# Statistics Unplugged

y Caldwell

# Statistics Unplugged

*Sally Caldwell*
*Southwest Texas State University*





THOMSON
WADSWORTH
Australia • Canada • Mexico • Singapore • Spain
United Kingdom • United States

THOMSON
WADSWORTH

Publisher: *Vicki Knight*
Assistant Editor: *Jennifer Wilkinson*
Editorial Assistant: *Monica Sarmiento*
Technology Project Manager: *Darin Derstine*
Marketing Manager: *Lori Grebe*
Marketing Assistant: *Laurel Anderson*
Advertising Project Manager: *Brian Chaffee*
Signing Representative: *Richard Colangelo*
Project Manager, Editorial Production: *Paula Berman*
Print/Media Buyer: *Kris Waller*

Permissions Editor: *Sarah Harkrader*
Production Service and Compositor: *Scratchgravel Publishing Services*
Text Designer: *John Edeen*
Copy Editor: *Margaret C. Tropp*
Illustrator: *Gregory Draus*
Cover design: *Cheryl Carrington*
Cover art: *Kevin Tolman*
Text and Cover Printer: *Transcontinental/Louiseville*



Printed in Canada
2 3 4 5 6 7 07 06 05 04 03

For more information about our products, contact us at:
**Thomson Learning**
**Academic Resource Center**
**1-800-423-0563**

For permission to use material from this text, contact us by:
**Phone:** 1-800-730-2214
**Fax:** 1-800-730-2215
**Web:** http://www.thomsonrights.com

Library of Congress Control Number: 2002115694

ISBN 0-534-52113-4

**Wadsworth/Thomson Learning**
**10 Davis Drive**
**Belmont, CA 94002-3098**
**USA**

**Thomson Learning**
5 Shenton Way #01-01
UIC Building
Singapore 068808

**Australia**
Nelson Thomson Learning
102 Dodds Street
South Melbourne, Victoria 3205
Australia

**Canada**
Nelson Thomson Learning
1120 Birchmount Road
Toronto, Ontario M1K 5G4
Canada

**Europe/Middle East/Africa**
Thomson Learning
High Holborn House
50/51 Bedford Row
London WC1R 4LR
United Kingdom

**Latin America**
Thomson Learning
Seneca, 53
Colonia Polanco
11560 Mexico D.F.
Mexico

**Spain/Portugal**
Paraninfo
Calle/Magallanes, 25
28015 Madrid, Spain

*In memory of Geoff Wood,*
*whose mom wrote the book on friendship*

## *About the Author*

Sally Caldwell earned her Ph.D. in Sociology from the University of North Texas. The author of *Romantic Deception* (Adams Media, 2000), Caldwell focuses her primary research interest on the topic of deception in social relationships. Caldwell resides in a small village in the hill country of south central Texas and serves on the faculty of the Department of Sociology at Southwest Texas State University.

# Preface

The idea behind this book came from my students, after I watched countless semesters unfold in a predictable fashion. The scene repeats itself each year in a classroom populated largely with panic-stricken students facing their first formal encounter with the field of statistical analysis. My passion for the subject matter is usually enough to quickly make a connection with some of the students, but certainly not all of them. A real connection, I've discovered, requires constant attention to the students' perspective, a willingness to respect the roadblocks (real or imaginary) that exist in their minds.

Over time, I've learned that there are two major obstacles for a lot of students. First, there's the *fear of the formula* factor, something that seems to plague many students. The second obstacle is the *so what* scenario: the tendency for many students to question the relevance of the subject matter—and why they have to take the course in the first place. I believe there's a way to overcome these roadblocks, and that way is what I've attempted to lay out in this book. I emphasize the *logic* behind statistical analysis and focus on an *intuitive* understanding that I believe lies within virtually every student. When the formulas take a back seat, magical things can happen. The world of statistical analysis becomes interesting, inviting, and (on occasion) enjoyable. When the magic takes hold, the exploration goes well beyond statistical techniques and into the larger realm of scientific inquiry. In the process, the subject matter is made relevant.

## Acknowledgments

The idea for any book remains just that—merely an idea—until the words hit the page. In the case of this book, the words would never have made it so far were it not for the support and encouragement of a lot of people. The individuals who came to be involved in this project are numerous. Many, I suspect, were unaware along the way of just how important their involvement was.

At the university, certain individuals in strategic positions had the talent for making things happen. To Ann Marie Ellis and Lawrence Estaville, Jr., I owe a particular debt of gratitude. They are, in a word or two, door openers of the first order. To the chair of my department, Susan Day, I owe daily thanks for her tireless efforts to carve out a supportive and sustaining environment—one with a true sense of community and commitment to intellectual endeavors. My thanks go also to certain colleagues who suffered through my countless commentaries about this project. Barbara Trepagnier, for example, was always in

her office down the hall and available when I chose to drop in (uninvited), just to prattle on about the project. My car pooling pals, Sue Johnson and Pam Showalter, willingly gave me feedback as we drove through the Wimberley Valley on our way to the university.

When it came to getting words onto paper, the support was endless. First, Richard Coleangelo, Wadsworth campus representative, took my idea up the ladder and into the talented hands of Vicki Knight, Editor and Publisher at Wadsworth. Vicki knows about words, so she knows what I mean when I say words cannot express my gratitude for her constant support, humor, and patience throughout. The list goes on. Paula Berman, Production Editor at Wadsworth, and Monica Sarmiento, Editorial Assistant, teamed up to give valuable guidance and keep me on task. Vernon Boes brought his incredible talents to the cover, and Anne and Greg Draus of Scratchgravel Publishing Services painstakingly provided the finishing touches (graciously taking an endless stream of calls from me). Finally, Sara Smith, student assistant without equal, kept me organized, focused, and optimistic. Without hesitation, she would read chapter after chapter, over and over again. My debt to her can never be fully repaid.

I thank the reviewers who read through the manuscript and offered valuable comments: James Knapp, Southeastern Oklahoma State University; Paul Ansfield, University of Wisconsin Oshkosh; Lora Schlewitt-Haynes, University of Northern Colorado; Ida Mirzaie, Ohio State University; Charles Harrington, University of Southern Indiana; Steve Weinert, Cuyamaca Community College; J. Oliver Williams, North Carolina State University; Holly Straub, University of South Dakota; Faye Plascak-Craig, Marian College; Michael Hurley, George Mason University; and Susan Nolan, Seton Hall University. In addition, the tables included in Appendixes A–E and Appendixes H and I were adapted from tables constructed by Victor Bissonnette of Berry College. His generosity in supplying the materials is greatly appreciated.

On the personal side of the ledger, an army of people always understood my endless preoccupation with the project. So to Gary Hartling, John Friedli, Nancy Middlebrook, Ellen Lewis, Ron Lenamon, Marilee Wood, Tevis Grinstead, Maria Canizales, Walter Brown, Steve Klepfer, Jimmie Robinson, Sam and Barbara Dawkins, Kay Cole, and Liz Sumter, I say a heartfelt thank-you for the many priceless moments that never failed to remind me of the true joys of life.

Finally, my thanks to Suzan Abughazaleh and Eric Groves, two very special people who are a constant presence in my life, even though there are miles in between. Like my parents, who never ran short with their encouragement, Suzan and Eric have always understood my pursuits. The mere thought of them always brings forth a smile.

*Sally Caldwell*

If you would like to give us your opinion and suggestions regarding this text, please go to http://psychology.wadsworth.com/caldwell1e/ and click on "Evaluation Form" in the left menu to complete the student's evaluation form.

# Brief Contents

# Contents

Exam I.

# 0

# *Introduction: Methods, Material, and Moments to Remember*

*Statistics, Quantitative Methods, Statistical Analysis*—words, phrases, and course titles that can shake the confidence of nearly any student. Let me put your mind at ease right away. Your experience with statistics doesn't have to be a horror story. In fact, your experience with statistics can be an enjoyable one—a venture into a new way of thinking and looking at the world. It's all a matter of how you approach the material.

Having taught statistics to legions of undergraduate students, I've spent a lot of time trying to understand how students react to the material and why they react the way they do. In the process, I've developed my own approach to the subject matter, and that's what I've tried to lay out in this book. As we get started, let me tell you a little more about what to expect as you work your way through this book.

First, let me explain my method. I'm committed to the idea that the subject matter of statistics can be made understandable, but I'm also convinced that it takes a method based on *repetition*. Important ideas and concepts can be introduced, but they have to be reintroduced and reemphasized if a student is to get the connection between one concept and the next. Repetition—that's the method I've used in this book, so you should be prepared for that.

At times you may wonder why you're rereading material that was emphasized at an earlier point. Indeed, you'll likely start muttering "not that again!" If that happens, enjoy the moment. It signals that you're beginning to develop a sense of familiarity with the central concepts.

I've also tried to incorporate *simplicity* into the method—particularly in the examples I've used. Some examples will probably strike you as extremely simplistic—particularly the examples that are based on just a few cases and the ones that involve numbers with small values. I trust that simplistic examples won't offend you. The goal here is to cement a learning process, not to master complicated mathematical operations. That brings us to the matter of the material you're going to encounter.

As it turns out, it's often the logic behind statistics that proves to be the key to success or failure. You can be presented with formulas—simple or complex—and you can, with enough time and commitment, memorize a string of them. All of that is well and good, but your ability to grasp the logic behind the formulas is a different matter altogether. I'm convinced that it's impossible to truly understand what statistics is all about unless you understand the logic behind the procedures. Consequently, it's the *logic* that I've tried to emphasize in this book.

Indeed, it's safe to say that numbers and formulas have taken a back seat in this book. Of course you'll encounter some formulas and numbers, but that's not where the emphasis is. Make no mistake about it—the emphasis in this book is on the conceptual basis behind the calculations.

There's one other thing about the material that deserves comment. Like it or not, the traditional approach to learning new material may come up short when you want to learn about statistical analysis. The reason is a simple one: The field of statistics is very different from other subjects you've studied in the past.

If, for example, you were to taking a course to learn a foreign language, you'd probably figure out the goal of the course fairly early. You'd quickly sense that you'd be learning the basics of grammar and vocabulary, trying to increase your command of both over time. I suspect you'd have a similar experience if you signed up for a history course. You'd quickly sense that you were being introduced to names, dates, places, and overall context with the goal of increasing your understanding of the how and why behind events.

Unfortunately, the field of statisticalal analysis doesn't fit that learning model very well. You may be able to immediately sense where you're going in a lot of courses, but that's not necessarily the case in the field of statistics. In fact, my guess is that a command of statistical analysis is probably best achieved when you're willing to go along for the ride without really knowing at first where you're going. A statement like that is close to heresy in the academic world, so let me explain.

There is an end game to statistical analysis. People use statistical analysis to describe information and to carry out research in an objective, quantifiable way. Indeed, the realm of statistical analysis is fundamental to scientific inquiry. But the eventual application of statistical analysis requires that you first have a firm grasp of some highly abstract concepts. You can't even begin to appreciate the very special way in which scientists pose research questions if you don't have the conceptual background.

For a lot of students (indeed, most students, I suspect), it's a bit much to tackle concepts and applications at the same time. The process has to be broken down into two parts—first the conceptual understanding, and then the applications. And that's the essence of my notion that you're better off if you don't focus at the outset on where you're going. Concentrate on the conceptual basis first. Allow yourself to become totally immersed in an abstract, conceptual world, without any thought about direct applications. In my judgment, that's the best way to conquer the field of statistical analysis.

If you're the sort of student who demands an immediate application of concepts—if you don't have much tolerance for abstract ideas—let me strongly suggest that you lighten up a bit. If you're going to master statistics—even at the introductory level—you'll have to open your mind to the world of abstract thinking.

Toward that end, let me tell you in advance that I'll occasionally ask you to take a moment to seriously think about one notion or another. Knowing students the way I do, I suspect there's a chance (if only a small chance) that you'll ignore my suggestion and just move ahead. Let me warn you. The approach of trying to get from Point A to Point B as quickly as possible usually doesn't work in the field of statistics. When the time comes to really think about a concept, take whatever time is necessary.

Indeed, many of my students eventually come to appreciate what I mean when I tell them that a particular concept or idea requires a "dark room moment." In short, some statistical concepts or ideas are best understood if contemplated in a room that is totally dark and void of any distractions. Those should become your moments to remember. I'm totally serious about that, so let me explain why.

Many statistical concepts are so abstract that a lot of very serious thought is required if you really want to understand them. Moreover, many of those abstract concepts turn out to be central to the statistical way of reasoning. Simply reading about the concepts and telling yourself that you'll remember what they're all about won't do it. And that's the purpose behind a dark room moment.

If I could give you a single key to the understanding of statistics, it would be this: Take the dark room moments seriously. Don't be impatient, and don't think a few dark room experiences are beneath your intellectual dignity. If I tell you that this concept or that idea may require a dark room moment, heed the warning. Head for a solitary environment—a private room, or even a closet. Turn out the lights, if need be, and undertake your contemplation in a world void of distractions. You may be amazed how it will help your understanding of the topic at hand.

Now, having said all of that as background, it's time to get started. Welcome to the world of statistics—in this case, *Statistics Unplugged*!