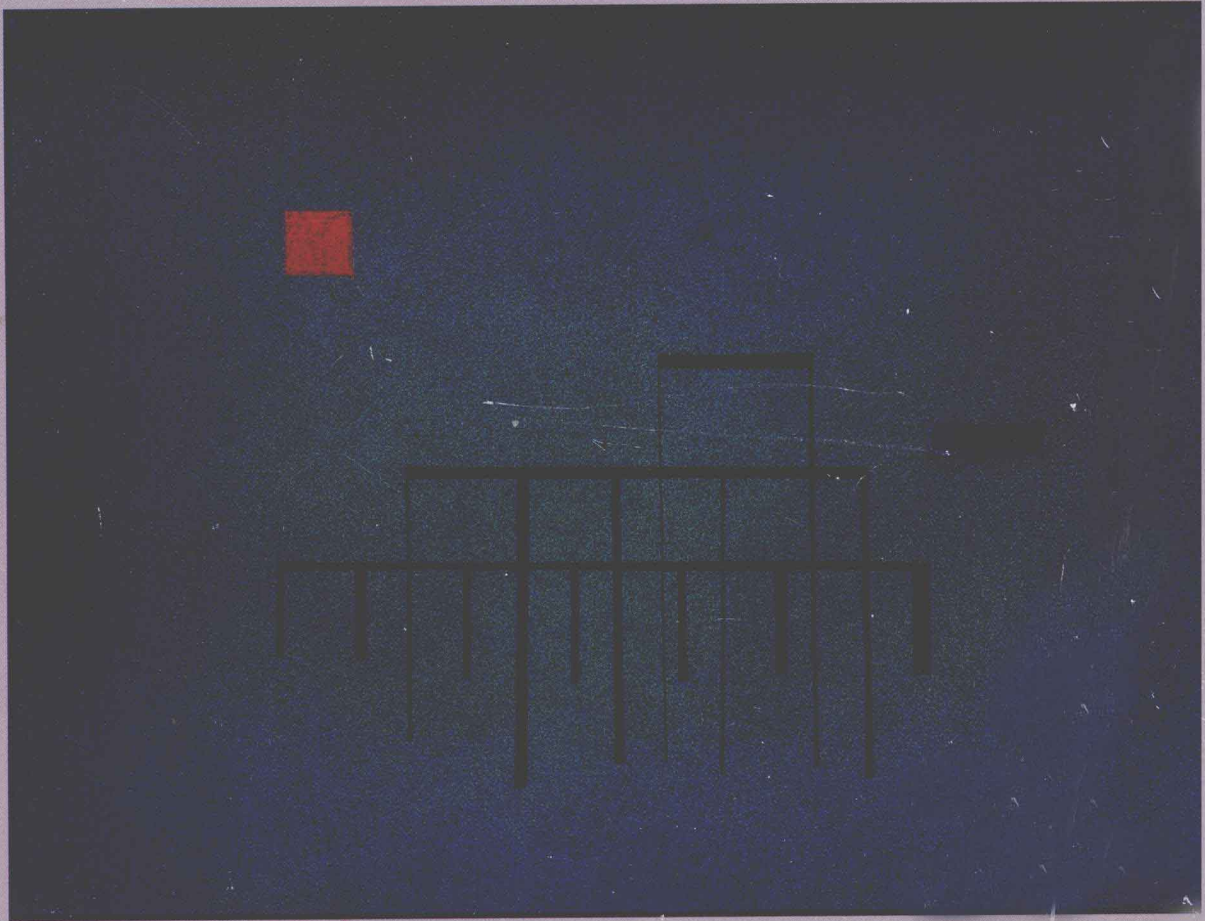


THIRD EDITION

E*ssentials of* *for the Behavioral Sciences* **S***tatistics*



GRAVETTER/WALLNAU

ESSENTIALS OF STATISTICS FOR THE BEHAVIORAL SCIENCES

THIRD EDITION

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Brooks/Cole Publishing Company

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Pacific Grove • Albany • Belmont • Bonn • Boston • Cincinnati • Detroit
Johannesburg • London • Madrid • Melbourne • Mexico City
New York • Paris • Singapore • Tokyo • Toronto • Washington

Sponsoring Editors: *Denis Ralling and Vicki Knight*
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Manuscript Editor: *Sherry Goldbecker*
Permissions Editor: *May Clark*
Design Editor: *Roy R. Neuhaus*
Cover Design: *Carolyn Deacy*
Cover Art: *Vasily Kandinsky*

Horizontal Blue (Wagerecht Blau), *December 1929.*
Watercolor, gouache, and blue ink on paper
24.2 × 31.7 cm (9 1/2 × 12 1/2 inches)
The Hilla von Rebay Foundation
The Solomon R. Guggenheim Museum, New York
Photography by David Heald © The Solomon R.
Guggenheim Foundation, New York.
Typesetting: The Clarinda Company
Cover Printing: Phoenix Color Corporation
Printing and Binding: Courier/Kendallville

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For more information, contact:

BROOKS/COLE PUBLISHING COMPANY
511 Forest Lodge Road
Pacific Grove, CA 93950
USA

International Thomson Editores
Seneca 53
Col. Polanco
11560 México, D.F., México

International Thomson Publishing Europe
Berkshire House 168-173
High Holborn
London WC1V 7AA
England

International Thomson Publishing GmbH
Königswinterer Strasse 418
53227 Bonn
Germany

Thomas Nelson Australia
102 Dodds Street
South Melbourne, 3205
Victoria, Australia

International Thomson Publishing Asia
60 Albert St.
#15-01 Albert Complex
Singapore 189969

Nelson Canada
1120 Birchmount Road
Scarborough, Ontario
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International Thomson Publishing Japan
Hirakawacho Kyowa Building, 3F
2-2-1 Hirakawacho
Chiyoda-ku, Tokyo 102
Japan

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Printed in the United States of America

10 9 8 7 6 5 4

Library of Congress Cataloging-in-Publication Data

Gravetter, Frederick J.
Essentials of statistics for the behavioral sciences / Frederick
J Gravetter, Larry B. Wallnau.—3rd ed.
p. cm.
Includes bibliographical references (p.) and index.
ISBN 0-534-35780-6
1. Social sciences—Statistical methods.— I. Wallnau, Larry B.
II. Title.
HA29.G726 1998
300'.7'2—dc21—

98-20983
CIP



To David W. Wallnau, my extraordinary mentor,
devoted father, and dear friend
—L. B. W.

PREFACE

There are three kinds of lies: Lies, damned lies, and statistics

We have used this quote in previous editions because it is timeless as well as humorous. It is attributed by Mark Twain to Benjamin Disraeli and reflects a commonly held belief that statistics (or perhaps even statisticians) should not be trusted. Unfortunately, this mistrust does have at least some basis in reality. In this book, we shall see that statistical techniques are tools that we use to organize information and to make inferences from our data. Like any other tool, however, statistics can be misused, which can result in misleading, distorted, or incorrect conclusions. It is no small wonder, then, that we are sometimes skeptical when a statistician presents findings. However, if we understand the correct uses of statistical techniques, then we will recognize those situations in which statistical procedures have been incorrectly applied. We can decide which statistical reports are more believable. By understanding statistical techniques, we can examine someone else's results, understand how they were analyzed, and arrive at our own thoughtful conclusion about the study. Therefore, the goal of this book is to teach not only the methods of statistics, but also how to apply these methods appropriately. Finally, a certain amount of mistrust is healthy, that is, we should critically examine information and data before we accept its implications. As you will see, statistical techniques help us look at data with a critical eye and a questioning mind.

For those of you who are familiar with previous editions of *Essentials of Statistics for the Behavioral Sciences*, you will notice that some changes have been made. These changes are summarized in the section entitled "To the Instructor." In revising this text, our students have been foremost in our minds. Over the years, they have provided honest and useful feedback. Their hard work and perseverance has made our writing and teaching most rewarding. We sincerely thank them. For the students who are using this edition, please read the section of the preface entitled "To the Student."

ANCILLARIES

Ancillaries for this edition include the following:

- *Study Guide*: Contains chapter overviews, learning objectives, new terms and concepts, new formulas, step-by-step procedures for problem solving, study hints and cautions, self-tests, and review.

- *SPSS Manual*: Contains step-by-step instructions on how to use SPSS to carry out statistical analysis.
- *Minitab Manual*: Includes instructions on using Minitab software to perform the statistical analyses covered in the text.
- *Instructor's Manual*: Contains test items, as well as solutions to all problems included in the text.
- *Transparency Masters*: Include about 90 tables and figures taken directly from the text.

ACKNOWLEDGMENTS

Our friends at Brooks/Cole have made an enormous contribution to this book. We thank our editor, Vicki Knight, who has been most supportive and encouraging. Editorial assistant Stephanie Andersen, production coordinator Laurie Jackson, and ancillaries editor Faith Stoddard are very capable people who possess many professional and technical skills and have helped in this undertaking.

Special thanks go to Emily Autumn of Clarinda. We have previously worked with her on other projects, and once more, her work on production has been extraordinary. The people at Minitab, Inc., deserve accolades for their Author Assistance Program, which was very helpful for the preparation of the Minitab Manual. Roxy Peck was most helpful in checking computations and finding errors we had missed.

Reviewers play a very important role in the development of a manuscript. Accordingly, we offer our appreciation to the following colleagues for their thoughtful reviews: Suzanne Bousquet, Kean University; Gregory Burton, Seton Hall University; Maria Czyzewska, Southwest Texas State University; Mark B. Fineman, Southern Connecticut State University; James Gardner, Ozarks Technical Community College; Richard Grow, Weber State University; Joe W. Hatcher, Jr., Ripon College; Bonnie Kind, Worcester State College; Thomas Nelson, Adrian College; Kerri Pickel, Ball State University; Carol Pandey, Los Angeles Pierce College; Stephen Schepman, Central Washington University; Martha Spiker, University of Charleston; and Davin Youngclarke, California State University at Fresno.

A Special Note of Thanks Our family members have endured weekends and evenings when we were not available because we were immersed in writing and proofreading. This endeavor would be impossible were it not for their support, encouragement, and patience. Heartfelt thanks go to Debbie, Justin, Melissa, Megan, JoAnn, and Nico.

TO THE INSTRUCTOR

Those of you familiar with the second edition of *Essentials of Statistics for the Behavioral Sciences* will notice several changes in the third edition. A general summary of the revisions follows:

- The end-of-chapter problem sets have been revised.
- Some learning checks have been revised, and more have been added to chapters where they were needed.
- Chapter 16 (Minitab) of the second edition is now an ancillary under separate cover (*The Minitab Manual*).
- A new chapter has been added to cover two-factor analysis of variance.

The following are examples of the specific and noteworthy revisions:

Chapter 1

- The section on the experimental method now includes new coverage of quasi-independent variables (subject variables).
- The discussion of theories and hypotheses now emphasizes the importance of developing *testable* hypotheses. The role of hypothesis tests in theory construction is discussed.
- The rules of summation notation have been reorganized, and information on order of operations is included.

Chapter 4

- A new section discusses the use of the standard deviation in descriptive statistics and the use of variance in inferential statistics.

Chapter 5

- The chapter now begins with an overview that “points the way” to inferential statistics. It briefly, and in simple terms, presents the interrelationship of issues addressed in Chapters 5, 6, and 7, which form the foundation for subsequent chapters on hypothesis testing.

Chapter 6

- The introduction begins with a new example that illustrates the notions of uncertainty and probability.
- A distinction is made between simple random samples and convenience samples.
- The *unit normal table* has been reorganized to make it easier for students to use when determining probabilities. The probabilities in the table columns now separate the tail of the distribution from the remaining body. (This change has been successful in *Statistics for the Behavioral Sciences, Fourth Edition*.) It also makes finding percentile ranks easier.

Chapter 7

- The standard error formula is developed in terms of variance, as well as of standard deviation. The inclusion of variance here facilitates the understanding of more complex standard error formulas in later chapters.
- The chapter ends with new discussions of the role of standard error in inferential statistics: (a) standard error and sampling error, (b) standard error as a measure of chance, and (c) standard error as a measure of reliability. These discussions provide a better transition to the hypothesis testing chapters that follow.

Chapter 8

- More attention is given to taking the student through the *entire* hypothesis test procedure early in the chapter, addressing other aspects of hypothesis testing later. This organizational change provides an uninterrupted flow of logic.

- Type I and Type II errors now are presented in the context of uncertainty in inferential statistics.
- A new section discusses concerns about the usefulness of hypothesis testing that have been argued among researchers recently.

Chapter 9

- The development of the t statistic has been modified to incorporate minor changes in the formula for standard error (Chapter 7); that is, the standard error formula is now expressed in terms of variance.

Chapter 12

- This chapter has been greatly streamlined. Rather than develop the estimation procedures and formulas that correspond to the test situations in Chapters 8 through 11, a general model for estimation of μ is developed from which all others are derived.

Chapter 13

- Explanations of between treatment and within treatment variability have been revised.
- A new box on sources of error variability has been included.
- The explanation of the F ratio was rewritten.
- A new section, “A Conceptual View of ANOVA,” examines the components of the F ratio using several small data sets.

Chapter 14

- This chapter is entirely new to this book, covering two-factor analysis of variance.

Chapter 15

- There is coverage of the role of outliers in measuring correlation.
- A new section provides coverage of the Spearman correlation.

TO THE STUDENT

There is a common (and usually unfair) belief that visits to the dentist will be associated with fear and pain, even though dentists perform a service of great benefit to us. Although you initially may have similar fears and anxieties about this course, we could argue that a statistics course also performs a beneficial service. This is evident when one considers that our world has become information-laden and information-dependent. The media informs us of the latest findings on nutrition and health, global warming, economic trends, aging and memory, effects of television violence on children, success or failure of new welfare programs, and so on. All these data-gathering efforts provide an enormous and unmanageable amount of information. Enter the statisticians, who use statistical procedures to analyze, organize, and interpret vast amounts of data. Having a basic understanding of a variety of statistical procedures will help you to understand these findings, to examine the data critically, and to question the statisticians about what they have done.

What about the fear of taking statistics? One way to deal with the fear is to get plenty of practice. You will notice that this book provides you with a number of opportunities to repeat the techniques you will be learning, in the form of learning checks, examples, demonstrations, and end-of-chapter problems. We encourage you to take advantage of these opportunities. Also, we encourage you to read the text rather than just memorize the formulas. We have taken great pains to present each statistical procedure in a conceptual context that explains why the procedure was developed and when it should be used. If you read this material and gain an understanding of the basic concepts underlying a statistical formula, you will find that learning the formula and how to use it will be much easier. In the following section, “Study Hints,” we provide advice that we give our own students. Ask your instructor for advice as well, we are sure other instructors will have ideas of their own.

Study Hints You may find some of these tips helpful, as our own students have reported.

- You will learn (and remember) much more if you study for short periods several times per week rather than try to condense all of your studying into one long session. For example, it is far more effective to study half an hour every night than to have a single $3\frac{1}{2}$ -hour study session once a week. We cannot even work on *writing* this book without frequent rest breaks.
- Do some work before class. Keep a little ahead of the instructor by reading the appropriate sections before they are presented in class. Although you may not fully understand what you read, you will have a general idea of the topic, which will make the lecture easier to follow. Also, you can identify material that is particularly confusing and then be sure the topic is clarified in class.
- Pay attention and think during class. Although this advice seems obvious, often it is not practiced. Many students spend so much time trying to write down every example presented or every word spoken by the instructor that they do not actually understand and process what is being said. Check with your instructor. There may not be a need to copy every example presented in class, especially if there are many examples like it in the text. Sometimes, we tell our students to put their pens and pencils down for a moment and just listen.
- Test yourself regularly. Do not wait until the end of the chapter or the end of the week to check your knowledge. After each lecture, work some of the end-of-chapter problems, and do the Learning Checks. Review the Demonstration Problems, and be sure you can define the Key Terms. If you are having trouble, get your questions answered *immediately* (re-read the section, go to your instructor, or ask questions in class). By doing so, you will be able to move ahead to new material.
- Do not kid yourself! Avoid denial. Many students observe their instructor solve problems in class and think to themselves, “This looks easy, I understand it.” Do you really understand it? Can you really do the problem on your own without having to leaf through the pages of a chapter? Although there is nothing wrong with using examples in the text as models for solving problems, you should try working a problem with your book closed to test your level of mastery.

- We realize that many students are embarrassed to ask for help. It is our biggest challenge as instructors. You must find a way to overcome this aversion. Perhaps contacting the instructor directly would be a good starting point, if asking questions in class is too anxiety-provoking. You could be pleasantly surprised to find that your instructor does not yell, scold, or bite! Also, your instructor might know of another student who can offer assistance. Peer tutoring can be very helpful.

Over the years, our students in our classes have given us many helpful suggestions. We learn from them. If you have any suggestions or comments about this book, you can send a note to us at the Department of Psychology, SUNY College at Brockport, 350 New Campus Drive, Brockport, NY 14420. Also, we can be reached by email at fgravett@po.brockport.edu and llwallnau@po.brockport.edu.

Frederick J Gravetter
Larry B. Wallnau

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