Statistics Without Maths for Psychology

Fourth edition

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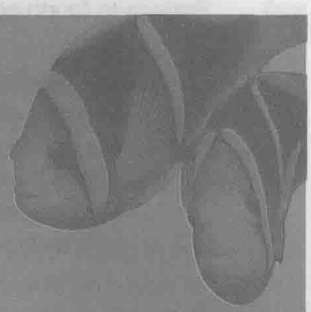
Preface



We wrote this book primarily for our students, most of whom disliked mathematics, and could not understand why they had to learn mathematical formulae when their computer software performed the calculations for them. They were not convinced by the argument that working through calculations gave them an understanding of the test – neither were we. We wanted them to have a conceptual understanding of statistics and to *enjoy* data analysis. Over the past decade we have had to adapt our teaching to large groups of students, many of whom have no formal training in mathematics. We found it was difficult to recommend some of the traditional statistics textbooks – either they were full of mathematical formulae, and perceived by the students as dull or boring, or they were simple, statistical cookbook recipes, which showed them how to perform calculations, but gave them no real understanding of what the statistics meant. We therefore decided to write this book, which seeks to give students a conceptual understanding of statistics while avoiding the distraction of formulae and calculations.

Another problem we found with recommending statistics textbooks was the over-reliance on the probability value in the interpretation of results. We found it difficult to convince them to take effect size, and confidence intervals, into consideration when the textbooks that were available made no mention of the debates around hypothesis testing, but simply instructed students to say $p < 0.05$ is significant and $p > 0.05$ is not significant! We hope in writing this book that students will become more aware of such issues.

We also wanted to show students how to incorporate the results of their analysis into laboratory reports, and how to interpret results sections of journal articles. Until recently, statistics books ignored this aspect of data analysis. Of course, we realise that the way we have written our example 'results sections' will be different from the way that other psychologists would write them. Students can use these sections to gain confidence in writing their own results, and hopefully they will build on them, as they progress through their course.

We have tried to simplify complex, sometimes very complex, concepts. In simplifying, there is a trade-off in accuracy. We were aware of this when writing the book, and have tried to be as accurate as possible, while giving the simplest explanation. We are also aware that some students do not use SPSS for their data analysis. SPSS, however, is the most commonly used statistical package for the social sciences, and this is why the text is tied so closely to SPSS. Students not using this package should find the book useful anyway. This edition of the book has been updated for use with SPSS version 15 but is still appropriate for earlier version of the software (versions 10 to 14).

Since writing the first edition of this book we have received numerous reviews, the vast majority of which have been very positive. Over the years the reviewers have been incred-

ibly helpful in ensuring the book has improved and best meets the needs of students and lecturers alike. We would thus like to thank all those who have taken the time and effort to provide us with feedback and we would urge you to keep doing so.

We hope that students who read the book will not only learn from it, but will also enjoy our explanations and examples. We also hope that as a result of reading this book students will feel confident in their ability to perform their own statistical analyses.

How to use this book

To help you get the most from this book we thought that it would be useful to provide a brief overview of the book and of the structure of the chapters. The best way to use the book if you are new to statistics in psychology or if you have been away from statistics for a long while is to work your way through the chapters from Chapter 1 onwards. The most important chapters to read and ensure that you understand fully are the first five chapters as these provide you with the core concepts for understanding the main statistical techniques covered later in the book. If you spend the time and effort on these opening chapters then you will be rewarded by having a better understanding of what the statistical tests are able to tell us about our data. We cannot stress enough the importance of such an understanding for appropriate use of statistical techniques and for your ability to understand and critique others' use of such techniques.

The chapters that follow these opening chapters generally explain the concepts underlying specific types of tests as well as how to conduct and interpret the findings from these. We start off with the more basic tests which look at the fewest possible variables ('variables' will be explained in Chapter 1) and then using these as a basis we move on to the more complex tests later in the book. In some ways it might be better to read about a basic type of test, say simple correlations (see Chapter 6) and then move on to the more complex versions of these tests, say regression and multiple regression (see Chapter 12). As another example, start with simple tests of differences between two groups in Chapter 7 and then move on to tests of differences between more than two groups (Chapters 10 and 11). However, often statistics modules don't follow this sort of pattern but rather cover all of the basic tests first and only then move on to the complex tests. In such a learning pattern there is the danger that to some extent some of the links between the simple and complex tests may get lost.

Rather disappointingly we have read some reviews of the book which focus entirely on the step-by-step guides we give to conducting the statistical analyses with SPSS for Windows (SPSSFW). We would like to stress that this book is not simply a 'cook book' for how to run statistical tests. If used appropriately you should come out with a good understanding of the statistical concepts covered in the book as well as the skills necessary to conduct the analyses using SPSSFW. If you already have a conceptual understanding of the statistical techniques covered in the book then by all means simply follow the step-by-step guide to carrying out the analyses, but if you are relatively new to statistics you should ensure that you read the text so that you understand what the statistical analyses are telling you.

There are a number of features in this book to help you learn the concepts being covered (in technical terms these are called 'pedagogic' features). These are explained below, but before we explain these we will give you a general overview of what to expect in each chapter. In each chapter we will highlight what is to come and then we will explain the stat-

istical concepts underlying the particular topics for that chapter. Once we have covered the statistical concepts you will be given step-by-step guides to conducting analyses using SPSSFW. Towards the end of each chapter you will be provided with a means of testing your knowledge, followed by some pointers to further reading. We will now describe some of the features found in the chapters in more detail.

At the beginning of every chapter there is a **Chapter overview**. These overviews provide you with information about what is contained in each chapter and what you should have achieved from working through it. Sometimes we will also highlight what you need to know beforehand to be able to get the most from the chapter. You should make sure that you read these (it is very easy to get into the habit of not doing this) as they will set the scene for you and prepare your mind for the concepts coming up in the book.

At the end of each chapter there are **Summaries** which outline the main concepts that were covered. These are important for consolidating what you have learned and help put the concepts learned later in the chapter back in the context of the earlier concepts. You will also find **SPSSFW exercises and multiple choice questions.** We cannot stress enough the importance of working through these when you finish each chapter. They are designed to test your knowledge and to help you actively work with the information that you have learned. The best way to learn about things is to do them. The answers to the multiple choice questions are also provided at the very end of each chapter so that you can check your progress. If you have answered questions incorrectly go back and read the relevant part of the chapter to ensure that you have a good understanding of the material. The answers to the SPSS exercises are provided at the end of the book. Check these and if you have different answers go back and try to work out where you might have gone wrong. Often it might be that you have input the data incorrectly into SPSS. There are additional multiple choice questions and SPSS exercises on the companion website and so please do make use of these also.

Within each chapter there are a number of features designed to get you thinking about what you have been reading. There are **Discussion points** which help you to explore different ideas or theories in more detail. There are also a number of **Activity boxes** which provide additional opportunities for you to test your understanding of the theories and ideas being discussed. It is important to complete the activities as we have placed these to ensure that you are actively engaging with the material. Our experience has shown that actively working with material helps learning (and makes reading more enjoyable). You will also find a number of **Example boxes** where we provide a concrete example of what we are discussing. Providing such concrete examples helps students understand the concepts more easily. There are also lots of **examples from the psychological literature** which show how active psychology researchers use the statistical techniques which have been covered in the chapters.

Where appropriate we have included as many **diagrams and pictures** as we can as these will help you to understand (and remember) the text more easily. The thought of giving you endless pages of text without breaking it up is not worth thinking about. This would probably lead to a lot of Zzzzzz. On a serious note though, remember that the pictures are not there to be pretty nor just to break up the text. Please consult these along with reading the text and this will help you learn and understand the concept under discussion. Occasionally in the book you will come across **Caution boxes**. These are there to warn you of possible problems or issues related to certain techniques or statistical concepts. These are useful in many ways as they are designed to help you to understand some of the limits of statistical tests and they serve as a reminder that we have to think carefully about how we analyse our data.

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Where in a chapter we want to show you how to use SPSSFW we provide **annotated screenshots**. These will show you which buttons to click in SPSSFW as well as how and where to move information around to get the analyses that you want. Finally, at the very end of each chapter there is a **Reference** section. In this we will provide details of all the other authors' works that we have mentioned within the chapter. This is pretty much what you should do when writing up your own research. Some of the references will provide the details of the examples from the literature that we have presented and some will be examples of potentially useful further reading. You can follow up these as and when you choose to. Sometimes it is good to follow up the examples from the research literature as you can then see the context to the example analyses that we present. Also, by looking at how the experts present their research you can better learn how to present your research.

Companion Website

We would urge you to make as much use as possible of the resources available to you on the companion website. When you get on to the site you will see that it is broken down into resources for each chapter. For each chapter you will find **SPSSFW data set files** which are simply the data for the examples that we provide in each chapter. You can access these to ensure that you have input data correctly or so that you can carry out the same analyses that we present in each chapter to make sure that you get the same results. Also, on the website you will find **additional multiple choice questions**. If you find that you have made mistakes in the multiple choice questions provided in the book you should go back through the chapter and try to make sure that you fully understand the concepts presented. It wouldn't make sense for you to then test yourself using the same multiple choice questions and so we have provided the additional ones on the companion website. As another means of testing yourself and to help you actively learn we provide an **additional SPSS exercises** for each chapter and a step-by-step guide to the analysis to conduct on this data and how to interpret the output.

Finally, you will find **links to interesting and useful websites** which are relevant to the concepts being covered in each chapter.

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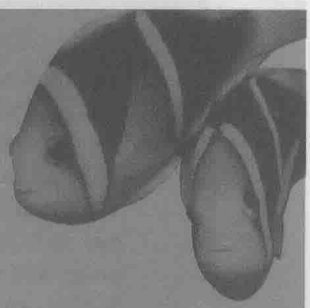

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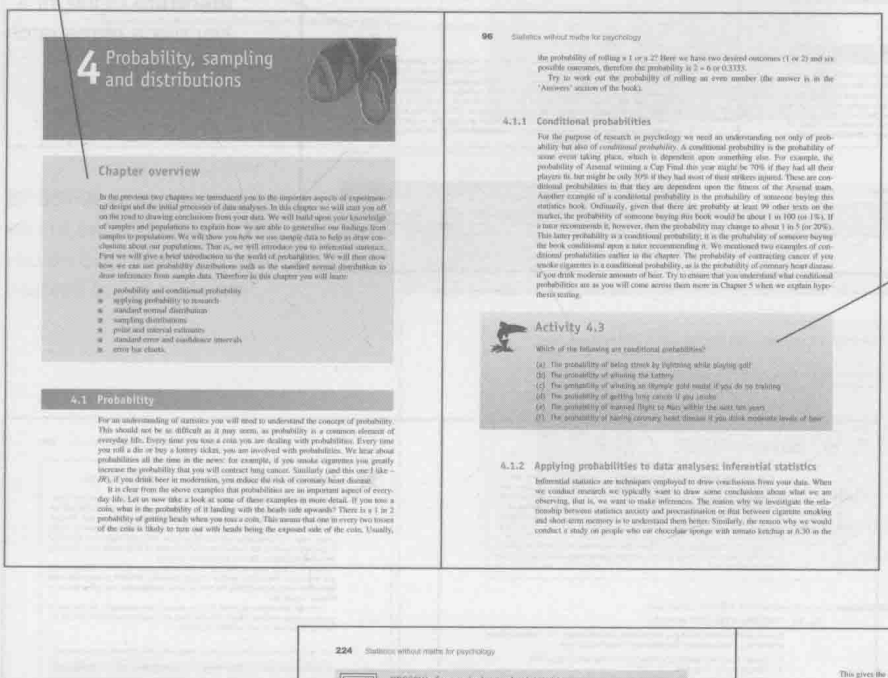
Christine would like to dedicate this book to James and Edward Dancey and to Jo, Michael and Robert Johnstone

John would like to dedicate this book to Eileen and David for the love you have shown and for making me feel so much a part of your family for the last 13 years. Thank you!

Guided tour of the book and website

The **Chapter overview** gives you a feel for what will be covered and what you should have learnt by the end of the topic



4 Probability, sampling and distributions

Chapter overview

In the previous two chapters we introduced you to the important aspects of experimental design and the initial processes of data analyses. In this chapter we will start you off on the road to drawing conclusions from your data. We will build upon your knowledge of samples and populations to explain how we are able to generalise our findings from samples to populations. We will show you how we use sample data to help us draw conclusions about our populations. That is, we will introduce you to inferential statistics. First we will give a brief introduction to the world of probabilities. We will then show how we can use probability distributions such as the standard normal distribution to draw inferences from sample data. Therefore in this chapter you will learn:

- probability and conditional probability
- applying probability to research
- standard normal distribution
- sampling distributions
- point and interval estimates
- standard error and confidence intervals
- error bar charts.

4.1 Probability

For an understanding of statistics you will need to understand the concept of probability. This should not be as difficult as it may seem, as probability is a common element of everyday life. Every time you toss a coin you are dealing with probabilities. Every time you roll a die or buy a lottery ticket, you are involved with probabilities. We hear about probabilities all the time in the news: for example, if you smoke cigarettes you greatly increase the probability that you will contract lung cancer. Similarly (and this one I like – JR), if you drink beer in moderation, you reduce the risk of coronary heart disease.

It is clear from the above examples that probabilities are an important aspect of everyday life. Let us now take a look at some of these examples in more detail. If you toss a coin, what is the probability of it landing with the heads side upwards? There is a 1 in 2 probability of getting heads when you toss a coin. This means that one in every two tosses of the coin is likely to turn out with heads being the exposed side of the coin. Usually,

the probability of rolling a 1 or a 2? Here we have two desired outcomes (1 or 2) and six possible outcomes, therefore the probability is 2 ÷ 6 or 0.3333.

Try to work out the probability of rolling an even number (the answer is in the 'Answers' section of the book).

4.1.1 Conditional probabilities

For the purpose of research in psychology we need an understanding not only of probability but also of *conditional probability*. A conditional probability is the probability of some event taking place, which is dependent upon something else. For example, the probability of Arsenal winning a Cup Final this year might be 70% if they had all their players fit, but might be only 30% if they had most of their strikers injured. These are conditional probabilities in that they are dependent upon the fitness of the Arsenal team. Another example of a conditional probability is the probability of someone buying this statistics book. Ordinarily, given that there are probably at least 99 other texts on the market, the probability of someone buying this book would be about 1 in 100 (or 1%). If a tutor recommends it, however, then the probability may change to about 1 in 5 (or 20%). This latter probability is a conditional probability; it is the probability of someone buying the book conditional upon a tutor recommending it. We mentioned two examples of conditional probabilities earlier in this chapter. The probability of contracting cancer if you smoke cigarettes is a conditional probability, as is the probability of coronary heart disease if you drink moderate amounts of beer. Try to ensure that you understand what conditional probabilities are as you will come across them more in Chapter 5 when we explain hypothesis testing.

Activity 4.3

Which of the following are conditional probabilities?

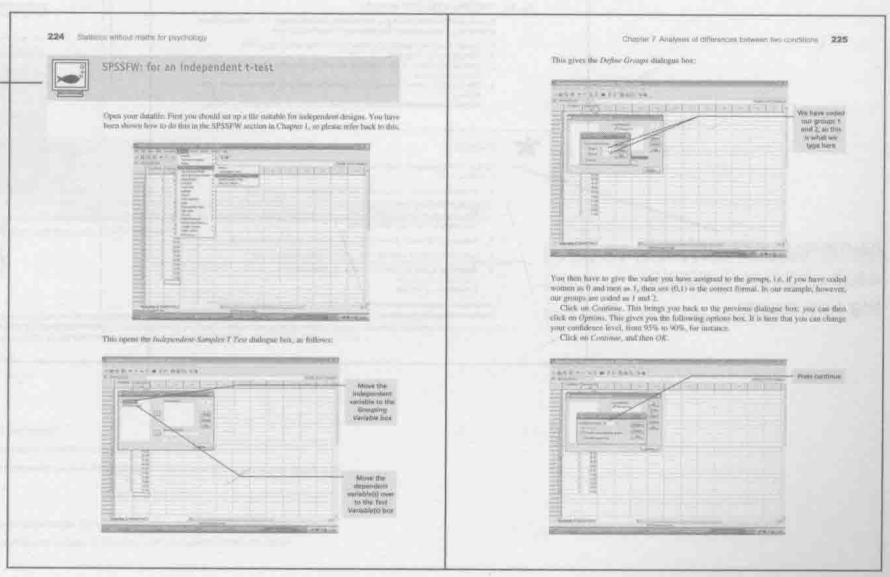
(a) The probability of being struck by lightning while playing golf
(b) The probability of winning the lottery
(c) The probability of winning an Olympic gold medal if you do no training
(d) The probability of getting lung cancer if you smoke
(e) The probability of manned flight to Mars within the next ten years
(f) The probability of having coronary heart disease if you drink moderate levels of beer

4.1.2 Applying probabilities to data analyses: inferential statistics

Inferential statistics are techniques employed to draw conclusions from your data. When we conduct research we typically want to draw some conclusions about what we are observing, that is, we want to make inferences. The reason why we investigate the relationship between statistics anxiety and procrastination or that between cigarette smoking and short-term memory is to understand them better. Similarly, the reason why we would conduct a study on people who eat chocolate sponge with tomato ketchup at 8.30 in the

Activity boxes provide you with opportunities to test your understanding as you go along

SPSSFW sections guide you through how to use the software for each process with annotated screenshots to demonstrate what should be happening on-screen



SPSSFW: for an independent t-test

Open your datafile. First you should set up a file suitable for independent designs. You have been shown how to do this in the SPSSFW section in Chapter 1, so please refer back to this.

This opens the *Independent-Samples T Test* dialogue box, as follows:

Move the independent variable to the Grouping Variable box

Move the dependent variable(s) over to the Test Variable(s) box

This gives the *Define Groups* dialogue box:

We have coded our groups 1 and 2, so this is what we type here

You then have to give the value you have assigned to the groups, i.e. if you have coded women as 0 and men as 1, then sex (0,1) is the correct format. In our example, however, our groups are coded as 1 and 2.

Click on *Continue*. This brings you back to the previous dialogue box; you can then click on *Options*. This gives you the following options box. It is here that you can change your confidence level, from 95% to 90%, for instance.

Click on *Continue*, and then *OK*.

Press continue

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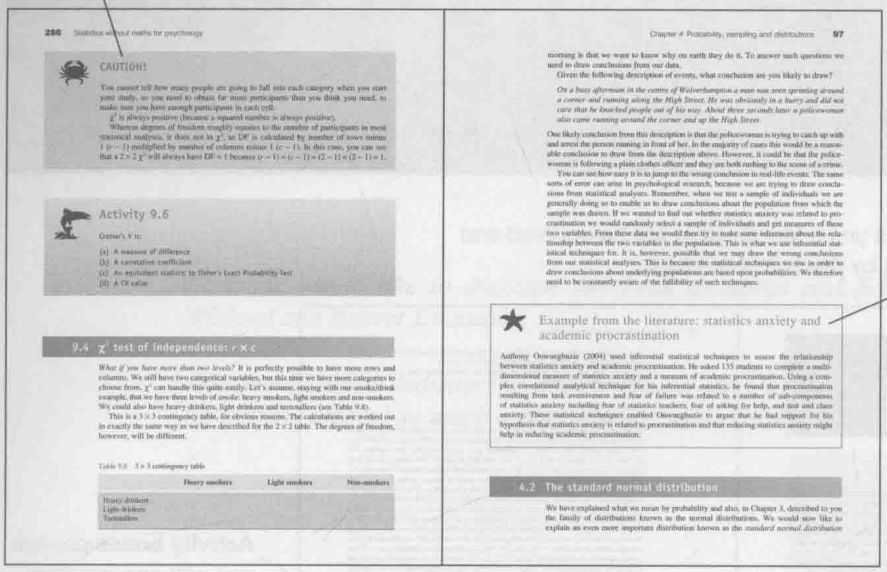
Caution boxes highlight possible problems you may encounter or issues for consideration



CAUTION!

You cannot tell how many people are going to fall into each category when you start your study, so you need to obtain far more participants than you think you need, to make sure you have enough participants in each cell.

χ^2 is always positive (because a squared number is always positive).

Whereas degrees of freedom roughly equates to the number of participants in most statistical analyses, it does not in χ^2, as DF is calculated by number of rows minus 1 ($r - 1$) multiplied by number of columns minus 1 ($c - 1$). In this case, you can see that a 2×2 χ^2 will always have DF = 1 because $(r - 1) \times (c - 1) = (2 - 1) \times (2 - 1) = 1$.

Activity 9.6

Cramer's V is:

(a) A measure of difference
(b) A correlation coefficient
(c) An equivalent statistic to Fisher's Exact Probability Test
(d) A CV value

9.4 χ^2 test of independence: $r \times c$

What if you have more than two levels? It is perfectly possible to have more rows and columns. We still have two categorical variables, but this time we have more categories to choose from. χ^2 can handle this quite easily. Let's assume, staying with our smoke/drink example, that we have three levels of *smoke*: heavy smokers, light smokers and non-smokers. We could also have heavy drinkers, light drinkers and teetotallers (see Table 9.8).

This is a 3×3 contingency table, for obvious reasons. The calculations are worked out in exactly the same way as we have described for the 2×2 table. The degrees of freedom, however, will be different.

Table 9.8 3×3 contingency table

	Heavy smokers	Light smokers	Non-smokers
Heavy drinkers			
Light drinkers			
Teetotallers			

morning is that we want to know why on earth they do it. To answer such questions we need to draw conclusions from our data.

Given the following description of events, what conclusion are you likely to draw?

On a busy afternoon in the centre of Wolverhampton a man was seen sprinting around a corner and running along the High Street. He was obviously in a hurry and did not care that he knocked people out of his way. About three seconds later a policewoman also came running around the corner and up the High Street.

One likely conclusion from this description is that the policewoman is trying to catch up with and arrest the person running in front of her. In the majority of cases this would be a reasonable conclusion to draw from the description above. However, it could be that the policewoman is following a plain clothes officer and they are both rushing to the scene of a crime.

You can see how easy it is to jump to the wrong conclusion in real-life events. The same sorts of error can arise in psychological research, because we are trying to draw conclusions from statistical analyses. Remember, when we test a sample of individuals we are generally doing so to enable us to draw conclusions about the population from which the sample was drawn. If we wanted to find out whether statistics anxiety was related to procrastination we would randomly select a sample of individuals and get measures of these two variables. From these data we would then try to make some inferences about the relationship between the two variables in the population. This is what we use inferential statistical techniques for. It is, however, possible that we may draw the wrong conclusions from our statistical analyses. This is because the statistical techniques we use in order to draw conclusions about underlying populations are based upon probabilities. We therefore need to be constantly aware of the fallibility of such techniques.

Example from the literature: statistics anxiety and academic procrastination

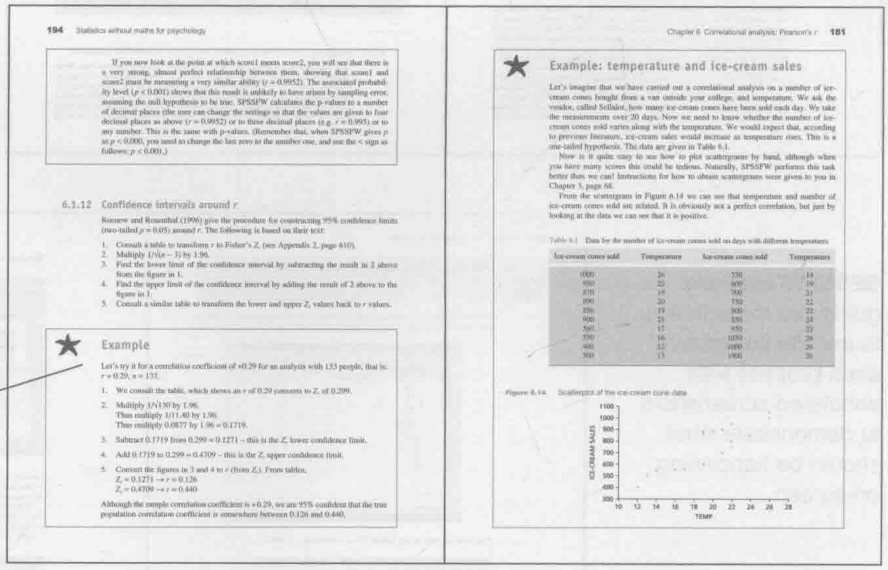
Anthony Onwuegbuzie (2004) used inferential statistical techniques to assess the relationship between statistics anxiety and academic procrastination. He asked 135 students to complete a multidimensional measure of statistics anxiety and a measure of academic procrastination. Using a complex correlational analytical technique for his inferential statistics, he found that procrastination resulting from task aversiveness and fear of failure was related to a number of sub-components of statistics anxiety including fear of statistics teachers, fear of asking for help, and test and class anxiety. These statistical techniques enabled Onwuegbuzie to argue that he had support for his hypothesis that statistics anxiety is related to procrastination and that reducing statistics anxiety might help in reducing academic procrastination.

4.2 The standard normal distribution

We have explained what we mean by probability and also, in Chapter 3, described to you the family of distributions known as the normal distributions. We would now like to explain an even more important distribution known as the *standard normal distribution*

Examples from the literature highlight a key piece of research in the area

Numerous **examples** in each chapter illustrate the key points



If you now look at the point at which score1 meets score2, you will see that there is a very strong, almost perfect relationship between them, showing that score1 and score2 must be measuring a very similar ability ($r = 0.9952$). The associated probability level ($p < 0.001$) shows that this result is unlikely to have arisen by sampling error, assuming the null hypothesis to be true. SPSSPW calculates the p-values to a number of decimal places (the user can change the settings so that the values are given to four decimal places as above ($r = 0.9952$) or to three decimal places (e.g. $r = 0.995$), or to any number. This is the same with p-values. (Remember that, when SPSSPW gives p as $p < 0.000$, you need to change the last zero to the number one, and use the < sign as follows: $p < 0.001$.)

6.1.12 Confidence intervals around r

Rosnow and Rosenthal (1996) give the procedure for constructing 95% confidence limits (two-tailed $p = 0.05$) around r. The following is based on their text:

1. Consult a table to transform r to Fisher's Z_r (see Appendix 2, page 610).
2. Multiply $1/\sqrt{(n-3)}$ by 1.96.
3. Find the lower limit of the confidence interval by subtracting the result in 2 above from the figure in 1.
4. Find the upper limit of the confidence interval by adding the result of 2 above to the figure in 1.
5. Consult a similar table to transform the lower and upper Z_r values back to r values.

Example

Let's try it for a correlation coefficient of +0.29 for an analysis with 133 people, that is: $r = 0.29$, $n = 133$.

1. We consult the table, which shows an r of 0.29 converts to Z_r of 0.299.
2. Multiply $1/\sqrt{130}$ by 1.96.
   Thus multiply 1/11.40 by 1.96.
   Thus multiply 0.0877 by 1.96 = 0.1719.
3. Subtract 0.1719 from 0.299 = 0.1271 – this is the Z_r lower confidence limit.
4. Add 0.1719 to 0.299 = 0.4709 – this is the Z_r upper confidence limit.
5. Convert the figures in 3 and 4 to r (from Z_r). From tables,
   $Z_r = 0.1271 \rightarrow r = 0.126$
   $Z_r = 0.4709 \rightarrow r = 0.440$

Although the sample correlation coefficient is +0.29, we are 95% confident that the true population correlation coefficient is somewhere between 0.126 and 0.440.

Example: temperature and ice-cream sales

Let's imagine that we have carried out a correlational analysis on a number of ice-cream cones bought from a van outside your college, and temperature. We ask the vendor, called Sellalot, how many ice-cream cones have been sold each day. We take the measurements over 20 days. Now we need to know whether the number of ice-cream cones sold varies along with the temperature. We would expect that, according to previous literature, ice-cream sales would increase as temperature rises. This is a one-tailed hypothesis. The data are given in Table 6.1.

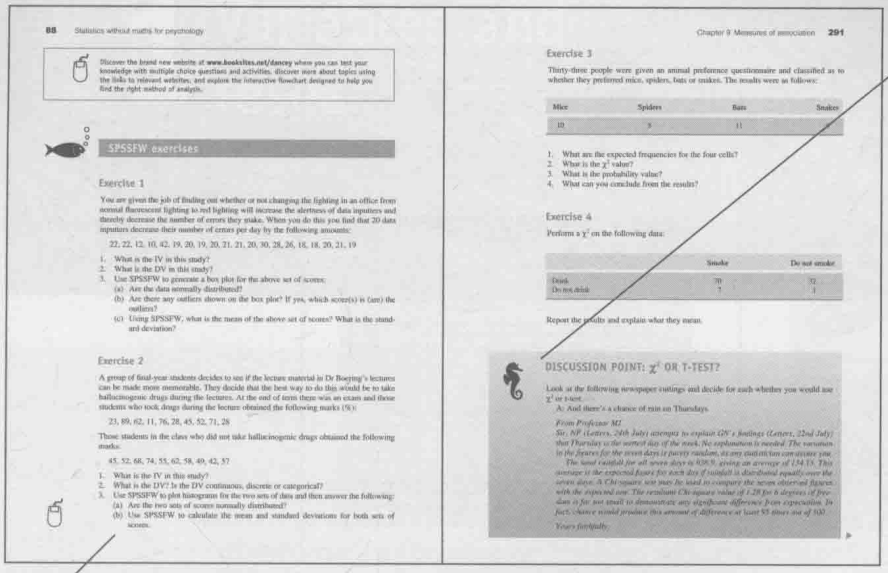
Now it is quite easy to see how to plot scattergrams by hand, although when you have many scores this could be tedious. Naturally, SPSSPW performs this task better than we can! Instructions for how to obtain scattergrams were given to you in Chapter 3, page 68.

From the scattergram in Figure 6.14 we can see that temperature and number of ice-cream cones sold are related. It is obviously not a perfect correlation, but just by looking at the data we can see that it is positive.

Table 6.1 Data for the number of ice-cream cones sold on days with different temperatures

Ice-cream cones sold	Temperature	Ice-cream cones sold	Temperature
1000	26	330	14
930	25	600	19
870	19	700	21
890	20	750	22
350	19	900	22
800	23	550	18
560	17	950	23
550	16	1050	26
400	12	1000	26
500	13	1000	28

Figure 6.14 Scatterplot of the ice-cream cone data



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SPSSFW exercises

Exercise 1

You are given the job of finding out whether or not changing the lighting in an office from normal fluorescent lighting to red lighting will increase the alertness of data inputters and thereby decrease the number of errors they make. When you do this you find that 20 data inputters decrease their number of errors per day by the following amounts:

22, 22, 12, 10, 42, 19, 20, 19, 20, 21, 21, 20, 30, 28, 26, 18, 18, 20, 21, 19

1. What is the IV in this study?
2. What is the DV in this study?
3. Use SPSSFW to generate a box plot for the above set of scores:
   (a) Are the data normally distributed?
   (b) Are there any outliers shown on the box plot? If yes, which score(s) is (are) the outliers?
   (c) Using SPSSFW, what is the mean of the above set of scores? What is the standard deviation?

Exercise 2

A group of final-year students decides to see if the lecture material in Dr Boejeng's lectures can be made more memorable. They decide that the best way to do this would be to take hallucinogenic drugs during the lectures. At the end of term there was an exam and those students who took drugs during the lecture obtained the following marks (%):

23, 89, 62, 11, 76, 28, 45, 52, 71, 28

Those students in the class who did not take hallucinogenic drugs obtained the following marks:

45, 52, 68, 74, 55, 62, 58, 49, 42, 57

1. What is the IV in this study?
2. What is the DV? Is the DV continuous, discrete or categorical?
3. Use SPSSFW to plot histograms for the two sets of data and then answer the following:
   (a) Are the two sets of scores normally distributed?
   (b) Use SPSSFW to calculate the mean and standard deviations for both sets of scores.

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Exercise 3

Thirty-three people were given an animal preference questionnaire and classified as to whether they preferred mice, spiders, bats or snakes. The results were as follows:

Mice	Spiders	Bats	Snakes
10	9	11	3

1. What are the expected frequencies for the four cells?
2. What is the χ^2 value?
3. What is the probability value?
4. What can you conclude from the results?

Exercise 4

Perform a χ^2 on the following data:

	Smoke	Do not smoke
Drink	70	72
Do not drink	7	3

Repeat the results and explain what they mean.

DISCUSSION POINT: χ^2 OR T-TEST?

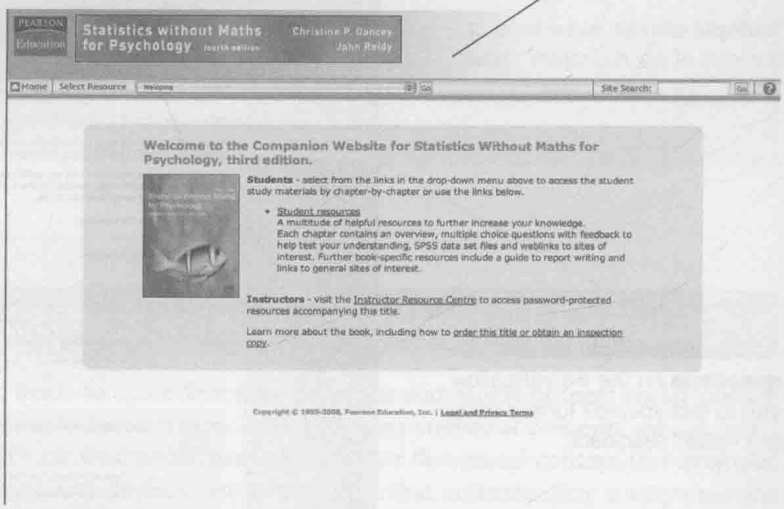
Look at the following newspaper cuttings and decide for each whether you would use χ^2 or t-test.

A: And there's a chance of rain on Thursdays.

From Professor MJ.
Sir, NP (Letters, 24th July) attempts to explain GW's findings (Letters, 22nd July) that Thursday is the wettest day of the week. No explanation is needed. The variations in the figures for the seven days is purely random, as any statistician can assure you.
The total rainfall for all seven days is 920.9, giving an average of 131.55. This average is the expected figure for each day if rainfall is distributed equally over the seven days. A Chi-square test may be used to compare the seven observed figures with the expected one. The resultant Chi-square value of 1.28 for 6 degrees of freedom is far too small to demonstrate any significant difference from expectation. In fact, chance would produce this amount of difference at least 95 times out of 100.
Yours forthrightly,

Discussion points explore different theories or ideas in more detail

SPSSFW exercises at the end of each chapter give you an opportunity to test yourself using real data



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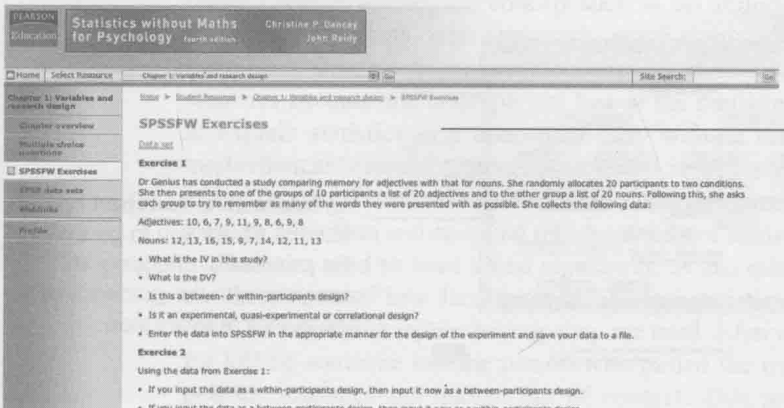

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SPSSFW Exercises

Data set

Exercise 1

Dr Genius has conducted a study comparing memory for adjectives with that for nouns. She randomly allocates 20 participants to two conditions. She then presents to one of the groups of 10 participants a list of 20 adjectives and to the other group a list of 20 nouns. Following this, she asks each group to try to remember as many of the words they were presented with as possible. She collects the following data:

Adjectives: 10, 6, 7, 9, 11, 9, 8, 6, 9, 8

Nouns: 12, 13, 16, 15, 9, 7, 14, 12, 11, 13

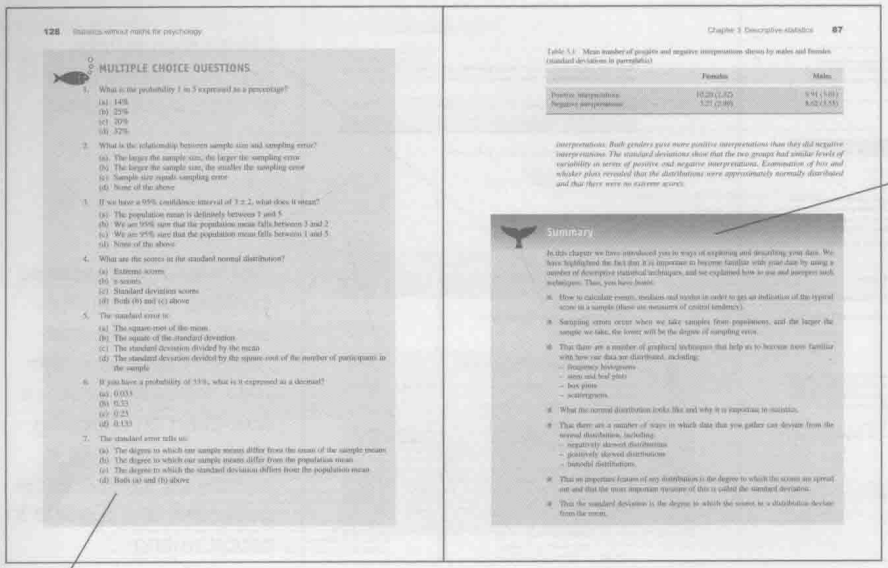
- What is the IV in this study?
- What is the DV?
- Is this a between- or within-participants design?
- Is it an experimental, quasi-experimental or correlational design?
- Enter the data into SPSSFW in the appropriate manner for the design of the experiment and save your data to a file.

Exercise 2

Using the data from Exercise 1:

- If you input the data as a within-participants design, then input it now as a between-participants design.
- If you input the data as a between-participants design, then input it now as a within-participants design.

Extra **SPSSFW exercises** on the website allow you to practice the skills you've learnt



MULTIPLE CHOICE QUESTIONS

1. What is the probability 1 in 5 expressed as a percentage?
   (a) 14%
   (b) 25%
   (c) 20%
   (d) 32%
2. What is the relationship between sample size and sampling error?
   (a) The larger the sample size, the larger the sampling error
   (b) The larger the sample size, the smaller the sampling error
   (c) Sample size equals sampling error
   (d) None of the above
3. If we have a 95% confidence interval of 3 ± 2, what does it mean?
   (a) The population mean is definitely between 3 and 5
   (b) We are 95% sure that the population mean falls between 3 and 2
   (c) We are 95% sure that the population mean falls between 1 and 5
   (d) None of the above
4. What are the scores in the standard normal distribution?
   (a) Extreme scores
   (b) z-scores
   (c) Standard deviation scores
   (d) Both (b) and (c) above
5. The standard error is:
   (a) The square root of the mean.
   (b) The square of the standard deviation
   (c) The standard deviation divided by the mean
   (d) The standard deviation divided by the square root of the number of participants in the sample
6. If you have a probability of 33%, what is it expressed as a decimal?
   (a) 0.033
   (b) 0.33
   (c) 0.23
   (d) 0.133
7. The standard error tells us:
   (a) The degree to which our sample scores differ from the mean of the sample means
   (b) The degree to which our sample means differ from the population mean
   (c) The degree to which the standard deviation differs from the population mean
   (d) Both (a) and (b) above

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Table 3.1 Mean number of positive and negative interpretations shown by males and females (standard deviations in parentheses)

	Females	Males
Positive interpretations	10.20 (2.82)	8.94 (3.01)
Negative interpretations	5.27 (2.99)	8.62 (3.55)

interpretations. Both genders gave more positive interpretations than they did negative interpretations. The standard deviations show that the two groups had similar levels of variability in terms of positive and negative interpretations. Examination of box and whisker plots revealed that the distributions were approximately normally distributed and that there were no extreme scores.

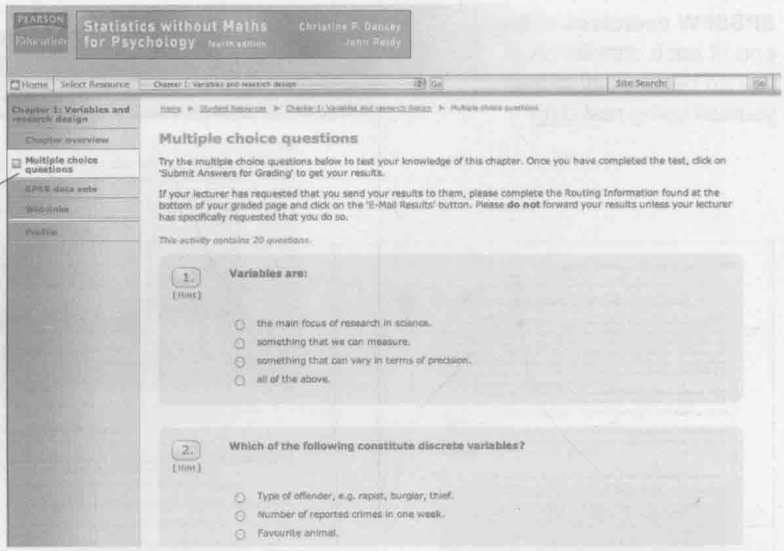
Summary

In this chapter we have introduced you to ways of exploring and describing your data. We have highlighted the fact that it is important to become familiar with your data by using a number of descriptive statistical techniques, and we explained how to use and interpret such techniques. Thus, you have learnt:

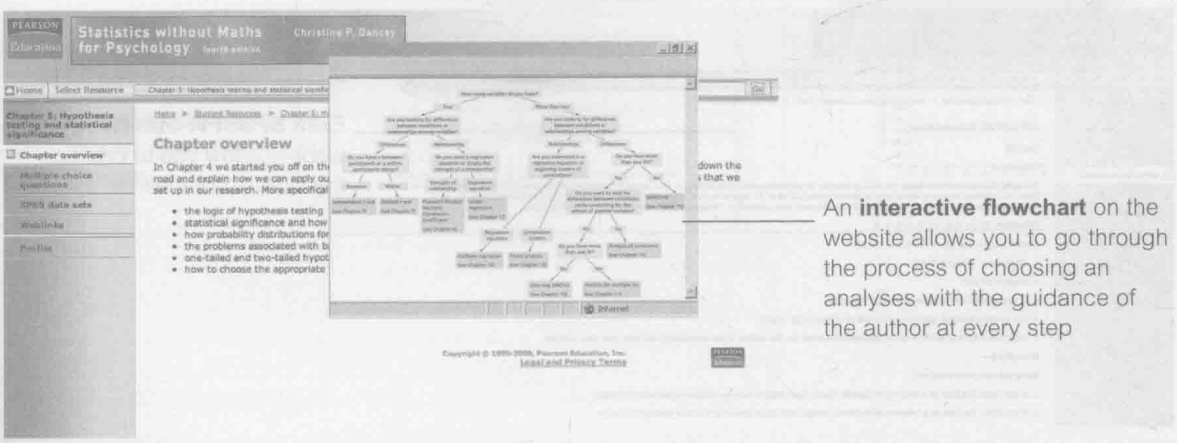
- How to calculate means, medians and modes in order to get an indication of the typical score in a sample (these are measures of central tendency).
- Sampling errors occur when we take samples from populations, and the larger the sample we take, the lower will be the degree of sampling error.
- That there are a number of graphical techniques that help us to become more familiar with how our data are distributed, including:
  - frequency histograms
  - stem and leaf plots
  - box plots
  - scattergrams.
- What the normal distribution looks like and why it is important in statistics.
- That there are a number of ways in which data that you gather can deviate from the normal distribution, including:
  - negatively skewed distributions
  - positively skewed distributions
  - bimodal distributions.
- That an important feature of any distribution is the degree to which the scores are spread out and that the most important measure of this is called the standard deviation.
- That the standard deviation is the degree to which the scores in a distribution deviate from the mean.

End of **chapter summaries** enable you to revise the main points of the chapter

Multiple choice questions at the end of each chapter allow you to test your knowledge



Additional **multiple choice questions** on the website allow you to test yourself further and get instant feedback



An **interactive flowchart** on the website allows you to go through the process of choosing an analyses with the guidance of the author at every step

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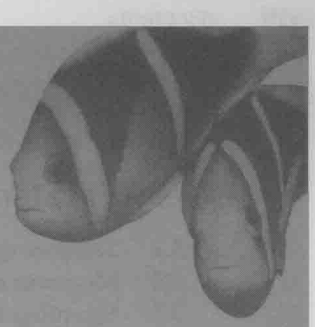

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