules, and chemicals interacting with each other. It is the witness who asks whether the science of the scientist is relevant, ethical, and generally worth doing. But most important, it is the witness who brings together the procedures of the scientist and the experience of the research participant and allows them to have a relationship in the first place.

Once we have developed these aspects of ourselves—scientist, research participant, and witness—we will be in a better position to understand the strengths and weaknesses of using science to study ourselves. Until then, we suggest that you neither accept nor reject the scientific approach, but rather, that you allow that it may have something to offer you. That is, you can allow yourself to become actively involved in trying to solve problems and answer questions using this method while remaining free to remember

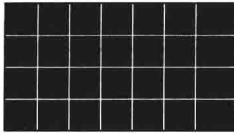
its problems and limitations. As in anything else, it is only through active involvement that you will come to understand fully what the method has to offer. Let us now begin the drama of science with a problem—how did we as children come to know the world?—and, from this, develop methods for a science of behavior and experience.

William J. Ray



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