

Paired t test in SPSS (Quiz)

Paired t test practical questions

In this example you will use a paired t-test to address the question of whether students from England in the PISA sample scored more highly, on average, in the science test (SCISCORE) or the maths test (MATHSCORE).

A first step to perform a paired t test in SPSS is to construct a variable that is the difference between the two variables to be compared, in this case **Science test score[SCISCORE]** and **Math test score[MATHSCORE]**. Do this now and then use SPSS to test for normality of this difference variable.

- Question: Do the histogram and normality tests suggest that the difference variable follows a normal distribution?

Next perform the paired t test in SPSS to compare differences between **Science test score[SCISCORE]** and **Math test score[MATHSCORE]**.

- Question: From the Paired sample statistics block which variable has the larger mean?
- Question: Which variable has the largest variability?
- Question: Looking at the second SPSS output table what is the correlation between **SCISCORE** and **MATHSCORE** and is it significant?
- Question: Looking at the third SPSS table is there a significant difference between **SCISCORE** and **MATHSCORE**?
- Question: How would you write up these findings?

Solutions to Paired t test practical questions

To construct the difference variable and test it for normality:

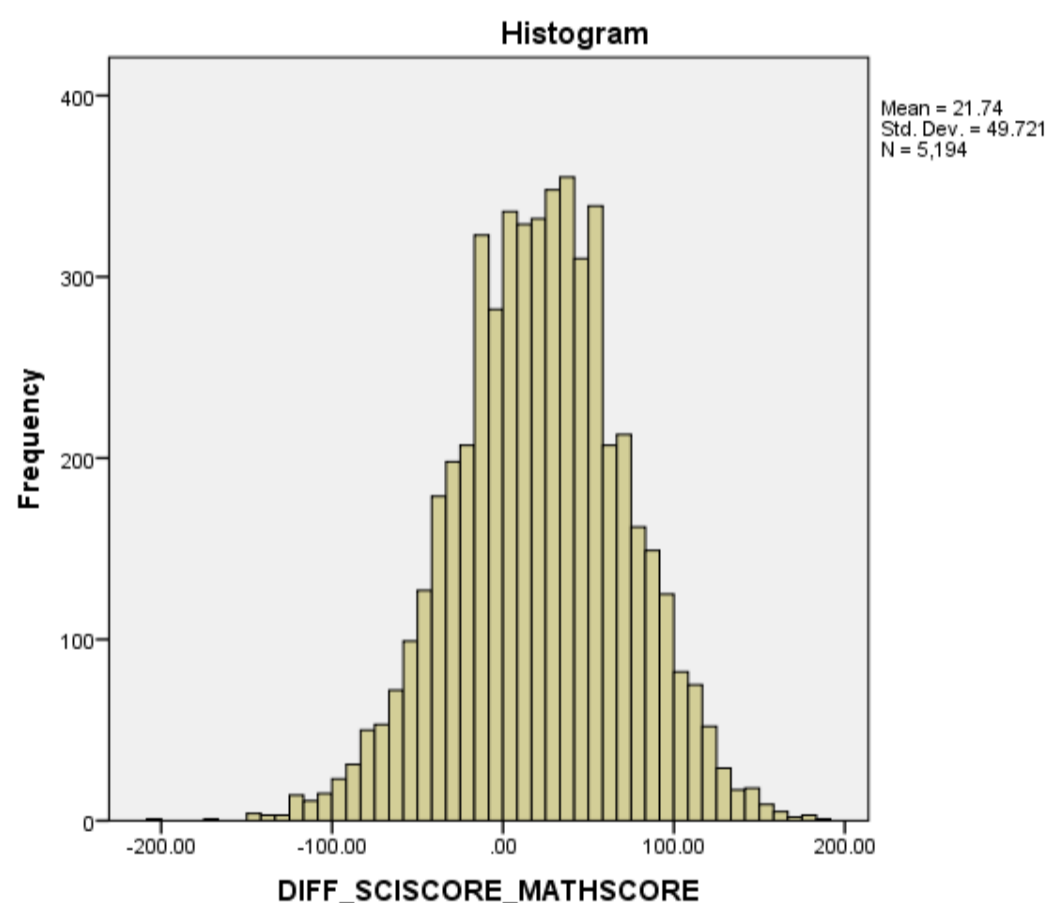
- Select **Compute** from the **Transform** menu.
- Type **DIFF_SCISCORE_MATHSCORE** into the **Target Variable** box.
- Type **SCISCORE - MATHSCORE** into the **Numeric Expression** box.
- Click on the **OK** button

We can now use this new generated variable to perform normality checks. Do this as follows:

- Select **Descriptive Statistics** from the **Analyze** menu.
- Select **Explore** from the **Descriptive Statistics** sub-menu.
- Click on the **Reset** button.
- Copy the **DIFF_SCISCORE_MATHSCORE** variable into the **Dependent List:** box.
- Click on the **Plots...** button.
- On the screen that appears select the **Histogram** tick box.
- Unselect the **Stem and leaf** button.
- Select the **Normality plots with tests** button.
- Click on the **Continue** button.
- Click on the **OK** button.

Question: Do the histogram and normality tests suggest that the difference variable follows a normal distribution?

Solution: The output from SPSS is as follows:



Ideally for a normal distribution this histogram should look symmetric around the mean of the distribution, in this case 21.73539. This distribution appears to be significantly skewed to the left (negatively skewed).

Tests of Normality

	Kolmogorov-Smirnov ^a		
	Statistic	df	Sig.
DIFF_SCISCORE_MATHSCORE	.011	5194	.116

a. Lilliefors Significance Correction

The Kolmogorov Smirnov test produces test statistics that are used (along with a degrees of freedom parameter) to test for normality. Here we see that the Kolmogorov Smirnov statistic takes value .011. This has degrees of freedom which equals the number of data points, namely 5194.

Here we see that the p value (quoted under Sig. for Kolmogorov Smirnov is .116 which is greater than 0.05 and therefore we cannot reject the null hypothesis that the distribution is normal.

Although the Kolmogorov Smirnov statistic tells the researcher whether the distribution followed by a variable is statistically significantly different from a normal distribution one should take care in not overinterpreting such findings. Significance will be strongly effected by the number of observations and so only a small discrepancy from normality will be deemed significant for very large sample sizes whilst very large discrepancies will be required to reject the null hypothesis for small sample sizes.

Here are the instructions to perform the paired t test in SPSS:

- Select **Compare Means** from the **Analyze** menu.
- Select **Paired-Samples T Test...** from the **Compare Means** sub-menu.
- Click on the **Reset** button.
- Copy the **Science test score[SCISCORE]** variable into the **Variable1:** box for Pair 1.
- Copy the **Math test score[MATHSCORE]** variable into the **Variable2:** box for Pair 1.
- Click on the **OK** button.

- Question: From the Paired Samples statistics block which variable has the larger mean?
- Question: Which variable has the larger variability?

Solutions: The output from SPSS is as follows:

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Science test score	523.5944	5194	102.57804	1.42332
	Math test score	501.8590	5194	97.10044	1.34732

The answers are as follows:

- The variable **SCISCORE** has the larger mean.
- The variable **SCISCORE** has the larger variability.
- Question: Looking at the second SPSS output table what is the correlation between **SCISCORE** and **MATHSCORE** and is it significant?

Solution: The output from SPSS is as follows:

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Science test score & Math test score	5194	.877	.000

Here we see that the correlation between **SCISCORE** and **MATHSCORE** is .877. SPSS also gives out a p value which describes whether the correlation is statistically significantly different from zero. Here we see that the p value is less than 0.05 and therefore we can reject the null hypothesis that the correlation is zero.

- Question: Looking at the third SPSS table is there a significant difference between **SCISCORE** and **MATHSCORE**?

Solution: The output from SPSS is as follows:

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Science test score - Math test score	21.73539	49.72085	.68990	20.38290	23.08789	31.505	5193	.000

Looking up the t statistic in the appropriate table gives the associated p value, in this case .000. Here we see that the p value is less than 0.05 and therefore we can reject the null hypothesis that the two groups have the same means.

- Question: How would you write up these findings?

Solution:

In conclusion, we could report this to a reader as follows: Mean values were compared for 2 variables with sample size 5194. The mean was higher for variable **SCISCORE** (M=523.5944, SD=102.57804) than for variable **MATHSCORE** (M=501.8590, SD=97.10044). The difference in means (difference = 21.73539) was statistically significant, $t(5193) = 31.505$, $p=.000$.

The evidence here suggests that students were significantly better at science than they were at maths.