

TEXTBOOK REVIEW

The Design of Experiments in Neuroscience.

by Mary Harrington

2006 Thompson Wadsworth, 180 pages

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The author, Mary Harrington, is an accomplished professor and neuroscientist, teaching Research Methods courses in both the Psychology and Neuroscience departments at Smith College, with a prolific publication record of research on the neural control of the circadian clock. She is also an associate editor of *The Journal of Neuroscience*, and a member of the Neuroscience and Behavior Program at the University of Massachusetts, Amherst as well as the incoming president of Faculty for Undergraduate Neuroscience.

Dr. Harrington describes her motivation in preparing *The Design of Experiments in Neuroscience* to provide an introduction for sophomore neuroscience students to the basics of research design and analysis, using current examples from the neuroscience research literature. I have recently assigned parts of the text to an upper-level Neuroscience Research Methods class, with very favorable results. This compact, eight-chapter text is a wonderful 'how to' primer for conducting research from "soup to nuts", as my post-doctorate advisor was fond of saying. It is extremely easy to read, packed full of great examples from diverse fields of neuroscience, with clear figures to aid comprehension, and useful end-of-chapter questions, web-resources, and road-tested primary research articles for undergraduates. Below I will summarize the overall format of the text and ancillary materials, as well as the content of each chapter. Then I will describe how we used the text in my previous course, student responses, and how I plan to use the text in the future.

Overall Format and Ancillary Materials

The eight chapters progress from general to specific, from the ethics of conducting scientific research and how to come up with your research questions, to the details of designing your experiment and how to statistically analyze your results, plus how to write-up your results as a formal research paper. At the end of each chapter, there are 'Check your Understanding' fact-based questions and deeper 'Think About it' essay-style questions to help students review the material (the answers are found in Appendix F).

There are six appendices (A-F), and the ones that I believe will get the most use are the first two. The first, (A) "Working with your Data" is a well-written and illustrated, simple review of exploratory analyses using descriptive statistics, with t-test, chi-square and simple ANOVA methods, as well as advice on how to present figures clearly and pick the right statistical test. The second, (B) 'Writing a Research Paper' reviews what should be

included in each part of a scientific report, and the format and reference requirements in *The Journal of Neuroscience* and *American Psychological Association* guidelines. It's a great place to start for students writing their first manuscript. The other appendices provide a random number table, glossary, and 46 review questions and exercises with text page-number cross-referencing.

Ancillary materials come in the form of an Instructor's Manual with Test Bank by Beth Powell, also at Smith. These materials can be downloaded as a .pdf file, or come printed as a three-ring binder-ready booklet. If you do not receive the materials automatically, be sure to contact the publisher to receive the materials. At first I was not aware that they were available, so the one disclaimer of this review is that I have not yet used the Instructor's Manual. The Manual includes outlines, key terms, and test questions (multiple choice, true/false, and short-answer/essay) for each chapter – standard fare. However, here Powell also shares the wealth of her 25 years of experience as an instructor of research methods courses in Psychology by providing ideas for lecture and discussion, in-class activities, handouts for students, and links to relevant web sites with descriptions of the materials available on those sites. For example, there are instructions to conduct an in-class experiment on the effects of olfactory cues in detecting the flavors of life-savers, used to demonstrate characteristics of experimental design, statistical analyses, and presenting results. Thus, this little book comes with a full complement of resources to help you implement it in the classroom. My only criticisms of the ancillary materials are that some of the class exercises/lecture suggestions were only described in general terms, which left me desiring more specific reference-information, and some of the web-addresses are no longer operational, although this is understandably unavoidable.

At the end of each chapter there is a "Web Resources" symbol with directions for students to explore links to web resources available at the publisher's (Wadsworth's) website. Although these links are not yet posted for me to review, the publisher has recently communicated to the author that these will be made available soon. Also, for the second edition (approximately 2009), the publisher has plans to make the figures available electronically.

Text Content

Chapter 1: The Varieties of Scientific Experience

Chapter 1 engages students in the epistemological question of how we know what we know. It provides

students with tools to distinguish pseudoscientific claims from research that utilizes the scientific method, and encourages them to be skeptical consumers of science. Immediately, Harrington sucks students into the text with diverse, compelling examples, including testicular implants to restore sex drive, phrenology, Leonardo de Vinci drawings of the ventricles, and the use of St. John's Wort to treat depression.

Chapter 2: Ethics

This chapter on research ethics provides comprehensive coverage of the major ethical guidelines for conducting neuroscience research in humans and animals, and discusses fraud and plagiarism. There is an informative historical review of how and why the IACUC and human IRB procedures were put in place, with provocative descriptions of prior abuses, such as the U.S. Public Health Service study of the natural course of syphilis in poor, rural African-American men (Tuskegee experiment), conducted without subjects consent or providing treatment for the disease when it became available. An example of plagiarism involving close paraphrasing is provided, with links to further web-based plagiarism resources in the Instructor's Manual.

Chapter 3: Getting Started

Here students are advised how to go about selecting their research questions and narrow their focus to specific, testable hypotheses by following the progress of Mary's student 'Dora' as she comes up with her experiment to test the effects of estrogen on circadian rhythms in mice. There are excellent discussions of how bias may influence our choice of research questions and "What makes a good hypothesis?" that I find useful for scientists of all ages and stages to review.

Chapter 4: What is an Experiment?

Chapter 4 poses the question 'What is an Experiment?' by contrasting observational and case studies with controlled experiments; covering a wealth of topics including scales of measurement, dependent/independent/control variables, double-dissociation, and testing the null hypothesis (type 1, type 2 errors, etc.). Sound boring? It isn't! It is statistics translated into English, and within a context that makes you want to learn or review it! The layout is impressive – there are tables, figures, pictures to make the material come alive, and again – really interesting examples; measuring cortisol levels in snow from the urine of low-socially ranked timber wolves, Case H.M.'s memory deficits and spared abilities, or twin studies of the relationship between Post-Traumatic Stress disorder and hippocampal size, to name a few.

Chapter 5: Controlling Extraneous Variables

This critical aspect of experimental design, as well as placebos, order effects, within- and matched- sample designs, internal and external validity, distinguishing real from quasi-experiments, and special notes about the design and analysis of pharmacological and functional

magnetic resonance imaging (fMRI) experiments, are all explored in this chapter. There is a seamless flow of captivating dialogue from examining the effects of anesthetics on GABA receptors in frog eggs to the role of neurogenesis in antidepressant treatments in mice and humans, and the potential benefits and pitfalls of using transgenic animals in research, or fMRI studies in humans. I especially like the many critical questions about the research posed in the text, showing students by example how to think analytically and take nothing for granted. There are also many experimental descriptions for students to practice determining the flaws in their designs in the 'Think About It' section at the end of the chapter.

Chapter 6: More than One Predictor Variable: Factorial Designs

Here factorial designs are fully described, with a series of figures that show the layout of simple and more complex factorial designs, plus all possible outcomes of main effects and interactions. The figures complement the text, which uses recent experimental data, such as blocking cocaine craving in rats by blocking pERK (phosphorylated extracellular signal-regulated kinase) via infusions into the amygdala, to provide students with concrete examples with which to relate the statistical vocabulary (independent variables, factors, etc.), and practice describing results. Particularly useful is how Harrington introduces a complex experiment on forced-limb use in a rat model of Parkinson's disease by first introducing a simplified version of the task, walking students through it, and then later revealing the more complex design.

Chapter 7: Correlational Designs

Does a shrinking brain region with aging correlate with reduced memory skills? Are our SAT scores related to grade-point average? In the context of general interest questions such as these, Harrington lays out the rationale behind correlational studies, reviews the Pearson and Spearman correlation coefficients, reminds us that correlation does not imply causation, and illustrates her points with no less than 18 graphs! Visually pleasing, clear, and "to-the-point," adjectives I would use to describe this as well as the other chapters of *Design*.

Chapter 8: Review of all Research Designs

This is more of an end-of-book summary, rather than a chapter (three pages, including review questions). The review questions test students understanding of all of the research designs covered in the preceding chapters; descriptive, case study, correlational, experiment, factorial (within-subject, between-subject), quasi-experiments and time-series. For the end-of-chapter questions, students are required to describe the independent and dependent variables and research design from brief descriptions of published research articles. Also, the 'Think About It' section provides more references for short, recent neuroscience articles that can be easily digested by undergraduate students.

Current and Future Use in my Neuroscience Research Methods course on Human Emotions

To pilot the text, I assigned chapters 1-6 at various times throughout the semester as outside reading material, and then in class we worked through and discussed some of the 'Check Your Understanding' or 'Think About It' questions as a group. Thus, I used the text very informally in this small, research-based course. I found the text to be very useful to help me gauge student understanding of research design methodology, and to review concepts using the examples. In this course we designed and conducted our own experiment, and we referred to the text and applied the knowledge to our own study, a worthwhile exercise that enhanced student understanding.

My NRM students found the authors writing style to be very clear and easy to understand. Because these were upper-level students, much of the statistics and research design topics were familiar to them, but students still commented that they liked having this material in an easily accessible format available to them for reference. As a testament to the many interesting examples of neuroscience research, I found students citing some of the primary research articles described in the text in their final research papers; everyone found something that was of special interest to them in the text!

I plan to use *Design* as a primary text in future Neuroscience Research Methods courses, and as a 'laboratory manual' for my Biopsychology course this coming fall. I think that assigning the chapters in the first half of the semester, with review-quizzes and required reading of some of the primary research articles will help prepare students for independent mini-experiments conducted in the latter half of the semester. Also, because there are often students in this course with little prior research experience, it will be a great introduction to prepare them for upper-level statistics and research design courses, and for their required senior thesis research project.

Finally, I must mention that the students and I really loved the cartoons throughout the text – humor makes the statistics and research design go down in a most delightful way.