

Repeated-Measures t-test

The t-test assesses whether the mean scores from two experimental conditions are statistically different from one another. A *repeated-measures* t-test (also known by other names such as the 'paired samples' or 'related' t-test) is what you should use in situations when your design is **within participants**. In a within participants design, participants contribute data for the dependent variable in **ALL** of the experimental conditions.

If you have a study design where different participants take part in your different experimental conditions, then you have a between-participants design. In this case you would need to use the *independent t-test*. There is a separate tutorial for this type of test.

The following example demonstrates what happens after you have created the data file. See *Tutorial 3: Adding Variables* for how to create your own file.

Running a Repeated-Measures t-test in SPSS

This tutorial will walk you through how to run and interpret a repeated measures t-test in SPSS. In this tutorial we will examine fictional data based on a study by Correll et al (2002) that was inspired by the accidental shooting of Amadou Diallo, a 22-year-old West African, who was mistaken for a rape suspect in New York. Specifically, this study will examine whether race plays a role in the decision to shoot (or not shoot) a suspect.

To investigate this, imagine that we showed participants a series of 80 images of armed and unarmed suspects in a range of situations. Half of the suspects were white and the other half are black. Participants were then be asked to make 'shoot/don't shoot' decisions as accurately as possible in a video-game simulation. They were also asked to respond as quickly as possible to try to simulate the kind of high-pressure, split-second decision that would need to be made in the real world.

As we are interested in the effect the race of the suspect might have on shoot/no-shoot decisions, Suspect Race is our **independent variable**. The two conditions (or levels) would be whether the suspect was black or white. Participants see all of the images in both conditions, so this is a within-participants design.

Unlike the original study, in this case we are **only** interested in whether the race of the suspect affects participants' likelihood of shooting an unarmed suspect (i.e. making an incorrect shoot decision). As such, our **dependent variable** (the thing we are measuring) is the number of 'shoot' decisions that participants made for the unarmed suspects. Scores here range from 0 to 20.

Here is the data file for this example:

	id	black_errors	white_errors	var	var	var	var	var	var
1	1	10	8						
2	2	8	7						
3	3	3	0						
4	4	2	2						
5	5	5	4						
6	6	3	1						
7	7	4	3						
8	8	6	7						
9	9	3	4						
10	10	3	0						
11	11	1	2						
12	12	1	3						
13	13	11	9						
14	14	1	1						
15	15	5	4						
16	16	2	0						
17	17	7	6						

The data above can be found in the SPSS file: 'Week 7 Data.sav'.

The different columns display the following data:

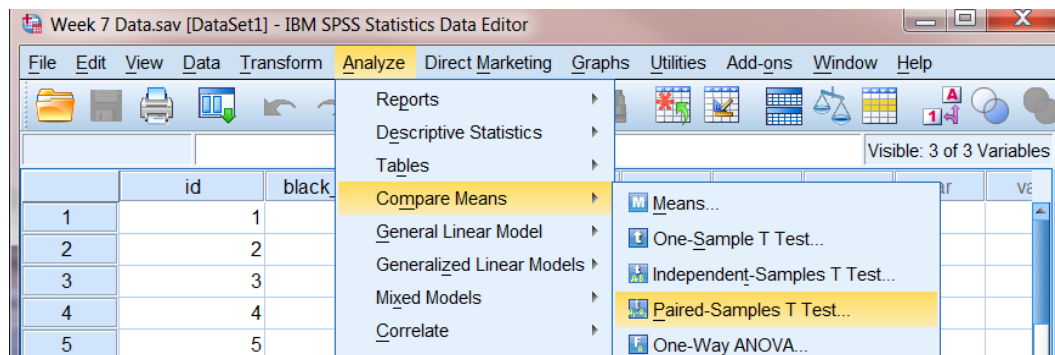
- **id** : This just refers to the ID number assigned to the participants. We use these numbers as identifiers instead of participant names, as this allows us to collect data while keeping the participants anonymous. This is good practice in psychology, especially when collecting potentially sensitive data.
- **black_errors** : This variable represents the number of 'shoot' decisions that participants made for the unarmed suspects when they were black (condition 1 of our IV). The scores entered here make up part of our dependent variable (DV) in this example.
- **white_errors** : This variable represents the number of 'shoot' decisions that participants made for the unarmed suspects when they were white (condition 2 of our IV). The scores entered here make up part of our dependent variable (DV) in this example.

Have you spotted the difference between this data file and the one we used for the independent t-test?

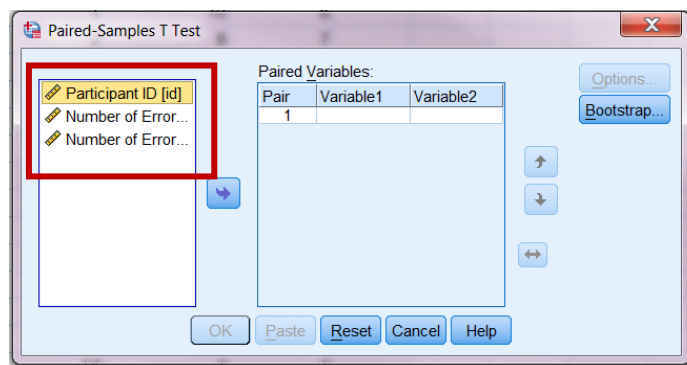
When setting up data files for a **repeated measures t-test** there is no column for the independent variable (IV). Instead, this IV is 'encoded' by the columns representing

the two conditions under which the dependent variable was measured (e.g. black_errors and white_errors). This differs from the independent t-test where the conditions of the independent variable are coded in a single separate column, and the different levels of the IV refer to separate individuals. Please refer back to the *independent t-test tutorial* for an illustration of this.

To start the analysis, we first need to **CLICK** on the **Analyze** menu, select the **Compare Means** option, and then the **Paired-Samples T Test** sub-option.

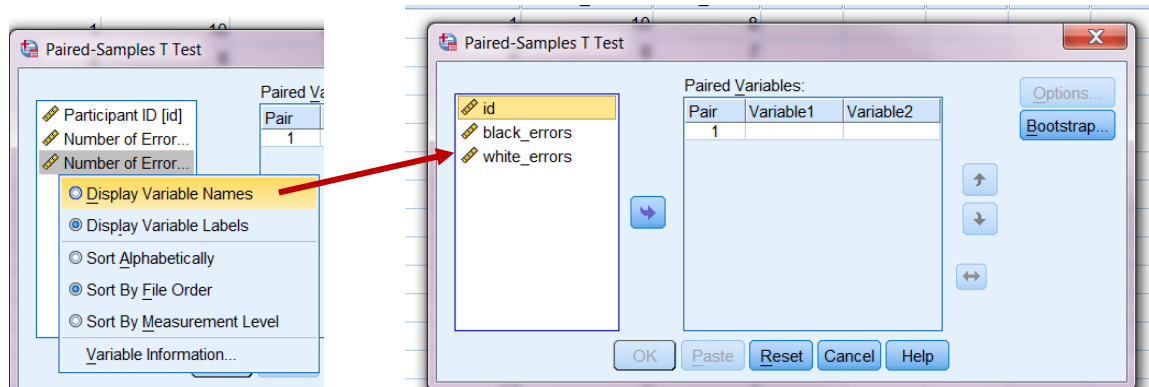


This opens the **Paired-Samples T-Test** dialog box. Here we need to tell SPSS what variables we want to analyse.



You may notice that your variables are now listed in the left hand window. As the Variable Labels are displayed, rather than the shorter Variable Names, they can be difficult to read.

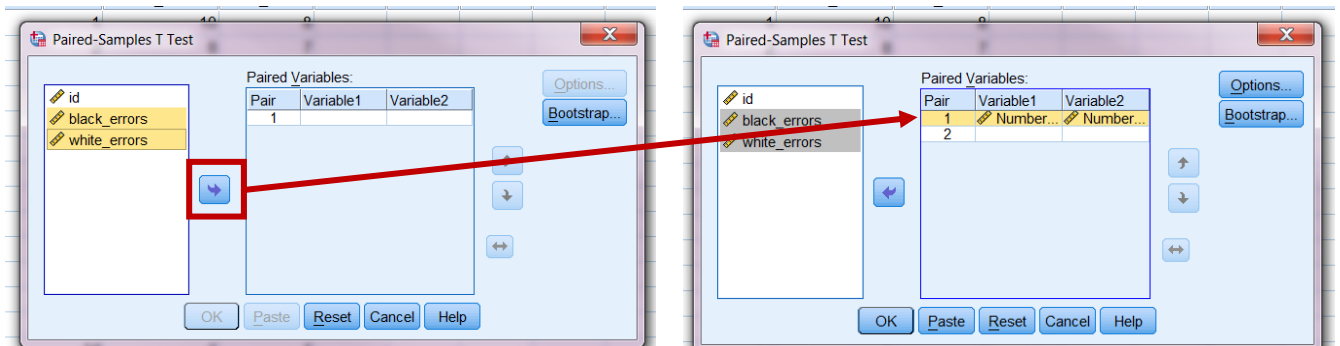
To change this, use your mouse to **right click** in the window and change the display option, as follows:



This changes the variable list so it is easier to read. We can now start the analysis.

To set up the analysis we first need to specify which *pairs* of variables we want to add to the analysis. We only have one sensible pair available here – but if we had more, we could run multiple t-tests simultaneously.

For this example we want to compare the scores in the `black_errors` and `white_errors` conditions. To start the analysis, **SELECT** the both of these conditions (while holding down the **Ctrl** key on your keyboard) and add them to the **Paired Variables** window by **CLICKING** on the arrow button to the right of the variable list.



Now we have told SPSS what conditions we want to compare, **CLICK** on the **OK** button to run the analysis.

You can now view the output from the **repeated measures t-test** in the output viewer.

*Output1 [Document1] - IBM SPSS Statistics Viewer

File Edit View Data Transform Insert Format Analyze Direct Marketing Graphs Utilities Add-ons Window Help

Output

- Log
- T-Test
- Title
- Notes
- Active
- Paired
- Paired
- Paired

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Number of Errors for Unarmed Black Suspects	3.95	44	2.693	.406
	Number of Errors for Unarmed White Suspects	2.80	44	2.539	.383

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Number of Errors for Unarmed Black Suspects & Number of Errors for Unarmed White Suspects	44	.818	.000

Paired Samples Test

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Number of Errors for Unarmed Black Suspects - Number of Errors for Unarmed White Suspects	1.159	1.584	.239	.678	1.641	4.854	43	.000

IBM SPSS Statistics Processor is ready

As the output contains a number of boxes, let's go through each one, one at a time:

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Number of Errors for Unarmed Black Suspects	3.95	44	2.693	.406
	Number of Errors for Unarmed White Suspects	2.80	44	2.539	.383

Paired Samples Statistics

The first table here displays the descriptive statistics for our two conditions. We are mainly interested in the **mean** and the **standard deviation** here. We can see from the two means that participants made a larger amount of 'shoot errors' for black suspects (mean= 3.95) than for white suspects (mean = 2.80). We can also see from the standard deviations that the scores in both conditions are similarly dispersed.

Note the value under **N** refers to the number of participants in each condition. Don't forget though that the same participants take part in both conditions.

QUESTION: Looking at the means in the table, can we accept the hypothesis that more erroneous shoot decisions will be made for black suspects than for white suspects?

ANSWER: While it certainly looks like the participants performed differently under the two experimental conditions, we need further information in the form of **inferential statistics** to tell us whether it is possible to reject the null hypothesis (that there was no real difference between the two conditions) in favour of our research hypothesis.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Number of Errors for Unarmed Black Suspects & Number of Errors for Unarmed White Suspects	44	.818	.000

Paired Samples Correlations

The second table in the SPSS Output tells us how the two conditions relate to one another. This table is not necessary for the interpretation of the t-test results, so feel free to ignore it at this point!

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Number of Errors for Unarmed Black Suspects - Number of Errors for Unarmed White Suspects	1.159	1.584	.239	.678	1.644	4.854	43	.000

Paired Samples Test

The third table is the most important table, as it contains our inferential t-test statistics. This table will help us decide whether there is a statistically significant difference between the conditions, and whether our null hypothesis can be rejected in favour of our research hypothesis.

There are a number of columns included in this table, but the most important ones are the three on the right hand side, outlined in red. These important sections are described below:

- **t - the t-test statistic** : This is the t-value calculated by the repeated measures t-test. This is an important statistic that you will need to report when writing up your findings.

It is an expression of the difference between the scores in your two experimental conditions. The larger the value of t, the more pronounced the difference between your conditions and the smaller the probability that this difference occurred by chance.

- **df** : this stands for **degrees of freedom**. It is an important statistic that needs to be reported, as its value directly impacts the significance of the t-statistic. In a repeated-measures t-test the value of df will be one less than the number of participants in the study (in this case there are 44 participants, so df = 43).

Note: you will encounter df when using many other tests, although the formula for calculating it differs from test to test. For example, the way the df is calculated in a repeated-measures t-test is different to that for an independent t-test.

- **Sig (2-tailed)** : Sig stands for **Significance level**. This column gives you the probability that the results could have occurred by chance (if the null hypothesis was true). The convention is that the p-value should be smaller than or equal to 0.05 for the value of t to be significant. If this is significant can reject the null hypothesis in favour of our experimental hypothesis. If it is larger, we have to retain the null hypothesis that there are no differences between the conditions.

Paired samples t-tests only calculate two-tailed p-values. However if your hypothesis is directional you can make it 1-tailed test by simply halving the p-value.

What do we need from our output?

When writing up the results of your t -test you need to report whether or not the test was significant following this formula:

$$t (df) = \underline{t \text{ value}}, p = \underline{p \text{ value}}$$

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	Number of Errors for Unarmed Black Suspects - Number of Errors for Unarmed White Suspects	1.159	1.584	.239	.678	1.641	4.854	43	.000

...where you insert the relevant numbers into the underlined sections. For this particular example, we have found that the t -test is significant as the p -value is less than 0.05. This is reported as:

$$t(43) = 4.85, p < 0.001$$

So... what do our findings tell us?

When interpreting and writing up your findings you need to use information from *both* the **descriptive** and the **inferential** statistics in your output. It doesn't matter which order you report these two types of statistics, but always finish by interpreting your results meaningfully.

- Step One:** Describe the pattern of your data using the means and standard deviations from the first output table. In this case you could say something like:
Results showed participants made a larger amount of 'shoot errors' for black suspects (mean= 3.95, SD = 2.69) than for white suspects (mean = 2.80, SD = 2.54).
- Step Two:** Report whether or not this difference is *significant*:
A repeated-measures t-test found this difference to be significant, $t(43) = 4.85, p < 0.001$.
- Step Three:** Finally, you need to put this information together to interpret and summarise what you have found in terms of your hypothesis. This should be written *in plain English*, for example:
Together this suggests that race may affect erroneous shoot decisions made for unarmed suspects, supporting our hypothesis.

What next...

Now you have learned how to carry out an Independent t-test using SPSS, why not try downloading the Week 7 data file and see if you can produce the same output on your own?

Remember, practice makes perfect.