Part I: Promise and Problems

Chapter 1: Introduction

They always say time changes things, but you actually have to change them yourself.

Andy Warhol (quoted in Honnef, 2000, p. 90)

The quote that opens this chapter speaks to the idea that it is best to be the architect of your own destiny. By taking previous courses in research methods and statistics and perhaps also by enrollment in your particular academic program, such as specialization or honors at the undergraduate level, you have already taken the first steps toward becoming a behavioral science researcher. This book is all about helping you to consolidate what you already know but in a more complete way and also to build essential skills for making the transition from

1. reading or listening about research produced by others with some understanding to doing so with even better comprehension or conducting your own research;

2. being a relatively passive recipient of information (a student) from authority figures (your instructors or supervisor) to someone who both takes in and disseminates knowledge through what you write and say (you become an authority figure, too); and

3. being aware of limitations with the way research is conducted or reported in the behavioral sciences to being capable of doing something about them (you learn to appreciate the need for reform and can act on it, too).

The last point just mentioned is a recurring theme throughout the book as we consider various issues and challenges in becoming an capable behavioral scientist.

NOT YET READY FOR PRIME TIME
This book is intended for senior undergraduate or junior graduate students in the behavioral sciences—including psychology, education, and other disciplines where empirical studies are conducted with humans or animals—who are learning how to conduct independent (but still supervised) research. It is assumed that such students (1) have already taken at least one introductory course in each of research methods and statistics and (2) are considering careers in which the ability to understand or produce research is important. The overall goal is to help such students develop the cognitive and applied skills needed in order to eventually become behavioral scientists. Specifically, this book will provide information about (1) an integrative perspective on the connections among the elements of the “trinity” of research, design, analysis, and measurement; (2) structural details (including pros and cons) of many of the most widely-used designs and analysis options today; (3) foundational information (what, why, how) on measurement in the behavioral sciences; (4) practical aspects of data analysis; and (5) how to write manuscript-length summaries of research results and make effective presentations about those results.

After completing basic (introductory) courses in research methods and statistics, students are usually not yet ready to carry out independent research projects. This is something that instructors of research seminar courses and supervisors of thesis projects know only too well, and students themselves often feel the same way, too. Part of the problem is that there are some critical gaps in the knowledge and skills of students who undertake thesis projects. For example, students’ familiarity with basic concepts about research design and statistics is often rather poor, despite their previous coursework. Some possible reasons why are outlined next.

There are some critical shortcomings in the way that research methods and statistics courses are often taught. One is that these subjects are typically dealt with in separate courses
and, consequently, their integration may not be emphasized. For example, various types of research designs may be discussed in a methods course with little attention paid to options for data analysis. Techniques for analyzing data are covered in statistics courses, but their connection with design may not be obvious. That is, each of methods and statistics may be presented outside the context of the other, but in real research projects they are integral parts of the same whole. A related problem is that too many behavioral science statistics courses are old-fashioned in that statistical tests ($t$, $F$, etc.) are the main topic. More modern approaches, including effect size estimation, the reporting of confidence intervals, and synthesis of results from replications in a meta-analysis, may not even be mentioned in a traditional statistics course (Aiken et al., 1990; Frederich, Buday, & Kerr, 2000). The approaches just listed are an important part of statistics reform, which has been a matter of increasing importance across disciplines as diverse as psychology, wildlife management, actuarial science, and empirical economics, among many others. As a result of recent greater emphasis on reform, methods of data analysis in the behavioral sciences are changing (Kline, 2004), and students should be so informed.

A third pedagogical problem is that the instruction of measurement theory, or psychometrics, has been virtually eliminated from many undergraduate and graduate programs in psychology (Aiken et al.). This is unfortunate because strong knowledge of measurement is crucial for behavioral science researchers, especially if they work with human research participants. If students have never been exposed to measurement theory, then they may lack basic skills needed in order to understand the characteristics of their scores, which are analyzed with statistical techniques. If the scores are flawed due to measurement-related problems, then the results may be tainted, too. Aiken et al. expressed the related concern that the substantial
decline of measurement in the psychology curriculum opens the door to a proliferation of poorly constructed measures, the use of which would degrade the quality of psychological research.

One consequence of the problems just mentioned is that students often have difficulty when it comes time to analyze data in their own research projects. They may experience a lack of confidence in what they are doing or, worse, wind up conducting a series of statistical analyses the results of which they do not really understand. That is, students too often carry out their analyses in a relatively blind way in which they have lost sight of the connections between their hypotheses (research questions), study design and procedures, scores, and interpretation of the results. Students also tend to become overly fixated on the statistical analysis and thus pay less attention than they should to other issues, including those of methods and measurement. The problems just described occur more often among undergraduate students, but many graduate students evidence the same difficulties, too.

Students who carry out thesis research projects need to do a lot of writing, from a proposal before starting the project to the final version of the thesis. Students in research seminar courses may also be required to make presentations about their projects. This could involve an oral presentation to the rest of the class or participation in a poster session at the end of the semester. Both of these forms of communication, written and oral, are critical skills for researchers. However, students are often unprepared to express themselves effectively in writing. This happens in part because few demands for writing may have been placed on them in earlier courses. Indeed, depending on the particular academic program and luck in course registration, it is possible to get a university degree without doing much, if any, serious writing. Thus, many students are simply unpracticed in writing before they enter a research seminar or graduate school. Even for students experienced in other types of writing, such as in the
humanities, it is not easy to learn how to write research reports. This is because scientific writing has its own style and tenor, and it requires extensive practice in order to master.

Students who are obliged to make oral presentations about their research projects are often given little guidance beyond specifying a time limit (e.g., 20 minutes), asking for coverage of particular content (e.g., describe your project, hypotheses, and methods), and showing them the basic workings of Microsoft PowerPoint or similar computer tools for making and showing electronic slides (overheads). Sure, today’s students see plenty of PowerPoint presentations during course lectures, some of which may be experienced as pretty awful and trivial but others as more engaging and educational. However, it is difficult for students to identify and articulate specific principles for making effective PowerPoint presentations based on hit-or-miss experiences as audience members. Consequently, it is not surprising that many students find oral presentations to be intimidating. They worry both about dealing with anxiety related to public speaking and how to organize their content in PowerPoint. A few students eventually develop by trial and error an effective presentation style, but many others do not. As you know, not all instructors are effective presenters, so this is not an indictment directed specifically against students. Perhaps the period of trial-and-error learning could be reduced if students (and their instructors, too) were offered more systematic instruction in how to make effective presentations, including both what to do and what not to do as a speaker and also in PowerPoint, too.

WHAT STUDENTS SAY THEY NEED

In the last few sections of my research seminar courses in which undergraduate psychology students in specialization or honors programs conduct a thesis project, I have asked of them at the beginning of the semester the question, What do you want to learn? The students respond in writing but anonymously when I am not present. Also, they can list anything they want in
response to this open-ended question. Summarized next are their most common responses:

About 75% of students indicated that they wanted to learn how to better conduct their statistical analyses and interpret the results. About the same proportion said that learning how to make effective oral presentations is a priority. A somewhat smaller proportion, but still the majority (65%), responded that they wanted to learn how to write a research paper for an empirical study. So the “big three” items on the students’ wish list concern the statistical analysis and developing better communication skills. Other kinds of responses were given by a minority of the students. These include receiving information about graduate school (30%), how to manage the logistics of a research project (10%), how to make effective posters for presentation in poster session (10%), research ethics (5%), other research areas besides their own (5%), and technical details of APA style (5%). The latter refers to specifications for formatting manuscripts according to the *Publication Manual* of the American Psychological Association (2005). I make no claim that these results are representative, but I bet that many senior undergraduate students—and junior graduate students, too—who conduct thesis projects would mention the same “big three” concerns as my own students.

PLAN OF THE BOOK

The organization of this book and the contents of its three parts are intended to address the issues just discussed concerning the preparation of students for research-based careers. The starting point of this process is the discussion in the next chapter (2) about the promise and pitfalls (i.e., the good, bad, and ugly) of our collective research enterprise in the behavioral sciences. Many of our students could probably articulate potential benefits of a research-based education. However, the same students may be less aware of some critical problems with behavioral science research. For example, most articles published in our research literature are never cited by other
authors and thus, by definition, have little or no impact on the field. There are also problems with the quality of many published studies in terms of their actual scientific contribution, how the data were analyzed, or how the results were interpreted. There is also a disconnect across many behavioral science disciplines between the conduct of research on the one hand and application of those results on the other. Many students never hear about such problems in undergraduate programs, and too many at the graduate level are also unaware of these issues. If we expect students to do a better job than those of us who now teach or supervise them, then you need to know about both the strengths and weaknesses of our research literature.

The five chapters of Part II (chaps. 3-7) concern essential concepts about design, analysis, and measurement, all presented within a framework that emphasizes their integration. In Chapter 3, this framework is laid out through description of the connections among these three pillars of research and how each is associated with a particular type of validity concerning the accuracy of inferences. Various threats to inference accuracy that involve design, analysis, measurement, and sampling, too, are also identified. Chapter 4 deals in more detail with design and analysis together. By this I mean that major types of research designs used in behavioral science research are reviewed along with options for data analysis. Emphasized in this discussion are standard statistical techniques that are more accessible to students, but I also point out a few more advanced methods. Students who go on to graduate school may later use some of these advanced methods, so it is good that you at least hear about them now.

Chapter 5 “tells the truth” about statistics in that it (1) acknowledges that many students do not have positive experiences in these courses; (2) notes that traditional statistics courses do not cover what students really need to know (they are not well prepared); and (3) points out that there are many widespread and incorrect beliefs (myths) about the outcomes of statistical tests,
even among experienced researchers and university professors. The correct interpretation of outcomes of statistical tests latter is discussed, and reviewed in the appendix of Chapter 5 are the fundamental statistical topics of standard errors, confidence intervals, and statistical tests. 

Chapter 6 deals with topics in the area of statistics reform, including the estimation and reporting of effect sizes and the construction of approximate confidence intervals for effect sizes. Described in the appendix of this chapter is an advanced method for constructing more accurate confidence intervals for effect sizes. This same method also underlies the estimation of statistical power. Some journals in psychology and education now require the reporting of effect sizes, and doing so is also called for in the APA *Publication Manual*. The basics of classical measurement theory and the estimation of score reliability and validity are the subject of Chapter 7. For too many students, the material covered in this chapter may be the only more-substantial presentation about measurement they have encountered so far. Accordingly, the main goal of this chapter is to help you to make better choices about measurement in your own project, given this reality. It also briefly introduces a few more modern developments in test theory, including generalizability theory and item-response theory.

Part III concerns skills that are essential for students and researchers alike. Chapter 8 deals with practical aspects of data analysis. In contrast, mainly theoretical issues are covered in statistics courses, but relatively little may be said about how to manage a real analysis. Emphasized in this chapter is the need to develop a clear analysis plan in which the simplest techniques that will get the job done are selected. That is, students are encouraged to resist the temptation to conduct too many analyses or ones that are unnecessarily complicated. Suggestions for handling more complex analyses are offered, and there is also discussion of the critical topic of data screening, or how to prepare your data for analysis. How to write a
manuscript-length summary of an empirical study is the subject of Chapter 9. Also considered in this chapter are general principles of good writing and more specific requirements for good scientific writing. Examples of common writing mistakes are also given. Presented in the appendix of Chapter 9 is an example of how to write results from an actual factorial design in a way that emphasizes effect size and de-emphasizes statistical significance. The last chapter (10) deals with how to make effective oral presentations using a computer tool such as PowerPoint. Tips for dealing with “stage fright” are offered in the first part of the chapter, and some common mistakes to avoid in PowerPoint presentations are identified. Next, specific principles for planning what to say and what to show in your presentations are considered, and examples of bad and better PowerPoint slides are compared. Considered in the last part of Chapter 10 are principles for constructing effective posters when presenting your work in poster sessions. Presented in the appendix of this chapter are example of slides, an audience handout, and a poster for a hypothetical 20-minute presentation based on the classical study of bystander intervention by Darley and Latané (1968).

Exercises are presented in chapters (3-8) that involve design, analysis, or measurement. These exercises are intended as opportunities for you to consolidate and apply your knowledge in each of these areas. Some of the exercises involve more theoretical matters, but others are computer exercises with small data sets. The latter are intended to give you hands-on practice with the corresponding quantitative concepts. There are also exercises for Chapter 10, but they concern preparing yourself to make a presentation about your particular research project.

CAREER PATHS FOR BEHAVIORAL SCIENTISTS

At first glance it might seem that most behavioral scientists work strictly in academia; that is, as faculty members in universities. Some do, of course, but only a relatively small proportion of
people with graduate degrees in psychology, education, or related areas go on to pursue academic careers. That is, the range of career possibilities for behavioral scientists is actually quite wide. Some possibilities for research-based careers are considered next.

Besides universities, behavioral scientists work in a range of government agencies or ministries, including those involved in health, education, transportation, engineering, criminal justice, statistics and standards, finance, and social services, among others. Other behavioral scientists work for non-governmental organizations, such as those involved in human service delivery or public policy. Behavioral scientists also work in several different types of settings in the private sector, including hospitals, marketing research firms, pharmaceutical companies, software development corporations, manufacturing facilities, financial service organizations, and insurance companies, to name a few. Some also work as consultants, either as “free agents” (i.e., they work independently) or as members of consultancy firms. The main clients of such firms are governments and businesses.

Research training leaves graduates of behavioral science programs with clearly marketable skills for a wide variety of careers outside of universities. And, of course, research-related work is only part of what behavioral scientists do in these positions. This could involve actually carrying out research projects from start to finish. If so, then skills other those directly related to design, analysis, and measurement are needed, including the ability to convey study rationale to non-researchers (i.e., write a proposal for those who control project funds) and to work out project budget and personnel needs. University faculty members deal with the same issues when they write grant proposals. Another possibility includes working to evaluate research results generated by others but then conveying your recommendations, possibly to others with no formal training in research, but who count on your judgment. So, once again, the
ability to communicate research results in terms that are meaningful to non-researchers or multidisciplinary audiences is crucial for many behavioral scientists, and this is true both inside and outside universities. It helps that you really understand what your own results mean; otherwise, how can you explain them to others, if you cannot first do so to yourself? This is why there is so much emphasis in this book on the correct interpretation of statistical results and on statistics reform, too.

Working as a behavioral science researcher also requires other skills that are not covered directly in this book, but they are some of the same skills needed by professionals in many other fields. One is the ability to effectively manage your work schedule. Like other busy professionals, behavioral scientists typically have too many things to do within too little time. Thus, there is often a need to prioritize among many “in-basket” tasks and deal first with the most pressing ones. The ability to work with others in a team is often critical, especially in business settings where teamwork is the norm. As mentioned, these teams may be multidisciplinary in that they are made up of people with quite different backgrounds, including those with no research credentials at all. A good sense of personal, business, and research ethics is needed as is a general professional demeanor where others are treated with respect, honesty in communication is expected and given, and a business-like approach to tasks is taken (i.e., get the job done). And all that was just mentioned about demands on professionals must be balanced against your personal life, too. It is not easy, but few students nowadays are naïve about the challenges of a professional career. There are many rewards, too, especially for energetic, creative, and self-motivated people who want a stronger sense of making their own way than is often possible in non-professional positions.

As mentioned, a minority of behavioral scientists pursue academic careers. As you may
know, the academic job market is highly competitive in that there are typically many more applicants than available positions, especially for tenure-track slots. In large universities with a strong emphasis on research, it is not unusual for departments to receive dozens or perhaps hundreds of applications for a single tenure-track position. The boom in academic hiring due to the retirement of senior, tenured faculty members expected in the early 1990s never materialized, in part because universities have been hiring more and more part-time, non-tenure-track (contingent) instructors instead of full-time, tenure-track professors, which reduces personnel costs. As noted by van Dalen and Klamer (2005) and others, universities now place more of a premium on relatively early manifestation of research productivity and on the ability to secure funds from granting agencies than in the past. This emphasis works against “late bloomers” who do not discover a passion for research until later in their careers. In the past, some tenured professors did not really begin their academic careers until their early 40s. This is most rare now in that the usual starting age of those with assistant-level tenure-track positions today is during the late 20s or early 30s. Indeed, it is a reality that one needs to plan for an academic position quite early in graduate school by (1) seeking out a supervisor who is a prolific researcher; (2) participating in research above and beyond one’s particular thesis project; (3) presenting papers or posters at scientific conferences; and (4) publishing research articles while still a student, not just after graduation. It is also does not hurt to pick up some teaching experience while in graduate school, but not at the expense of getting your research done. This is a tough business, but it is better to consider an academic position with your eyes wide open. However, the potential rewards are great for those who believe that they will thrive in an academia.

SUMMARY

The fact that many students who are about to conduct supervised research projects are not yet
ready in terms of their conceptual knowledge and practical skills was discussed in this chapter. Specifically, thesis students often need help with (1) developing a more complete sense of how design, analysis, and measurement complement one another; (2) conducting their statistical analysis and correctly interpreting the results; and (3) communicating to others in written and spoken form about their findings. It was also noted that there are many career paths for those who become behavioral scientists. Some of these paths involve working in academia, but many others do not; indeed, the range of employment opportunities outside universities is wide and includes governmental, commercial, educational, and other types of settings. Want to see if one of these paths might be in your future? Then let us begin start by getting you ready. We do in the next chapter with a review of what is right and also what is wrong with behavioral science research.

RECOMMENDED READINGS

The books by Sternberg and also by Horowitz and Walker describe various career options for students in, respectively, psychology and education, while Marek’s book covers a wider range of social science career opportunities. Heiberger and Vick offer helpful suggestions for conducting an academic job search.


