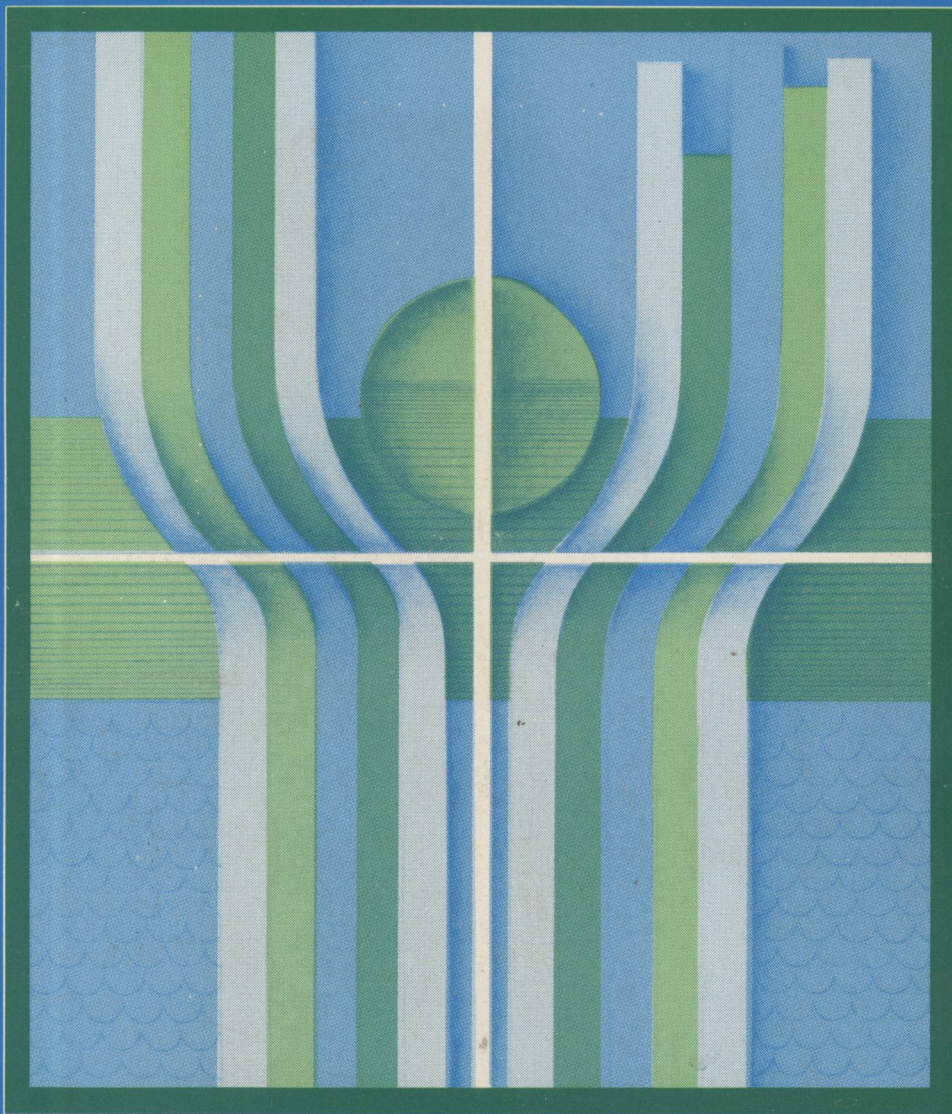


# Fundamentals of Behavioral Statistics

Fourth Edition



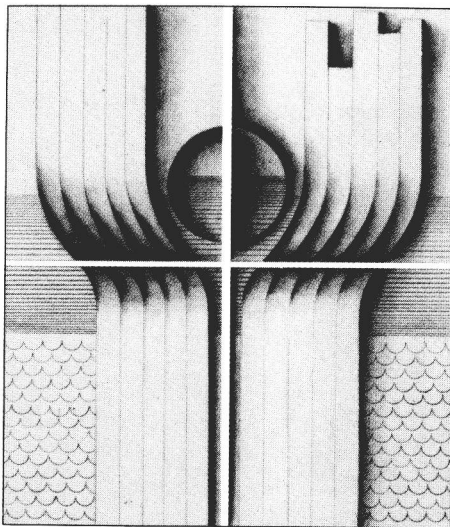
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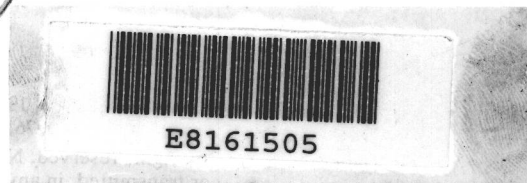
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# Fundamentals of Behavioral Statistics

Fourth Edition



Richard P. Runyon · Audrey Haber



Addison-Wesley Publishing Company

Reading, Massachusetts · Amsterdam · London  
Manila · Singapore · Sydney · Tokyo



This book is in the  
ADDISON-WESLEY SERIES IN PSYCHOLOGY

Sponsoring editor: Stuart Johnson  
Production editor: Mary Cafarella  
Designer: Robert Rose  
Illustrator: Robert Trevor  
Cover design: Richard Hannus

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of America. Published simultaneously in Canada. Library of Congress Catalog Card No. 79-  
17817.

ISBN 0-201-06624-6  
ABCDEFGHIJKL-HA-89876543210



# **Fundamentals of Behavioral Statistics**

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# Preface to Fourth Edition

There is something enormously satisfying and challenging about preparing a fourth edition of a text. The satisfaction derives from the fact that the book and its previous editions have obviously withstood a test of long duration. The challenge comes from the need to preserve the qualities that have brought us so many loyal friends while reflecting both the developments in the field of statistics and the suggestions made by colleagues.

Following are some of the modifications we have made in the present edition:

Recognizing the fundamental importance of definitions of terms in the field of statistics, we have placed both the terms and their definitions in the margins. As serendipity, these marginal definitions provide an excellent chapter summary. Occasionally a tentative definition of a term will be provided in an early chapter, and then elaborated on in a subsequent chapter when the student is better prepared to understand subtle nuances of meaning.

We have gone directly to the literature for many of the examples and exercises that appear throughout the text. Students are provided with the raw data of both published and unpublished research. They learn to handle these data at both the descriptive and the inferential level. We believe these examples will provide the student with rich and meaningful experiences in the analysis of ongoing research.

Throughout our years of teaching, we have often noted that the statistical tables appearing in the appendix are frequently not given the care and thought usually devoted to the textual material. Students sometimes correctly calculate a test statistic and then founder when relating it to a statistical table. We have attempted to design the tables to serve rather than frustrate the student. Thus, where appropriate, we indicate when probability values are one- or two-tailed. Moreover, we have included, along with the tables, sample examples illustrating their use. We have also extended some of the tables. To our knowledge, no other presently available text shows binomial probabilities through  $N \leq 49$  when  $P \neq Q$  (Table N), provides one- and two-tailed critical values of the binomial for  $N$ 's through 50 when  $P = Q$  (Table M), and shows two-tailed critical values of the  $F$ -table (Table  $D_1$ ).

The almost universal availability of pocket calculators has made it virtually unnecessary to calculate the various inexact statistics from grouped frequency distributions. Even with large masses of data, it is relatively easy to place the values of the variable in the calculator and find the mean and standard deviation. Consequently, methods for obtaining the mean and standard deviation from grouped frequency distributions have been dropped from the text. While on the topic of pocket calculators, we should note that the Student Workbook contains detailed calculator programs for most of

the statistical operations shown in the text. Although these programs assume the simplest calculator functions, suggestions are made for upgrading the programs when more sophisticated calculators are available. Indeed students are encouraged to devise their own programs. In so doing, they can enhance their grasp of calculating procedures.

All end-of-chapter exercises that are used to lay the groundwork for future discussions are preceded by an asterisk. Needless to say, it is vital that the student complete these exercises so that there is a smooth transition to concepts of increasing complexity.

Finally we have noted that the procedures for normalizing a nonnormal distribution of scores has become an almost-lost art. Nevertheless, references to these techniques frequently appear in the basic textbooks of many fields, including education, psychology, and sociology. We have included a detailed illustration of normalizing techniques in Appendix IV of the text.

Although we owe a debt of gratitude to many colleagues who have made suggestions for this edition, we are particularly indebted to the following, whose contributions were both lucid and insightful:

Robert J. Grissom  
San Francisco State University  
Steve Harkins  
Northeastern University  
Frederick L. Kitterle  
The University of Toledo  
Willard D. Larkin  
University of Maryland  
Neil Macmillan  
Brooklyn College

Scott E. Maxwell  
University of Houston  
Karin C. Meiselman  
Pitzer College  
Lawrence E. Melamed  
Kent State University  
Victor E. Montgomery  
University of Idaho  
Steven E. Poltrock  
University of Denver

David M. Snuttjer  
Calvin College  
Russell Veitch  
Bowling Green State University  
L. Carl Volpe  
Northeastern University  
Phyllis A. Walrad  
Macomb County Community College

A special note of thanks to Dr. Joseph Wingard (U.C.L.A.) who contributed numerous examples of research-related data for inclusion in this text.

We are grateful to the Literary Executor of the late Sir Ronald A. Fisher, F.R.S., to Dr. Frank Yates, F.R.S., and to Longman Group Ltd., London, for permission to reprint Table III from their book *Statistical Tables for Biological, Agricultural and Medical Research* (Sixth edition, 1974).

Tucson  
Los Angeles  
November 1979

R.P.R.  
A.H.

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### Part III Inferential statistics

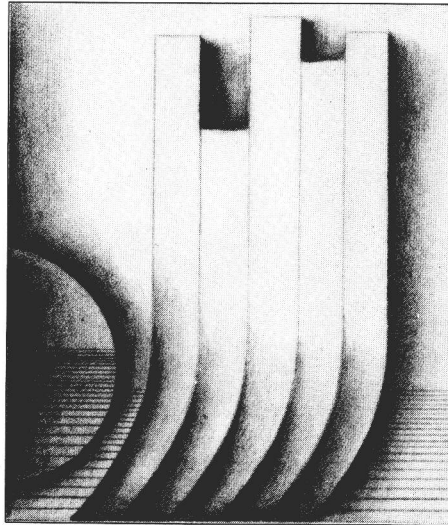
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Part I

# Introduction

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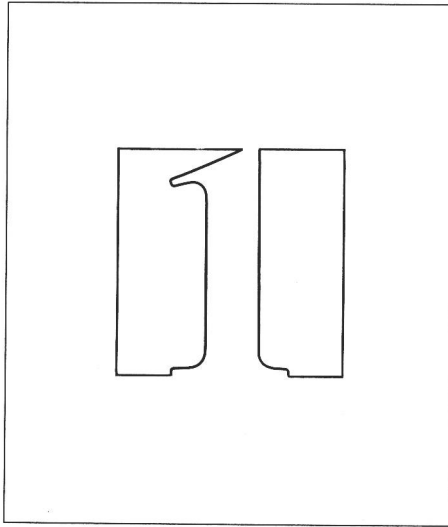






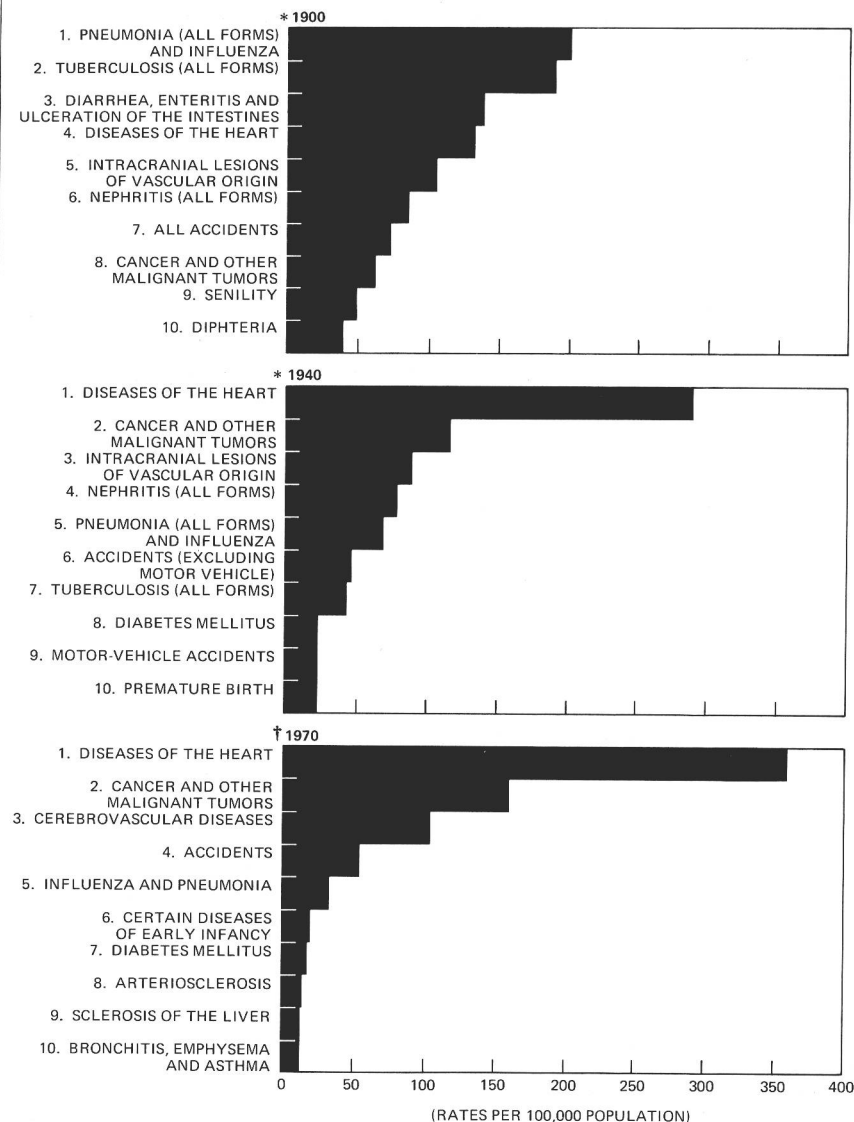
# The Definition of Statistical Analysis

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- 1.1** What is statistics? • **1.2** Definitions of terms commonly used in statistics  
**1.3** Descriptive statistics • **1.4** Inferential statistics • **1.5** A word to the student  
Chapter summary

## Box 1.1



Statistics is one of the most widely used tools in the behavioral, social, medical, and physical sciences. Statistical information is collected on virtually every aspect of life. Often, observations are made at varying times to permit the comparison of changes over time. The data presented in the accompanying figure illustrate that, since the turn of the century, the leading causes of death have changed

dramatically. Note, for example, that pneumonia and tuberculosis accounted for a large number of all deaths in 1900, whereas by 1970 relatively few deaths could be attributed to these causes. Although it doesn't show in the graphs, it is interesting to note that the average life expectancy increased from 47 years in 1900 to 71 in 1970.

\* From "The Ills of Man" by J. H. Dingle. Copyright © 1973 by Scientific American, Inc. All rights reserved.

† From "Mortality for leading causes of death; U.S.," 1976. *CA-A Cancer Journal for Clinicians*, Jan./Feb. 1979, 29(1).

## 1.1 | What is statistics?

Think for a moment of the thousands of incredibly complex things you do during the course of a day, and then stand in awe at the marvel you represent. You are absolutely unique. No one else possesses your features, your intellectual makeup, your personality characteristics, nor your value system. Yet, like billions of others of your species, you are the most finely tuned and enormously sophisticated statistical instrument ever devised by natural forces. Every moment of your life provides mute testimony to your ability to receive, integrate, and process a wealth of sensory data and then to act upon this information in an instant to generate a spectrum of probabilities relating to possible courses of action. To illustrate, imagine you are driving in heavy traffic. You are continuously scanning the road conditions, noting the speed of cars in front of you relative to your speed, the position and rate of approach of vehicles to your rear, and the presence of automobiles in the oncoming lane. If you are an alert driver, you are constantly summarizing this descriptive information—usually without words or awareness. Imagine next that, without warning, the car in front of you suddenly jams on its brakes. In an instant, you are summoned to act upon this prior descriptive information. You must brake the car, turn left, turn right, or pray. Your probability mechanism instantly assesses alternative courses of action: If you jam on the brakes, what is the likelihood that you will stop in time? Is the car behind you sufficiently distant to avoid a rear-end collision? Can you prevent an accident by turning into the left lane or onto the right shoulder? Most of the time, the decision made from sensory data is correct. It is for this reason that most of us grow up to reach a ripe old age. In this situation, as in many others during the course of a lifetime, you have accurately assessed the probabilities and taken the right course of action. And we make such decisions uncounted thousands of times each and every day of our lives. It is for this reason that you should regard yourself as a sublime mechanism for generating statistical decisions. In this sense, you are already a statistician.

In daily living, our statistical functioning is usually informal and loosely structured. We *behave* statistically, although we may be totally unaware of the formal laws of probability.

In this course, we shall attempt to provide you with some of the procedures for collecting and analyzing data, and making decisions or inferences based upon these analyses. Since we shall frequently be building upon your prior experiences, you will often feel you are in familiar territory: “Why, I have been calculating arithmetic means almost all my life—whenever I determine my test average in a course or the batting average of my favorite baseball player!” If you constantly draw upon your previous knowledge and relate course materials to what is familiar in daily life, statistics need not, and should not, be the bugaboo it is often painted to be.

What, then, is statistics all about? Although it would be virtually impossible to obtain a general consensus on the definition of statistics, it is possible to make a distinction between two definitions of *statistics*.

1. Statistics is commonly regarded as a *collection* of numerical facts that are expressed in terms of summarizing statements and that have been collected

---

### *statistics*

Collection of numerical facts which are expressed in summarizing statements; method of dealing with data: a tool for collecting, organizing, and analyzing numerical facts or observations.

---