Laboratory Tutorial 1-5: Correlation and difference tests

In this laboratory tutorial you will:

1. Use SPSS to determine the strength, direction and significance of correlation between given variables
2. Use SPSS to determine the significance of observed differences between two independent groups and paired-samples
3. Compute the effect size of observed differences using the t-test output and a calculator

Preamble

For the following three exercises you'll need your modified copy of the sleep survey data: "Sleep3ED.sav". Before attempting these exercises, be sure to read through the relevant lecture slides and/or the relevant chapter in the SPSS textbook.

This is a mandatory tutorial. In order to pass the coursework, you must achieve a score of 50% or higher on the associated Blackboard quiz (Lab Quiz 1-5).

***Note: We strongly suggest you do not start the Lab Quiz for this tutorial before you have all your answers ready.**

Exercise 1: Correlation

It seems reasonable to assume that people who tend to feel sleepy or lethargic during the daytime would be more likely to report not getting enough sleep each night. This is an example of a correlational **hypothesis** whereby we expect one variable to be related or **co-vary** with another. To test this hypothesis, we need to perform a correlation test, in this case between the variables "totsas" and "satsleep".

The first variable, "totsas", is the total for the "Sleepiness and Associated Sensations scale", which measures how fatigued, lethargic, tired, sleepy and lacking in energy respondents have felt over the previous month. The second variable, "satsleep", is the extent to which respondents felt they were getting enough sleep, rated along a scale of one to ten.

Before we run the correlation test we need to check various properties of the data. First, we need to check that the relationship between the variables is roughly linear (values gather around a straight line), homoscedastic and free from outliers. Homoscedasticity refers to whether the spread of points around the best fit line is even (i.e. is the plot a neat cigar shaped distribution?).

We can check these basic requirements initially by using a scatter plot graph. To create a scatter plot:

- Graphs → Legacy Dialogs → Scatter/Dot
- Choose Simple Scatter then Define
- Move totsas to the X-axis field and satsleep to the Y-axis field
- Move ID to the Label Cases By field
- Click OK and view the resulting graph in the Output window

Q1: Is the relationship roughly linear?

Q2: Is the correlation positive or negative?

Q3: Is this direction consistent with the hypothesis posited at the start of this exercise?

You will see there are quite a few outliers (exceptions) at both extremes i.e. those who report not feeling sleepy but are still dissatisfied with their sleep quantity versus those, at the other extreme, who report feeling very sleepy but yet are still satisfied with their sleep amount. To explore these unusual cases in more detail, double click on the scatter plot to open the Chart Editor. You can use the “Data label mode”, denoted by the  icon, to identify outlying cases.

Q4: What are the id numbers of the two most extreme cases where the respondents reported not feeling sleepy at all, yet were still highly dissatisfied with the amount of sleep they were achieving?

To determine the strength and statistical significance of the observed relationship we need to compute a correlation test. In this case, both variables are (arguably) scale level and their distributions are reasonably normal, so we will use the Pearson r test. If we had judged that either variable did not meet these requirements, we should have chosen the non-parametric equivalent test. This is called Spearman’s rho (sometimes rank) correlation test. Both tests can be accessed from the same dialogue located on the following menu path: “Analyze → Correlate → Bivariate Correlations”.

Q5: What is the Pearson correlation coefficient of correlation between totsas and satsleep (to 3 dp)?

Q6: Is this statistically significant to at least the 0.05 level?

Q7: According to the guide described in the lecture, is this a small, medium or large correlation?

The questionnaire asks people to rate the extent to which they feel they are under- or over-weight. Find this variable in the variable view or codebook. This **subjective** measure of weight contrasts with the **objective** measure, BMI (Body Mass Index), that we computed in an earlier lab.

Q8: If people were perfectly accurate/truthful judges of their own weight, what would you expect the correlation between these two measures of weight to be?

Q9: Compute the actual correlation coefficient and, from this, derive the proportion of variance shared between the two variables. What is this value?

Exercise 2: T-test for Independent samples

T-test for independent samples allows us to determine whether an observed difference between two groups (independent variable) on some continuous measure (dependent variable) is statistically significant. We can use such a test to answer a question of the following kind:

"Do people who consider themselves to be restless sleepers experience more feelings of sleepiness/lethargy?"

The variables you require are "restlss" and "totsas".

Q10: Which one is the independent variable?

We can see that indeed those who said they are restless sleepers scored an average of 30.23 on the SAS scale compared to the rest of the sample who scored 23.68. Compute a t-test and extract the necessary values to answer the following questions:

Q11: Can the group variances be considered equal (according to Levene's test)?

Q12: What is the t-score for this difference (to 3 dp)?

Q13: What is the p-value and is this significant?

Q14: What is the effect size (to 2 dp)?

Q15: According to the guidelines described in the lecture slides (originally proposed by Cohen, 1988), is this a small, moderate or large effect?

Exercise 3: T-test for Paired samples

T-test for paired samples is used when the cases are measured twice, on the same variable, under different treatment conditions. One example might be a study where users perform the same task using two different user interface designs and you want to find out which design resulted in the fastest task performance. Another example might be where people are exposed to some sort of intervention, like a training session. The effect of the training is measured by giving the same test both before and after the intervention. The objective in both examples, therefore, is to determine the change in performance **within the same sample** of subjects under different conditions.

The Sleep data is based on subjects completing a questionnaire on one occasion, so no 'before and after' data is available as such. However, one pair of variables could be analysed using a paired t-test if the question was:

"Do people tend to sleep longer at weekends?"

Here, the measure is the same (number of hours of sleep) but it is dependent upon different conditions (weekend vs. weekday) and all (most) subjects answered both questions.

If we compute the sample means for these two variables, we find that people sleep 6.98 hours on average during weeknights as opposed to 7.81 hours on weekends. Compute a t-test for the variables "hourwnit" and "hourwend" and answer the following questions:

Q16. What is the t-value for this difference (3 dp)?

Q17. What is the p-value and is this significant?

Q18. How big is the effect size (1 dp)?

Q19. Is this a small, moderate or large effect size?

Summary and further work

In this tutorial you have applied the concepts and rules learned in the lecture to perform and interpret the results of correlation and difference tests, in order to answer specific questions or hypotheses. All of the tests used in this tutorial were parametric tests (see lecture for definition). In next lab (1-6), you will receive a brief tutorial, with relevant exercises, on non-parametric tests. You are encouraged to prepare by reading Chapter 11, which touches upon the non-parametric equivalent of Pearson correlation, called Spearman's rho, and Chapter 16 of Pallant which deals with non-parametric tests in more detail.

Further Reading

Cohen, J.W. (1988) *Statistical power analysis for the behavioural sciences* (2nd Ed.). New York: Erlbaum.

Pallant, J. (2007) SPSS survival manual : a step by step guide to data analysis using SPSS for Windows (Version 15), Chapters 10, 11 and 17.