Sixteenth edition

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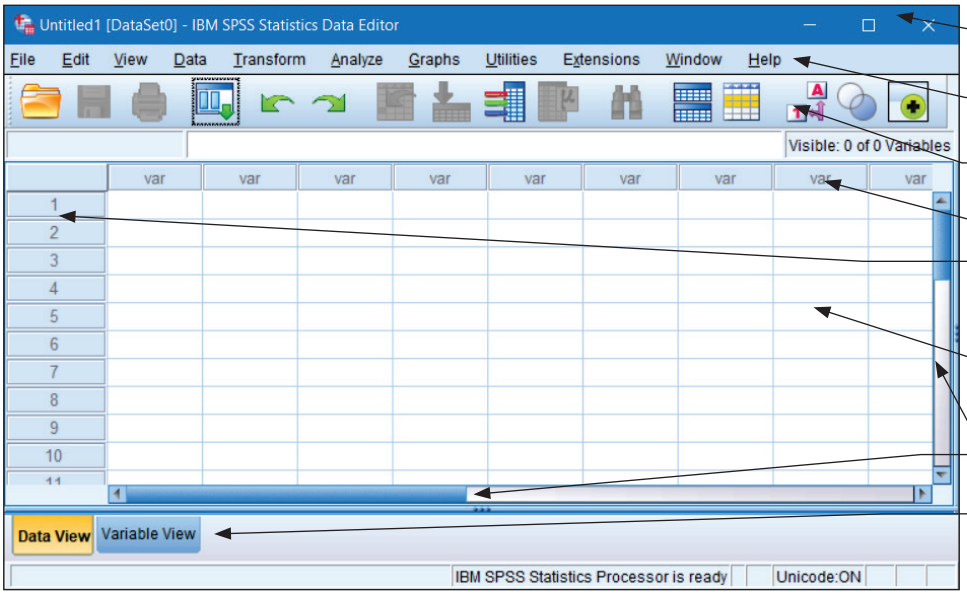
ROUTLEDGE

IBM SPSS Statistics 26 Step by Step

A Simple Guide and Reference

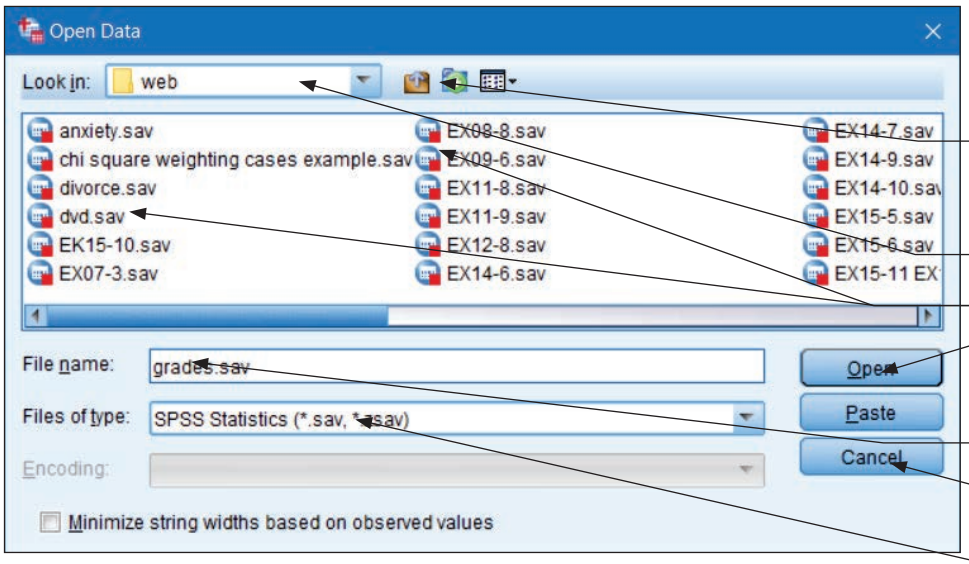
Darren George and Paul Mallery

Front 1
Initial data screen



Icon	Function	Icon	Function	Icon	Function
	Click this to open a file		Find data		(upper left corner) the "+" sign indicates that this is the active file
	Save current file		Insert subject or case into the data file		Shifts between numbers and labels for variables with several levels
	Print file		Insert new variable into the data file		Go to a particular variable or case number
	Recall a recently-used command		Split file into subgroups		Use subsets of variables/use all variables
	Undo the last operation		Weight cases		Access information about the current variable
	Redo something you just undid		Select cases		Spell check

Front 2
Open Data Screen



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IBM SPSS Statistics 26 Step by Step

IBM SPSS Statistics 26 Step by Step: A Simple Guide and Reference, sixteenth edition, takes a straightforward, step-by-step approach that makes SPSS software clear to beginners and experienced researchers alike. Extensive use of four-color screen shots, clear writing, and step-by-step boxes guide readers through the program. Output for each procedure is explained and illustrated, and every output term is defined. Exercises at the end of each chapter support students by providing additional opportunities to practice using SPSS.

This book covers the basics of statistical analysis and addresses more advanced topics such as multidimensional scaling, factor analysis, discriminant analysis, measures of internal consistency, MANOVA (between- and within-subjects), cluster analysis, Log-linear models, logistic regression and a chapter describing residuals. Back matter includes a description of data files used in exercises, an exhaustive glossary, suggestions for further reading and a comprehensive index.

IBM SPSS Statistics 26 Step by Step is distributed in 85 countries, has been an academic best seller through most of the earlier editions, and has proved invaluable aid to thousands of researchers and students.

New to this edition:

- Screenshots, explanations, and step-by-step boxes have been fully updated to reflect SPSS 26
- How to handle missing data has been revised and expanded and now includes a detailed explanation of how to create regression equations to replace missing data
- More explicit coverage of how to report APA style statistics; this primarily shows up in the Output sections of Chapters 6 through 16, though changes have been made throughout the text.

Darren George is a Professor of Psychology at Burman University whose research focuses on intimate relationships and optimal performance. He teaches classes in research methodology, statistics, personality/social psychology, and sport and performance psychology.

Paul Mallery is a Professor of Psychology at La Sierra University whose research focuses on the intersection of religion and prejudice. He teaches classes is research methodology, statistics, social psychology, and political psychology.

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IBM SPSS Statistics 26 Step by Step

A Simple Guide and Reference

SIXTEENTH EDITION

Darren George
Burman University

Paul Mallery
La Sierra University

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To Elizabeth
—D.G.

To my son Aydin, for his love of the arts and ways to improve the world
—P.M.

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Preface

IBM SPSS Statistics Software ("SPSS") is a powerful tool that is capable of conducting just about any type of data analysis used in the social sciences, the natural sciences, or in the business world. Mathematics is the language of science, and data analysis is the dialect of research. The present book is designed to make data analysis more comprehensible and less toxic.

In our teaching, we have frequently encountered students so traumatized by the professor who cheerily says, "Analyze these data on SPSS; read the help files if you need help" that they dropped the course rather than continue the struggle. It is in response to this anguish that the present book was conceived. In our previous jobs (before we became academic psychologists), Darren George taught high school mathematics, and Paul Mallery programmed computers and trained people how to use them. Both of us find great pleasure in the challenge of making a process that is intrinsically complex as clear as possible. The ultimate goal in all our efforts with the present book has been to make SPSS procedures, above all else, clear.

As the book started to take shape, a second goal began to emerge. In addition to making SPSS procedures clear to the beginner, we wanted to create a tool that was an effective reference for anyone conducting data analysis. This involved the expansion of the original concept to include most of the major statistical procedures in SPSS Standard. The result of years of effort you now hold in your hands.

Although this edition is not a major update to the text, it does include many new screenshots, output details that have changed, and improvemens to clarity throughout. In addition, more significant improvements include:

- How to handle missing data has been significantly clarified in Chapter 4, with additional information in Chapter 16 as well.
- Although we have always used APA style, this edition is more explicit in how to report APA style statistics; this primarily shows up in the Output sections of Chapters 6 through 16, though changes have been made throughout the text.

As usual, every step-by-step sequence has been executed and all outputs scrutinized to make certain everything in the current edition is accurate.

If you have been following the work of SPSS over the couple of years, you may have heard of the "new interface" that is currently available (while still under development) for the subscription version of SPSS. It is likely that this will become the primary version of SPSS with SPSS 27. This will involve only minor changes to interpreting output or the introductions to each chapter, but major changes to what you see and what you click when you are following the step-by-step procedures. As the biggest revision of SPSS since SPSS 16, the next version of SPSS will be a major departure (and a major new edition of this book).

While the first 16 chapters of the book cover basic topics and would be understandable to many with very limited statistical background, the final 12 chapters involve procedures that progressively require a more secure statistical grounding. Those 12 chapters have provided our greatest challenge. At the beginning of each chapter we spend several pages describing the procedure that follows. But, how can one adequately describe, for instance, factor analysis or discriminant analysis in five or six pages? The answer is simple: We can't, but we can describe the procedures at a common sense, conceptual level that avoids excessive detail and excessive emphasis on computation that is useful as an introduction for beginners or as a useful adjunct to more advanced reading or mentoring for more advanced data analysts. Writing these introductions has not at all been simple. The chapter introductions are the most pains-

takingly worked sections of the entire book. Although we acknowledge the absence of much detail in our explanation of most procedures, we feel that we have done an adequate job at a project that few would even attempt. How successful have we been at achieving clarity in limited space? The fact that this book is now in its 16th edition, has been an academic best seller for most of those editions, and is distributed in 85 countries of the world suggests that our efforts have not been in vain.

Authors' Biographical Sketches and Present Addresses

Darren George is currently a professor of Psychology at:

Burman University
7630 University Drive
Lacombe, AB, T4L 2E5
403-782-3381, Ext. 4082
dgeorge@burmanu.ca

where he teaches personality psychology, social psychology, and research methods. He completed his MA in Experimental Psychology (1982) at California State University, Fullerton; taught high school mathematics for nine years (1980–1989) at Mark Keppel High School (Alhambra, CA) and Mountain View High School (El Monte, CA); and then completed a Psychology PhD at UCLA (1992) with emphases in personality psychology, social psychology, and measurement and psychometrics. Darren has now been a professor at Burman University for 26 years.

Paul Mallery is currently a professor of Psychology at

La Sierra University
4500 Riverwalk Parkway
Riverside, CA, 92515
951-785-2528
pmallery@lasierra.edu

where he teaches social psychology and related courses and experimental methodology (including the application of SPSS). He received his PhD in Social Psychology from UCLA (1994), with emphases in statistics and political psychology. He has been on the faculty for 26 years, and still enjoys the challenge of teaching students to think clearly about research using statistics.

Acknowledgments

As we look over the creative efforts of the past years, we wish to acknowledge several people who have reviewed our work and offered invaluable insight and suggestions for improvement. Our gratitude is extended to Richard Froman of John Brown University, Michael A. Britt of Marist College, Marc L. Carter of the University of South Florida, Randolph A. Smith of Ouachita Baptist University, Roberto R. Heredia of Texas A&M International University, and several anonymous reviewers. We have had many editors over the years, but are especially appreciative of Hannah Shakespeare for her excellent guidance and commitment in the current edition. Further, we would like to express gratitude to Luke Solomon, the IT guy at Burman University, as Paul and I have worked toward fluency in the Adobe programs InDesign, Illustrator, and Photoshop. And then there's the standard (but no less appreciated) acknowledgment of our families and friends who endured while we wrote this. Particular notice goes to our wives Elizabeth George and Suzanne Mallery as well as our families for their support and encouragement.

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Chapter 1
An Overview of IBM® SPSS® Statistics

Introduction: An Overview of IBM SPSS Statistics 26 and Subscription Classic

THIS BOOK gives you the step-by-step instructions necessary to do most major types of data analysis using SPSS. The software was originally created by three Stanford graduate students in the late 1960s. The acronym "SPSS" initially stood for "**S**tatistical **P**ackage for the **S**ocial **S**ciences." As SPSS expanded their package to address the physical sciences and business markets, the name changed to "Statistical Product and Service Solutions." In 2009 IBM purchased SPSS and the name morphed to "IBM SPSS Statistics." SPSS is now such a standard in the industry that IBM has retained the name due to its recognizability. No one particularly cares what the letters "SPSS" stand for any longer. IBM SPSS Statistics is simply one of the world's largest and most successful statistical software companies. In this book we refer to the program as **SPSS**.

1.1 Necessary Skills

For this book to be effective when you conduct data analysis with SPSS, you should have certain limited knowledge of statistics and have access to a computer that has the necessary resources to run SPSS. Each issue is addressed in the next two paragraphs.

STATISTICS You should have had at least a basic course in statistics or be in the process of taking such a course. While it is true that this book devotes the first two or three pages of each chapter to a description of the statistical procedure that follows, these descriptions are designed to refresh the reader's memory, *not* to instruct the novice. While it is certainly possible for the novice to follow the steps in each chapter and get SPSS to produce pages of output, a fundamental grounding in statistics is important for an understanding of which procedures to use and what all the output means. In addition, while the first 16 chapters should be understandable by individuals with limited statistical background, the final 12 chapters deal with much more complex and involved types of analyses. These chapters require substantial grounding in the statistical techniques involved.

COMPUTER REQUIREMENTS You must:

- Have access to a personal computer that has
  - Microsoft® Windows® 7 or higher; or MAC OS® 10.10 (Yosemite) or higher installed
  - IBM SPSS Statistics 26 or the Classic version of SPSS Subscription installed. (At some point the SPSS Subscription New Interface will replace the Classic one, but it isn't there yet.)

- Know how to turn the computer on
- Have a working knowledge of the keys on the keyboard and how to use a mouse—or other selection device such as keyboard strokes or touch screen monitors.

This book will take you the rest of the way. If you are using SPSS on a network of computers (rather than your own PC or MAC) the steps necessary to *access* IBM SPSS Statistics may vary slightly from the single step shown in the pages that follow.

1.2 Scope of Coverage

IBM SPSS Statistics is a complex and powerful statistical program by any standards. Despite its size and complexity, SPSS and IBM have created a program that is not only powerful but is user friendly (you're the user; the program tries to be friendly). By improvements over the years, SPSS has done for data analysis what Henry Ford did for the automobile: made it available to the masses. SPSS is able to perform essentially any type of statistical analysis ever used in the social sciences, in the business world, and in other scientific disciplines.

This book was written for Version 26 of IBM SPSS Statistics (which is the same as SPSS Subscription Classic as of mid-2019). With few exceptions, what you see here will be similar to SPSS Version 16 and higher. Because only a few parts of SPSS are changed with each version, most of this book will apply to previous versions. It's 100% up-to-date with Version 26, but it will lead you astray only about 2% of the time if you're using Version 24 or 25 and is perhaps 75% accurate for Version 16 and 50% accurate for Version 7.0 (if you can find a computer and software that old).

Our book covers the statistical procedures present in SPSS Standard. If you are using SPSS Base, then you will not be able to do some of the multivariate analyses presented in the more advanced chapters. To support their program, SPSS has created a set of comprehensive manuals. To a person fluent in statistics and data analysis, the manuals are well written and intelligently organized. To anyone less fluent, however, the organization is often undetectable, and the comprehensiveness (the equivalent of almost 2,000 pages of fine-print text) is overwhelming. To the best of our knowledge, hard-copy manuals are no longer available but most of this information may now be accessed from SPSS as PDF downloads. The same information is also available in the exhaustive online Help menu. Despite changes in the method of accessing this information, for sake of simplicity we still refer to this body of information as "SPSS manuals" or simply "manuals." Our book is about 400 pages long. Clearly we cannot cover in 400 pages as much material as the manuals do in 2,000, but herein lies our advantage.

The purpose of this book is to make the fundamentals of most types of data analysis clear. To create this clarity requires the omission of much (often unnecessary) detail. Despite brevity, we have been keenly selective in what we have included and believe that the material presented here is sufficient to provide simple instructions that cover 95% of analyses ever conducted by researchers. Although we cannot substantiate that exact number, our time in the manuals suggests that at least 1,600 of the 2,000 pages involve detail that few researchers ever consider. How often do you really need 7 different methods of extracting and 6 methods of rotating factors in factor analysis, or 18 different methods for post hoc comparisons after a one-way ANOVA? (By the way, that last sentence should be understood by statistical geeks only.)

We are in no way critical of the manuals; they do well what they are designed to do and we regard them as important adjuncts to the present book. When our space limitations prevent explanation of certain details, we often refer our readers to the SPSS manuals. Within the context of presenting a statistical procedure, we often show a window that includes several options but describe only one or two of them. This is done without apology except for the occasional "description of these options extends beyond

the scope of this book" and cheerfully refer you to the SPSS manuals. The ultimate goal of this format is to create clarity without sacrificing necessary detail.

1.3 Overview

This chapter introduces the major concepts discussed in this book and gives a brief overview of the book's organization and the basic tools that are needed in order to use it.

If you want to run a particular statistical procedure, have used IBM SPSS Statistics before, and already know which analysis you wish to conduct, you should read the Typographical and Formatting Conventions section in this chapter (pages 5–7) and then go to the appropriate chapter in the last portion of the book (Chapters 6 through 28). Those chapters will tell you exactly what steps you need to perform to produce the output you desire.

If, however, you are new to IBM SPSS Statistics, then this chapter will give you important background information that will be useful whenever you use this book.

1.4 This Book's Organization, Chapter by Chapter

This book was created to describe the crucial concepts of analyzing data. There are three basic tasks associated with data analysis:

A. You must type data into the computer, and organize and format the data so both SPSS and you can identify it easily,
B. You must tell SPSS what type of analysis you wish to conduct, and
C. You must be able to interpret what the SPSS output means.

After this introductory chapter, Chapter 2 deals with basic operations such as types of SPSS windows, the use of the toolbar and menus, saving, viewing, and editing the output, printing output, and so forth. While this chapter has been created with the beginner in mind, there is much SPSS-specific information that should be useful to anyone. Chapter 3 addresses the first step mentioned above—creating, editing, and formatting a data file. The SPSS data editor is an instrument that makes the building, organizing, and formatting of data files wonderfully clear and straightforward.

Chapters 4 and 5 deal with two important issues—modification and transformation of data (Chapter 4) and creation of graphs or charts (Chapter 5). Chapter 4 deals specifically with different types of data manipulation, such as creating new variables, reordering, restructuring, merging files, or selecting subsets of data for analysis. Chapter 5 introduces the basic procedures used when making a number of different graphs; some graphs, however, are described more fully in the later chapters.

Chapters 6 through 28 then address Steps B and C—analyzing your data and interpreting the output. It is important to note that each of the analysis chapters is self-contained. If the beginner, for example, were instructed to conduct *t* tests on certain data, Chapter 11 would give complete instructions for accomplishing that procedure. In the Step by Step section, Step 1 is always "start the SPSS program" and refers the reader to Chapter 2 if there are questions about how to do this. The second step is always "create a data file or edit (if necessary) an already existing file," and the reader is then referred to Chapter 3 for instructions if needed. Then the steps that follow explain exactly how to conduct a *t* test. Interpreting the output (Step C) involves translating the SPSS output to a written narrative. We've used APA style throughout; if your discipline uses a different style, it is almost certainly (95% or higher) the same as APA style.

As mentioned previously, this book covers SPSS Standard edition. Because some computers at colleges or universities may not have all of these modules (the **Base** module is always present), the book is organized according to the structure SPSS has imposed: We cover most procedures included in the **Base** module and then selected procedures from the more complex **Advanced** and **Regression** modules. Chapters 6–22 deal with processes included in the Base module. Chapters 23–27 deal with procedures in the Advanced Statistics and Regression modules, and Chapter 28, the analysis of residuals, draws from all three.

IBM SPSS STATISTICS BASE: Chapters 6 through 10 describe the most fundamental data analysis methods available, including frequencies, bar charts, histograms, and percentiles (Chapter 6); descriptive statistics such as means, medians, modes, skewness, and ranges (Chapter 7); crosstabulations and chi-square tests of independence (Chapter 8); subpopulation means (Chapter 9); and correlations between variables (Chapter 10).

The next group of chapters (Chapters 11 through 17) explains ways of testing for differences between subgroups within your data or showing the strength of relationships between a dependent variable and one or more independent variables through the use of *t* tests (Chapter 11); ANOVAs (Chapters 12, 13, and 14); linear, curvilinear, and multiple regression analysis (Chapters 15 and 16); and the most common forms of nonparametric tests are discussed in Chapter 17.

Reliability analysis (Chapter 18) is a standard measure used in research that involves multiple response measures; multidimensional scaling is designed to identify and model the structure and dimensions of a set of stimuli from dissimilarity data (Chapter 19); and then factor analysis (Chapter 20), cluster analysis (Chapter 21), and discriminant analysis (Chapter 22) all occupy stable and important niches in research conducted by scientists.

IBM SPSS STANDARD: The next series of chapters deals with analyses that involve multiple dependent variables (SPSS calls these procedures General Linear Models; they are also commonly called MANOVAs or MANCOVAs). Included under the heading General Linear Model are simple and general factorial models and multivariate models (Chapter 23), and models with repeated measures or within-subjects factors (Chapter 24).

The next three chapters deal with procedures that are only infrequently performed, but they are described here because when these procedures are needed they are indispensable. Chapter 25 describes logistic regression analysis and Chapters 26 and 27 describe hierarchical and nonhierarchical log-linear models, respectively. As mentioned previously, Chapter 28 on residuals closes out the book.

1.5 An Introduction to the Example

A single data file is used in 17 of the first 19 chapters of this book. For more complex procedures it has been necessary to select different data files to reflect the particular procedures that are presented. Example data files are useful because often, things that appear to be confusing in the SPSS documentation become quite clear when you see an example of how they are done. Although only the most frequently used sample data file is described here, there are a total of 12 data sets that are used to demonstrate procedures throughout the book, in addition to data sets utilized in the exercises. Data files are available for download at **www.spss-step-by-step.net**. These files can be of substantial benefit to you as you practice some of the processes presented here without the added burden of having to input the data. We suggest that you make generous use of these files by trying different procedures and then comparing your results with those included in the output sections of different chapters.

The example has been designed so it can be used to demonstrate most of the statistical procedures presented here. It consists of a single data file used by a teacher who teaches three sections of a class with approximately 35 students in each section. For each student, the following information is recorded:

- ID number
- Name
- Gender
- Ethnicity
- Year in school
- Upper- or lower-division class person
- Previous GPA
- Section
- Whether or not he or she attended review sessions or did the extra credit
- The scores on five 10-point quizzes and one 75-point final exam

In Chapter 4 we describe how to create four new variables. In all presentations that follow (and on the data file available on the website), these four variables are also included:

- The total number of points earned
- The final percent
- The final grade attained
- Whether the student passed or failed the course

The example data file (the entire data set is displayed at the end of Chapter 3) will also be used as the example in the introductory chapters (Chapters 2 through 5). If you enter the data yourself and follow the procedures described in these chapters, you will have a working example data file identical to that used through the first half of this book. Yes, the same material is recorded on the downloadable data files, but it may be useful for you to practice data entry, formatting, and certain data manipulations with this data set. If you have your own set of data to work with, all the better.

One final note: All of the data in the **grades** file are totally fictional, so any findings exist only because we created them when we made the file.

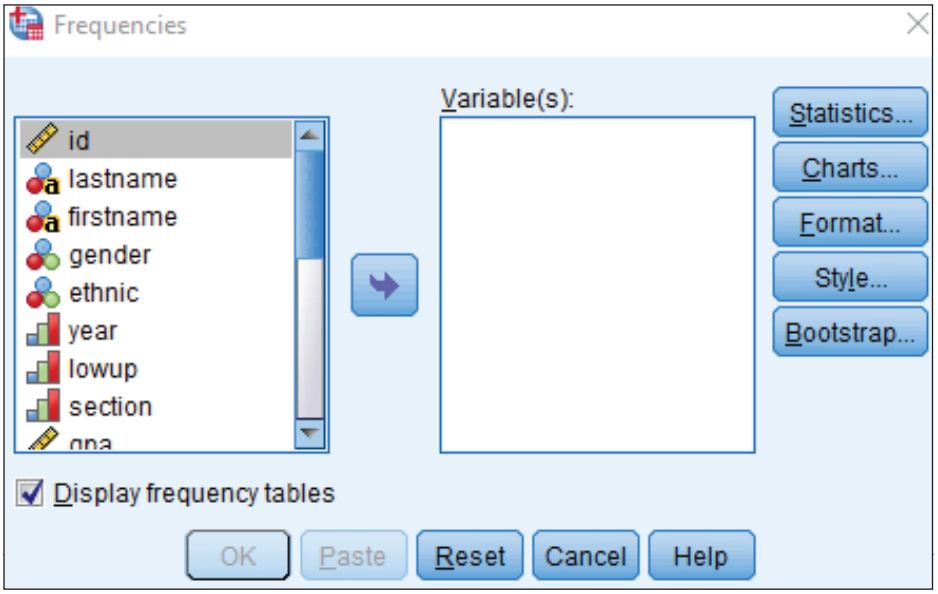
1.6 Typographical and Formatting Conventions

CHAPTER ORGANIZATION: Chapters 2 through 5 describe IBM SPSS Statistics formatting and procedures, and the material covered dictates each chapter's organization. Chapters 6 through 28 (the analysis chapters) are, with only occasional exceptions, organized identically. This format includes:

1. The **Introduction** in which the procedure that follows is described briefly and concisely. These introductions vary in length from one to seven pages depending on the complexity of the analysis being described.
2. The **Step by Step** section in which the actual steps necessary to accomplish particular analyses are presented. Most of the typographical and formatting conventions described in the following pages refer to the Step by Step sections.
3. The **Output** section, in which the results from analyses described earlier are displayed—often abbreviated. Text clarifies the meaning of the output, and all of the critical output terms are defined.

THE SCREENS: Due to the very visual nature of SPSS, every chapter contains pictures of screens or windows that appear on the computer monitor as you work. The first picture from Chapter 6 (below) provides an example. These pictures are labeled "Screens" despite the fact that sometimes what is pictured is a screen (everything that appears on the monitor at a given time) and other times is a portion of a screen (a window, a dialog box, or something smaller). If the reader sees reference to Screen 13.3, she knows that this is simply the third picture in Chapter 13. The screens are typically positioned within breaks in the text (the screen icon and a title are included) and are used for sake of reference as procedures involving that screen are described. Sometimes the screens are separate from the text and labels identify certain characteristics of the screen (see the inside front cover for an example). Because screens take up a lot of space, frequently-used screens are included on the inside front and back covers of this book. At other times, within a particular chapter, a screen from a different chapter may be cited to save space.

Screen 1.1 The Frequencies Window



Sometimes a portion of a screen or window is displayed (such as the menu bar included here) and is embedded within the text without a label.

The Step by Step boxes: Text that surrounds the screens may designate a procedure, but it is the Step by Step boxes that identify exactly what must be done to execute a procedure. The following box illustrates:

In Screen	Do This	Step 3 (sample)
Front1	File → Open → Data [or]	
Front2	type grades.sav → Open [or grades.sav]	Data

Sequence Step 3 means: "Beginning with Screen 1 (displayed on the inside front cover), click on the word **File,** move the cursor to **Open,** and then click the word **Data**. At this point a new window will open (Screen 2 on the inside front cover); type 'grades.sav' and then click the **Open** button, at which point a screen with your data file opens." Notice that within brackets shortcuts are sometimes suggested: Rather than the **File** --> **Open** --> **Data** sequence, it is quicker to click the icon. Instead of typing `grades.sav` and then clicking **Open**, it is quicker to double click on the **grades.sav** (with or without the **".sav"** suffix; this depends on your settings) file name. Items within Step by Step boxes include:

Screens: A small screen icon will be placed to the left of each group of instructions that are based on that screen. There are three different types of screen icons:

Type of Screen Icon	Example Icon	Description of Example
Inside Cover Screens	**Front1**	Screen #1 on the inside front cover
General Screens	**Menu**	Any screen with the menu bar across the top
	Graph	Any screen that displays a graph or chart
Chapter Screens	**4.3**	The third screen in Chapter 4
	21.4	The fourth screen in Chapter 21

Other images with special meaning inside of Step by Step boxes include:

Image	What it Means
	A single click of the left mouse button (or select by touch screen or key strokes)
	A double-click of the left mouse button (or select by touch screen or key strokes)
type	A "type" icon appears before words that need to be typed
press	A "press" icon appears when a button such as the **TAB** key needs to be pressed
→	Proceed to the next step.

Sometimes fonts can convey information, as well:

Font	What it Means
`Monospaced font` (Courier)	Any text within the boxes that is rendered in the Courier font represents text (numbers, letters, words) to be typed into the computer (rather than being clicked or selected).
Italicized text	*Italicized* text is used for information or clarifications within the Step by Step boxes.
Bold font	The **bold font** is used for words that appear on the computer screen.

The groundwork is now laid. We wish you a pleasant journey through the exciting and challenging world of data analysis!

Chapter 2A
IBM SPSS Statistics Processes for PC

WE MENTIONED in the introductory chapter that it is necessary for the user to understand how to turn the computer on and get as far as the Windows desktop. This chapter will give you the remaining skills required to use SPSS for Windows: how to use the mouse, how to navigate using the taskbar, what the various buttons (on the toolbar and elsewhere) do, and how to navigate the primary windows used in SPSS.

If you are fluent with computers, you may not need to read this chapter as carefully as someone less familiar. But everyone should read at least portions of this chapter carefully; it contains a great deal of information unique to SPSS for Windows.

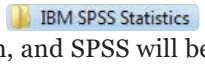
2.1 The Mouse

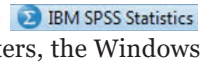
Over the years SPSS has modified their product so that mouse operations parallel those of many major programs. The left-mouse button **point and click**, **double click**, and **dragging** operate in ways similar to major word processing programs, although sometimes SPSS has unique responses to these common applications. Important differences will be noted in the chapters where they apply. A **right-click** and running the cursor over a word or object also produces similar results. In early editions of the book we provided a thorough description of mouse operations. Now, the computer world is moving in a direction where one day the mouse may be obsolete—touch screens, key-stroke operations, and other selection devices may one day predominate. Because of this we have shifted our former "mouse-click" icon ( ) to an icon designed to mean "select" ( ). If you are operating with a mouse this icon still means "left mouse click."

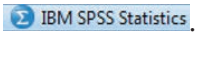
2.2 The Taskbar and Start Menu

Once you have arrived at the Windows desktop, your screen should look something like that shown on the following page. It will certainly not look exactly like this, but it will be similar. There will typically be a number of icons along the left side of the screen, and a bar across the bottom (or top) of the screen (with the word "Start" on the left, and the time on the right).

There are two main types of icons on the Windows desktop: **Program** icons represent a particular program, while **folder** icons actually contain other icons (usually several programs that are related in some way).

The most important thing you need to know about the Windows desktop (at least as long as you are reading this book) is how to start the SPSS program. To do this on most computers, you need to click the button, and move the cursor over the 

program icon. Once 

emerges, click on the icon, and SPSS will begin. On most computers, the Windows desktop will look similar to that shown in Screen 2.2 (following page) immediately before you click on the 

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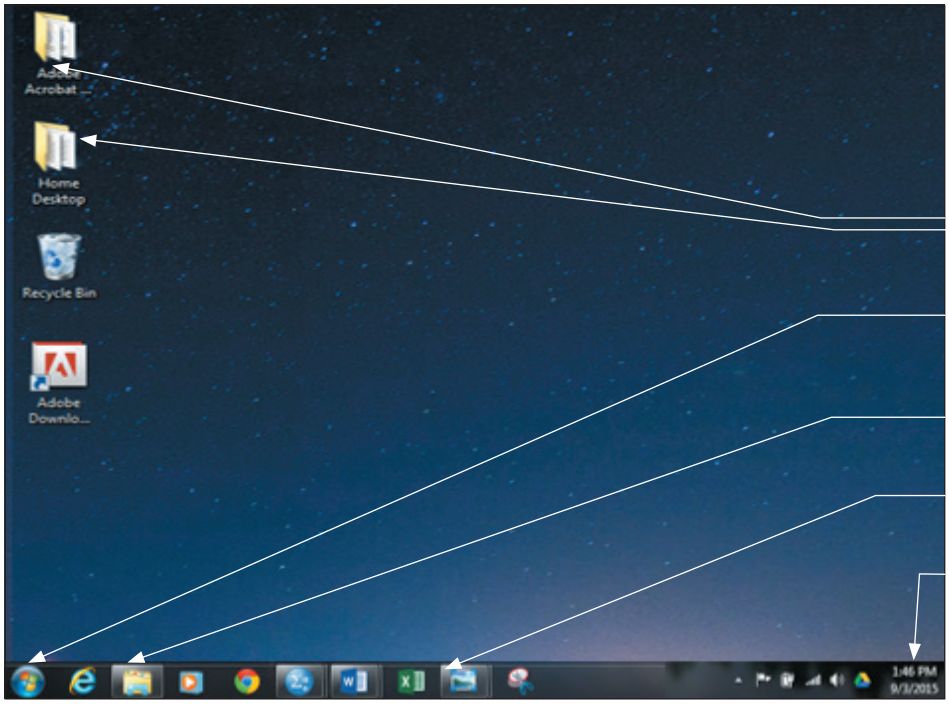
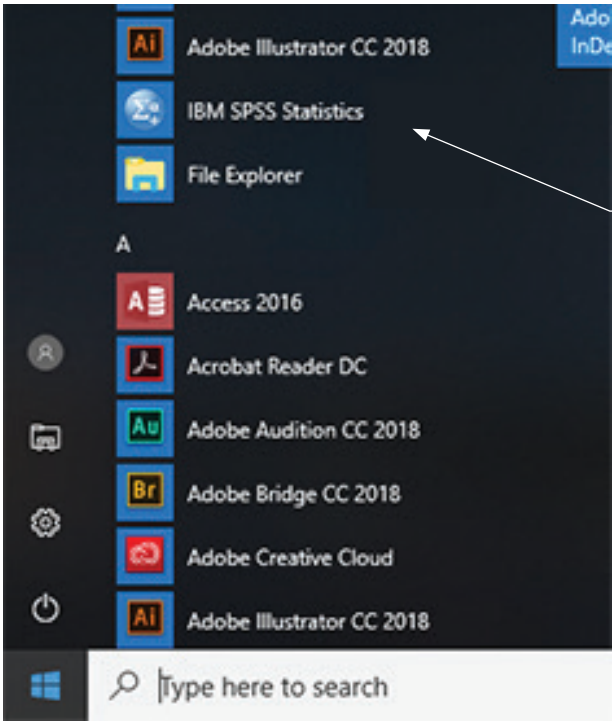
Screen 2.1 Windows Desktop



One word of warning: On some computers, the SPSS program icon may be in a different location within the Start menu. You may have to move the cursor around the Start menu (look especially for any folders labeled "IBM" or "SPSS"). Occasionally, the icon is on the Windows desktop (along the left side), and you don't have to use the Start button at all.

Screen 2.2 View of the Windows Desktop Start Menu Immediately Before Clicking to Start the SPSS Program



In addition to starting the SPSS program, the other important required skill when using the Taskbar is changing between programs. This is especially important because SPSS is actually a collection of several programs. When you first start the SPSS system,