

Chapter 10

Paired Samples t-Test: Assessing Differences Between Correlated Group Means

10.1 Introduction to the Paired-Samples t-Test

In the previous chapter we distinguished between two distinct applications of the t-test: the independent samples t-test and the correlated samples t-test. Recall that when a **between-subjects design** is used, the **independent-samples t-test** is the appropriate test. This is the procedure introduced in Chapter 9.

Use of a **within-subjects design** (sometimes called a *repeated measures* design) or a participant-by-participant matched design requires analysis with the paired samples t-test (also known as the *correlated* or **paired-samples t-test**). We turn our attention to this application of the t-test in this chapter.

The differences in these types of designs is both procedural and statistical. In the independent samples design, separate (and independent) groups of participants are compared, and each participant is measured only once on the dependent variable. The two sets of scores are therefore independent (uncorrelated).

In the correlated samples design, there are still two sets of scores on the dependent variable, but the scores are not independent. There are three ways in which a design can result in correlated scores:

- **Repeated Measures** are obtained on one group of participants, such as in measuring participants **before** a treatment is applied and again **after** the treatment. Thus, each person serves as his/her own control, and because the two sets of scores to be compared are obtained from the same people, the two groups of scores are not independent.
- Groups are established by **pairing** participants on the basis of some **natural relationship** between the individuals in each pair. For example, EZ employees' social skills might be compared to those of their fathers. Each person would be paired with his/her father in this design, and because of this natural relationship, the scores are not independent.
- A **matched-participant** design is employed in which the participants are paired based on receiving similar scores on some pretest. One person in each pair is then assigned to the experimental group (e.g., the group receiving some treatment) and one in each pair is assigned to the control group (which doesn't receive the treatment). This is sometimes done in order to control for some individual difference variable. For example, we might want to control for intelligence in assessing the effects of a drug on memory. We would first

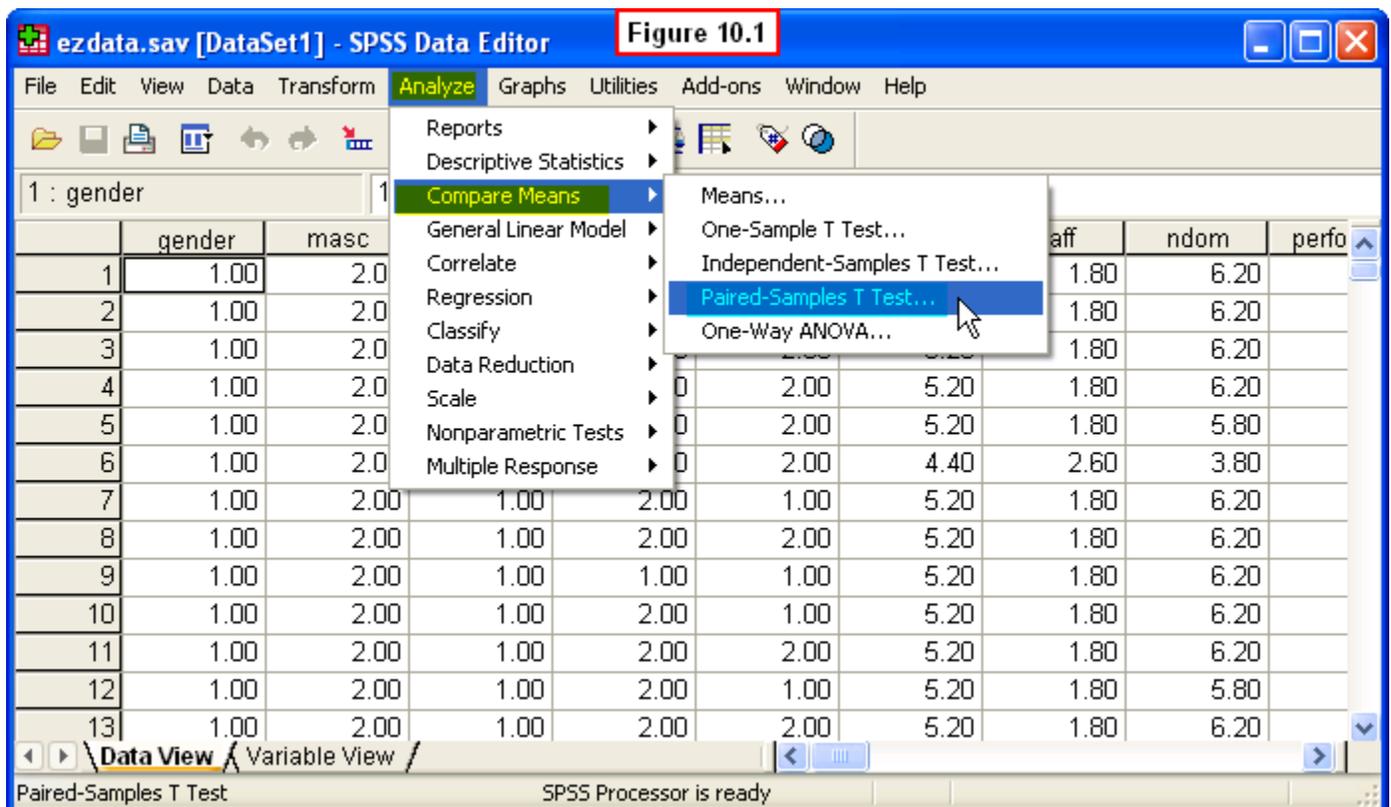
measure the participants' IQ and then match them based on their IQ scores before randomly assigning one to the drug and the other to the no-drug condition.

If any of the above three situations exists, the scores in the two groups will be correlated based on the pairing. This intercorrelation must be accounted for statistically when comparing the two groups, and that is what the **paired-samples t-test** does.

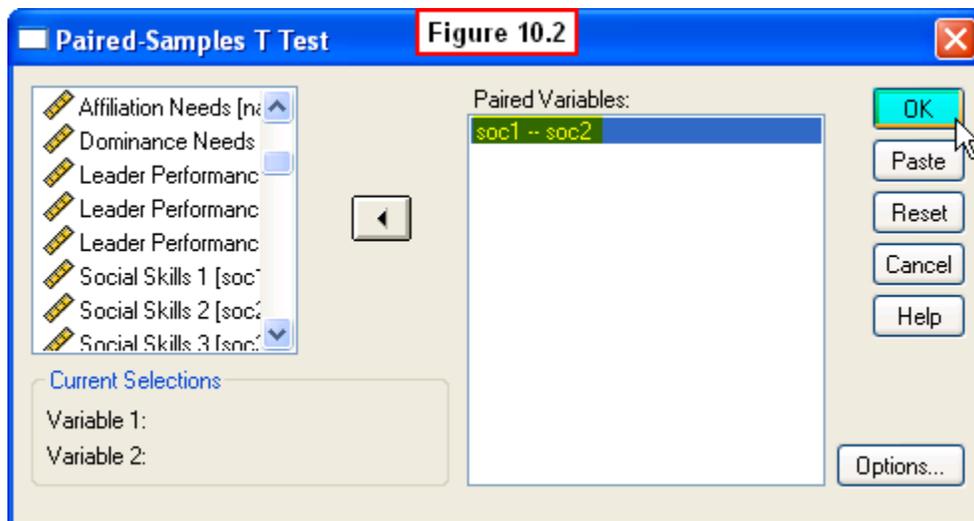
Recall from the EZ Manufacturing project that we do have three **repeated-measures** variables. Participants' **social skills**, **task skills** and **performance** scores were obtained prior to attending a leadership training workshop, then again after the workshop. The **paired-samples t-test** is the appropriate statistical test to determine whether or not there was a significant change in scores on these variables after the workshop compared to before participation. We will use **social skills** for the example in this chapter.

10.2 Running the t-test

Open your **ezdata.sav** file in the Data Editor. Select **Analyze, Compare Means, Paired-Samples T Test...** from the menu (Figure 10.1).



In the left pane of the **Paired-Samples T test** dialog window, select **Social Skills 1 (soc1)** and **Social Skills 2 (soc2)** and move them to the **Paired Variables:** pane on the right by clicking the arrow button in the middle. Then click the **OK** button.



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10.3 Interpreting the Output

Several statistics are presented in the first table, **Paired Samples Statistics** (Figure 10.3). The most relevant for our purposes are the two means. Examination of these means suggests that the average leadership performance score was higher after the workshop. However, the t-test will determine whether or not this difference is real or due to chance.

Figure 10.3

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Social Skills 1	5.4605	228	2.02043	.13381
	Social Skills 2	5.8553	228	2.05242	.13593

The paired-samples t-test procedure automatically computes the correlation between the two sets of scores (Figure 10.4). As discussed in the previous section, we can see that there is, indeed, a significant positive correlation between the scores before and after the workshop ($r = .29, p < .001$), indicating that those who scored high on social skills before the workshop also tended to score high on social skills after the workshop.

Figure 10.4

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Social Skills 1 & Social Skills 2	228	.288	.000

The next table presents the results of the t-test (Figure 10.5). The first column shows the actual difference between the two means (-.40), which is the numerator of the t-test formula. This is a negative number because the mean after the workshop (a larger value) is subtracted from that before the workshop (a smaller value).

The second column presents the standard deviation of the difference scores (2.43). The third column shows the standard error of the mean (.16), which is the denominator of the t-test formula. The 95% Confidence Interval presents the lower and upper limits of the mean difference (i.e., we can be 95% confident that the difference between the means falls somewhere between -.71 and -.08)

Figure 10.5

Paired Samples Test

		Paired Differences					t	df	Sig.
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Social Skills 1 - Social Skills 2	-.39474	2.43006	.16093	-.71185	-.07762	-2.453	227	

The most important columns for our purposes are the one presenting the obtained t-value (-2.45) and its probability, or significance (.02). Since the probability is less than .05, we reject the null hypothesis of no difference in favor of the alternative hypothesis that the difference is real. To report the results in APA format, we would state the following:

A paired-samples t-test revealed a significant differences in the social skills scores before and after the workshop, $t(227) = -2.45, p < .02$. This indicates that the mean social skills score after the workshop ($M = 5.86$) was significantly higher than the mean before the workshop ($M = 5.46$).

This analysis provides evidence that the leadership training workshop was, indeed, effective in leading to increased social skills in leadership situations. This type of research is essential to evaluate the effectiveness of any new program or procedure implemented, and as such, it is frequently called program evaluation research. In the exercise at the end of the chapter you will be asked to determine whether or not **task**

skills also changed significantly after the workshop. You might also be curious to determine whether or not leader **performance** changed as well.

10.4 Chapter Review Video

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10.5 Try It! Exercises

1. Using Paired-Sample t-test: Effects of Leadership Training Workshop on Task Skills

Use the procedures described in Section 10.2 to determine if there was a significant change in task skills scores before and after the leader training workshop. Select **Task Skills 1 (task1)** and **Task Skills 2 (task2)** as the **Paired Variables** in the **Paired Samples T Test** dialog window.

- **Print** your output file to submit to your instructor.
- Answer the following questions for the affiliation variable:
 - What is the mean task skills score before the workshop?
 - What is the mean task skills score after the workshop?
 - How many degrees of freedom are associated with this test?
 - What is the value of the t-statistic?
 - What is the significance level?
 - Should you reject or fail to reject the null hypothesis of no difference in task skills before and after the workshop?
- **Write an interpretation of the results** along with your answers to the above questions to submit to your instructor. Follow the example in Section 10.3.