



SEVENTH
EDITION

METHODS

TOWARD A SCIENCE OF
BEHAVIOR AND EXPERIENCE

William J. Ray

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METHODS TOWARD A SCIENCE OF BEHAVIOR AND EXPERIENCE

WILLIAM J. RAY

The Pennsylvania State University

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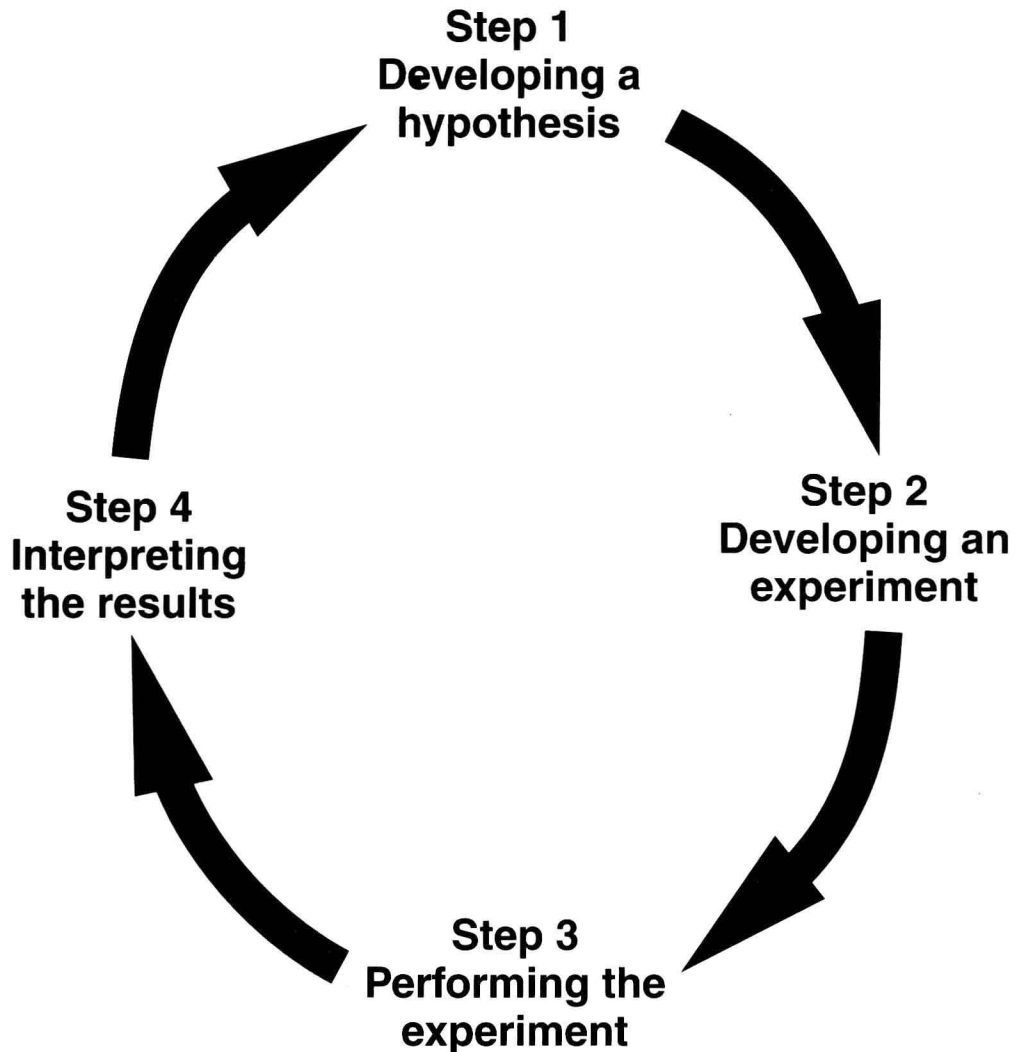
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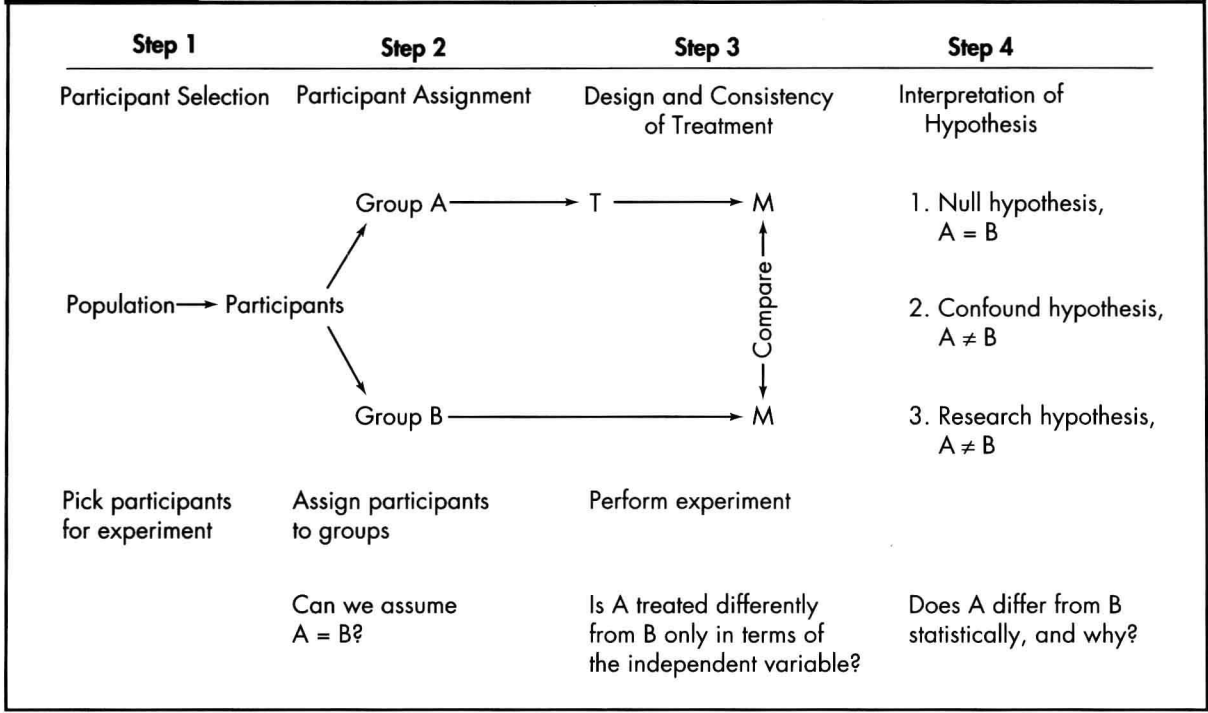
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THE FOUR MAJOR STEPS IN THE EXPERIMENTATION PROCESS



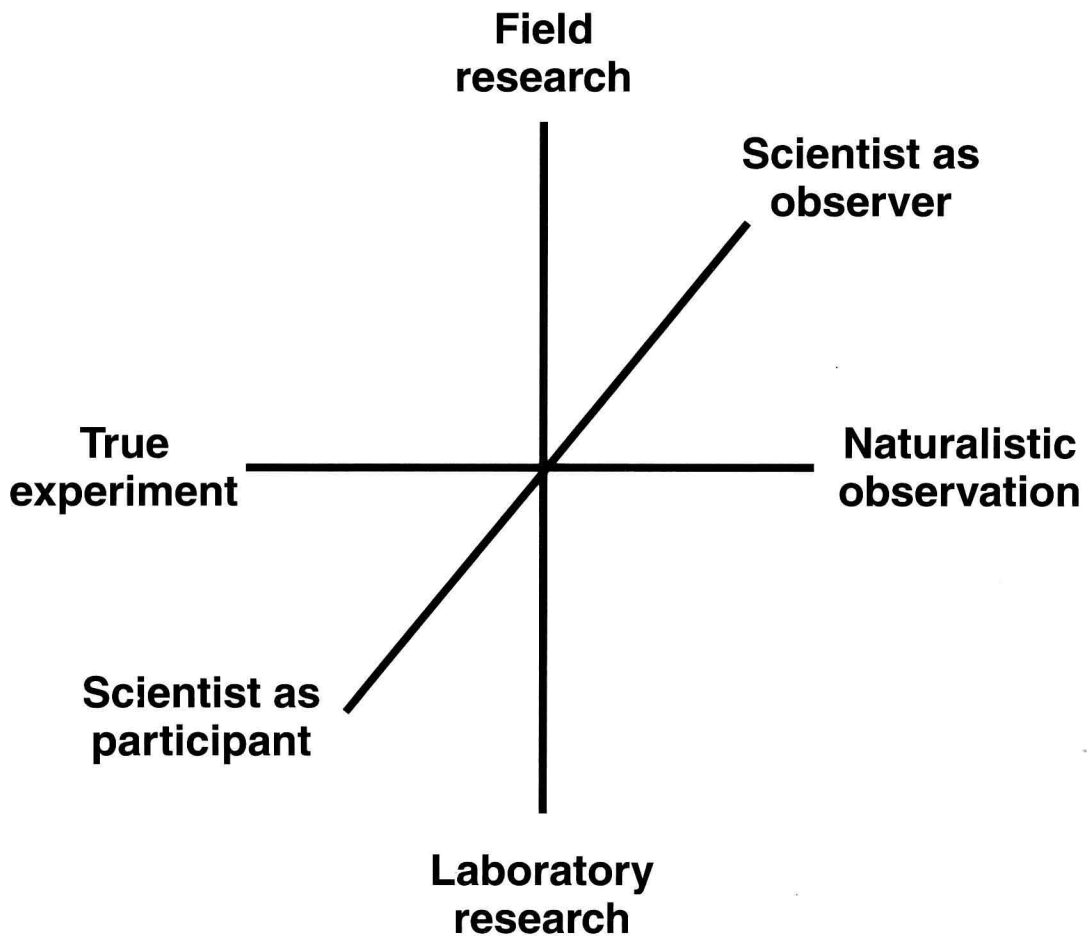
THE FOUR CONCEPTUAL STEPS IN EXPERIMENTATION



TYPE I AND TYPE II ERRORS

		True state of affairs	
		Chance is responsible	Chance is not responsible
Null hypothesis decision	Fail to reject	Correct acceptance	Type II error (incorrect acceptance)
	Reject	Type I error (incorrect rejection)	Correct rejection

THE THREE-DIMENSIONAL NATURE OF RESEARCH APPROACHES



To my parents and teachers.

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



PREFACE

We live in a time when books on science and the nature of ourselves and our world are setting sales records. For many people, science offers an exciting understanding of reality. Society itself is also calling on science for answers to difficult questions. Given problems ranging from AIDS to diminishing energy resources to terrorism to the effect of psychological processes on health and disease, scientists are being asked to present solutions and help shape policy. Despite this great interest in science, the experimental course remains the one that some students dread and put off until the last minute. This seemed strange to us, since many of our colleagues are excited about what they do in psychology and approach research with a real desire to know. This made us think that, in the process of teaching psychological research, we, as faculty, have neglected to include 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 our major 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 outside observers of science to those who participate in the process of science.

The responses of students and colleagues to the first six 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 when they are done, they will carry with them a greater understanding of the techniques of science as well as the experience of doing science. As we have moved through the various editions of this book, we have seen psychology change in its approach and subject matter. The current edition reflects many of these changes. This book began with Dick Ravizza as a co-author, and that first edition reflected, as have the later ones, important discussions between the two of us concerning 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 discuss these issues. For this reason, the plural “we” has been retained throughout all editions of this book. It is an ever-changing “we,” some of whom are acknowledged at the conclusion of this preface, who continue to suggest clarifications, new information, and additional changes that contribute to the overall quality of this book.

■ The Seventh Edition

Every chapter in this edition has been revised. In particular, we have added new research examples from the psychological literature. We have also added additional information on effect size and statistical power including the manner in which

these measures are reported in a research example. In relation to writing research articles, the American Psychological Association has published a new edition of its *Publication Manual* (the fifth), and these guidelines are reflected throughout this current edition. In this context Appendix A has been expanded to include guidelines for removing a variety of biases in language (e.g., gender, sexual orientation, racial and ethnics identity, disabilities, and age). We also continue to include an increasingly important information resource, the World Wide Web, and to offer links to relevant research sites. For example, links to issues of research integrity from the Public Health Service and American Association for the Advancement of Science as well as National Institutes of Health discussions of placebo research have been included in this edition. Also included with this book is access to InfoTrac® College Edition, which is a wide ranging source of information including encyclopedias, reference books, magazines, and scientific journals accessed through the Web. Although exercises with InfoTrac College Edition are included at the end of each chapter, faculty can also supplement specific topic areas of their own interest through these resources including the use of online research articles. As with every edition of this book, examples and research studies have been updated and clarifications have been added to help students in their learning. Over the past decade, we 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, we 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 briefly describe the goals and directions, which we have continued in this seventh edition.

■ Philosophy of Science

One idea we try to convey from the very beginning is the relationship of science and philosophy. We do this not only through the introduction of propositional logic in Chapter 2, but through a discussion of people who have shaped our ideas about science. For example, in the first two chapters, students are introduced to not only Newton's rules of reasoning, but also the views of Karl Popper and Thomas Kuhn on how science works. We 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, we show that science cannot be performed without reference to values. We do this not only in our discussion of the ecology of the experimental situation in Chapter 10 and our discussion of ethics in Chapter 14, but also 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 we also emphasize the concrete. We attempt to involve the student earlier in the process of experimentation in this edition. For example, in Chapter 3, we include detailed information on how to use major library reference works such as *PsycINFO*, *Science Citation Index*, *Social Science Citation Index*, and the information available from the National Library of Medicine (e.g., *MedLINE*). Since most researchers access this information from the Web, a discussion of Internet resources is also discussed. However, we still need basics. In our discussion of descriptive statistics in Chapter 4, we teach students how to read and plot

graphs. In Chapter 15, we not only teach students how to write up an experiment, but we also include a valuable checklist that can be used for writing an article and presenting a research proposal. Numerous examples from published articles also are included. Because of our desire to make science concrete, we have included interviews with active 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

Although most students grasp the idea of asking testable questions, they are often uncertain about what exactly it is they are testing in research. To help clarify this point, we have presented the process of hypothesis testing both conceptually and practically. In Chapter 5, we present a conceptual understanding of inferential statistics and probability. We 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. This information is important not only for those who seek a career in research but also for anyone who wishes to understand the daily headlines involving scientific research.

■ 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, we have also expanded our discussion of procedures to employ when the experimental situation does not allow for traditional experimental designs. For example, in the present edition we have expanded our coverage of correlational designs to reflect the ways in which such areas as behavioral medicine and developmental and social psychology rely on such approaches. We have likewise expanded our discussion of single-subject designs in the chapter 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) is devoted to questionnaires, survey research, and sampling, which provides students with a basic understanding of how to construct questionnaires and the logic involved in sampling procedures.

■ Clarification of Important Concepts

To help faculty teach this course and students understand the material better, we have made a special effort to define and illustrate what we know to be general problem areas for students. Talks with faculty across the country have led us 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. Given that an understanding of interaction effects continues to be a major problem for students, we have added even more actual examples from the literature in this present edition. We also carefully walk students through the interpretation of interaction effects. These discussions are facilitated by our 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 our discussions of experimental control and variation. By emphasizing the factors that influence either the numerator or the denominator of the F -ratio, students are able to grasp conceptually what factors will influence their acceptance or rejection of the null hypothesis. We 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. Also, we have included material at the end of each chapter that not only summarizes the main points in the chapter but also includes questions to test 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.

■ New Directions

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

■ Acknowledgments

This book grew out of discussions concerning our experience of science and the role it currently plays in psychology. At this time, I would like to acknowledge the many people who joined me in these discussions. For the first edition, Dale Harris spent his time discussing his perspective on the history of the experimental movement in psychology. I appreciate the willingness of Jude Cassidy, Jeff Parker, Nora Newcombe, Carolyn Sherif, and Lance Shotland to discuss how their ideas came about and how they began their important research programs. I appreciate the help of our colleague Mel Mark for his careful reading of and critical suggestions on the chapters related to inferential statistics and survey research. I also appreciate Judith Kroll's willingness to share with me her notes and ideas for helping women to find more of a home in science and Gordon Hall's perspective on multicultural research. Many colleagues at Penn State and other institutions both in this country and in Europe have shared with me knowledge and experiences in doing science. Others told me ways that 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.

There are many colleagues around the country who shared their experience of teaching with us and made this book richer in many 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, SUNY, 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 Babble, 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 our 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.

The comments of reviewers for the fourth edition have resulted in a number of major changes. Reviewers for that edition included Jonathon 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.

Reviewers for the fifth edition 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 also thank the sixth edition reviewers: Kevin Apple, James Madison University; Jill Booker, University of Indianapolis; Martin Bourgeois, University of Wyoming; Cynthia L. Crown, Xavier University; Lisa Fournier, Washington State University; Elizabeth Yost Hammer, Belmont University; Kurt A. Hoffman, University of California–Davis; Richard F. Martell, Montana State University; Debra L. Valencia-Laver, California Polytechnic University–San Luis Obispo; Heidi A. Wayment, Northern Arizona University; and Doug Wedell, University of South Carolina–Columbia.

Reviewing is somewhat of a lost art and I appreciate the consideration given this present edition by our reviewers who include Carrie Fried, Winona State University; Karen Jordan, University of Illinois at Chicago; William Langston, Middle Tennessee State University; Patricia Loesche, University of Washington; Deidra Schleicher, University of Tulsa; Aurora Torres, University of Alabama in Huntsville; Terri Vescio, Pennsylvania State University; and Jeffrey Walczyk, Louisiana Tech University. I hope the book has not suffered from our 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 an easy task to turn a manuscript into a finished product, and such efforts often go unnoticed. I also appreciate my association with Vicki Knight, psychology editor at Wadsworth, for her consistent concern with quality publishing. Finally, I would like to invite both students and faculty to write me with their comments concerning the book or examples from their courses or the literature that have helped to clarify the material. You can write me at the Department of Psychology, Pennsylvania State University, University Park, PA 16802 or send an e-mail to wjr@psu.edu. I will do my best to include your suggestions in the next edition.

William J. Ray



INTRODUCTION

You are about to begin a voyage of wonder and curiosity, of questionings and doubts. Historically, it is a voyage that human beings began many generations ago and that scientists like yourselves embark on every day. It is a voyage into the nature of ourselves and the world in which we live. It is a voyage with 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, which can in turn lead to a very real 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. It is important to emphasize from the outset that learning about science is an expansion of what you already are. It is an option, an alternative that you are free to use or not to use as you explore and interact with your world. You choose how and when to use it. In fact, after taking this course, you may decide it is not a way you wish to view the world at all and you may never use it again.

Some students are hesitant to explore science because they believe it is cold, anti-humanistic, and even antireligious. They believe it separates us from our beliefs, our faiths, our feelings, and ourselves. This is a serious and 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 exploration of all our great humanistic and spiritual traditions. This task of helping all of us more fully explore and understand our own potential may be the major function of science in the future evolution of human consciousness.

Our voyage into the science of behavior and experience begins by stressing that there are many childlike qualities that we hope will always remain part of us. Genuine laughter, spontaneous play, intimacy, curiosity, and creativity are some childlike qualities that form the very foundation of mature human experience. In a similar way, the scientific method we are about to explore has firm roots in the simple way children go about exploring their world. With this in mind, we begin our exploration of science by viewing ourselves as children who wish to explore. The world awaiting 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 roles, which we can define as actors in our drama of psychological inquiry.

The first role is that of the scientist. It is the active role in our drama. The task before you is to learn how the scientist goes about doing science. We will come to see that many activities of present-day, mature scientists are simply extensions of the way we 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 that they accept, and the way in which knowledge is approached and verified.

The second 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, it is the various experiences and behaviors of the participant that 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. This role is not always recognized, yet 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 this 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 role 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—the scientist, the research participant, and the witness—we will be in a better position to understand the strengths and weaknesses of using science to study ourselves. Until that time, we would like to 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 the problems and limitations of the scientific approach. 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.

TO THE OWNER OF THIS BOOK:

I hope that you have found *Methods Toward a Science of Behavior and Experience*, 7th Edition, useful. So that this book can be improved in a future edition, would you take the time to complete this sheet and return it? Thank you.

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