Learning Guide: Conducting a Paired Samples t-Test in SPSS

Authored by

Mohammed looti

November 8, 2025

RECOMMENDED CITATION

Mohammed looti (2025). *Learning Guide: Conducting a Paired Samples t-Test in SPSS*. PSYCHOLOGICAL STATISTICS. Retrieved from https://statistics.arabpsychology.com/?p=12948

The Paired Samples t-test, also known as the dependent samples t-test, is a fundamental statistical tool used when comparing the means of two related groups. This test is essential in research designs where observations in one sample are directly linked or matched with observations in the second sample. Common scenarios include "before and after" measurements on the same subjects, or when comparing two different treatments applied to matched pairs (e.g., twins or subjects matched on a key demographic variable).

The core strength of the Paired Samples t-test lies in its ability to control for inter-subject variability. By focusing on the difference between the paired measurements for each subject, rather than the raw means of the two groups, we effectively reduce the noise caused by individual differences. This often results in greater statistical power compared to an Independent Samples t-test, making it the appropriate choice for within-subjects designs. This comprehensive tutorial will guide you through the process of conducting and interpreting a Paired Samples t-test using SPSS Statistics.

The Statistical Rationale for Paired Data

Unlike independent samples, where the data points are assumed to be unrelated, paired data inherently includes a dependency. This relationship must be accounted for in the statistical analysis. If we were to incorrectly use an independent samples t-test on paired data, the standard error calculation would be inflated, potentially leading to a failure to detect a real, significant difference. The paired t-test solves this by calculating a difference score for each pair and then testing whether the mean of these difference scores is significantly different from zero.

To perform this test correctly, two core assumptions must be met: first, the data must consist of dependent pairs (i.e., observations must be related); and second, the distribution of the difference scores (not the raw data itself) must be approximately normally distributed. While SPSS handles the complex calculations, understanding these foundational principles ensures the validity of the final interpretation.

Example: Paired Samples t-test in SPSS

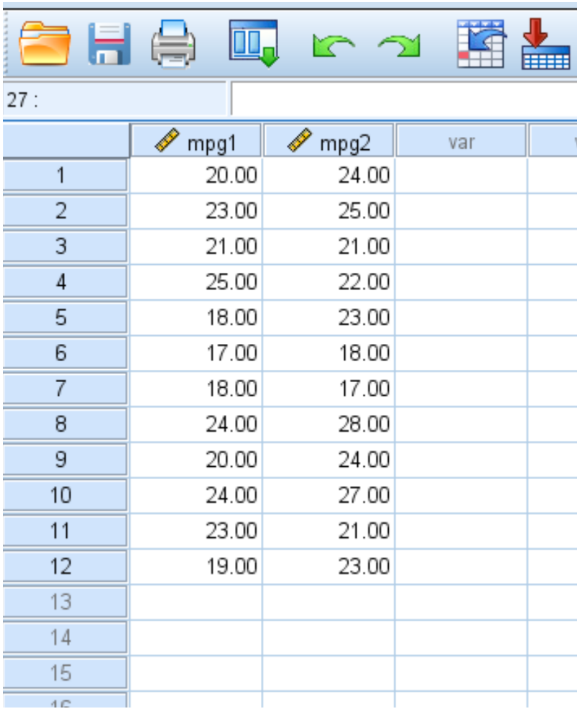
Consider a research scenario where automobile engineers are investigating the effectiveness of a newly developed fuel treatment aimed at improving vehicle mileage. Their primary goal is to determine if this treatment causes a statistically significant change in the average miles per gallon (mpg) achieved by a specific car model. To ensure a rigorous test, they conduct an experiment involving 12 identical cars.

In this design, the mpg is measured twice for each car: once without the fuel treatment (the baseline or control condition) and once after the treatment has been applied. Because each vehicle acts as its own control, the resulting dataset consists of 12 dependent pairs of observations. This experimental structure mandates the use of the Paired Samples t-test to assess the impact of the fuel treatment.

We approach this analysis using formal statistical hypotheses:

H0 (Null Hypothesis): $\mu 1 = \mu 2$. There is no difference in the true average mpg between cars with and without the fuel treatment. Any observed difference is due to random sampling variation.
H1 (Alternative Hypothesis): $\mu 1$? $\mu 2$. There is a statistically significant difference in the true average mpg between the two populations. The fuel treatment has an effect on mileage.

The following data setup in the SPSS environment displays the measurement for each car, labeled as **mpg1** (without treatment) and **mpg2** (with treatment):



	mpg1	mpg2	var
1	20.00	24.00	
2	23.00	25.00	
3	21.00	21.00	
4	25.00	22.00	
5	18.00	23.00	
6	17.00	18.00	
7	18.00	17.00	
8	24.00	28.00	
9	20.00	24.00	
10	24.00	27.00	
11	23.00	21.00	
12	19.00	23.00	
13			
14			
15			

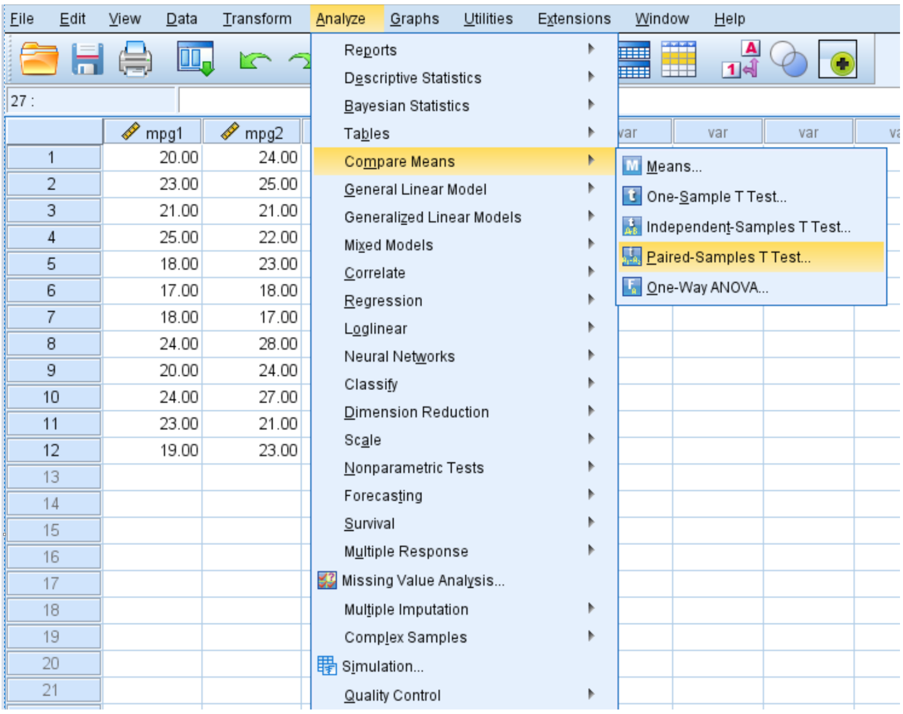
Our subsequent steps will involve processing this data in SPSS to determine whether the magnitude of the observed difference is large enough to reject the null hypothesis at a predefined significance level, typically $\alpha = 0.05$.

Executing the Paired Samples t-test in SPSS

Once the data is correctly entered into the SPSS Data View, performing the Paired Samples t-test is straightforward. The process involves navigating the menu structure to specify the two variables that form the dependent pairs.

Step 1: Choose the Paired-Samples T Test option.

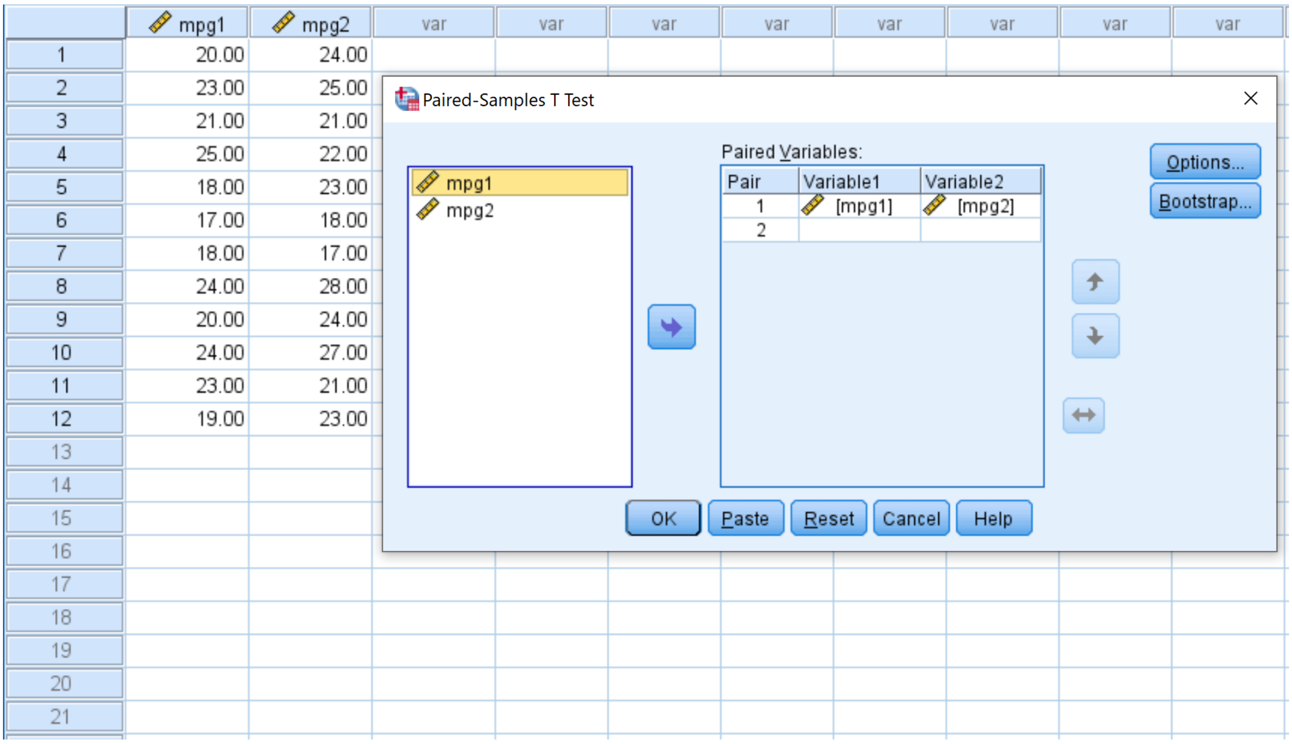
To initiate the analysis, click the **Analyze** tab located in the main menu bar. Hover over **Compare Means** to reveal the submenu, and then select the **Paired-Samples T Test** option. This sequence directs SPSS to the appropriate procedure for handling dependent measurements.



Step 2: Fill in the necessary values to perform the test.

The Paired-Samples T Test dialog box requires the user to define the pairs being compared. Since we are comparing the mpg before (mpg1) and after (mpg2) the treatment, these variables must be assigned correctly to form the pair.

Drag the baseline measurement, **mpg1**, into the box labeled **Variable1** under the Paired Variables section. Subsequently, drag the post-treatment measurement, **mpg2**, into the box labeled **Variable2**. Ensure that both variables appear under the same pair number. Once the variables are correctly assigned, click **OK** to execute the analysis. SPSS will then generate the output viewer displaying the results across several tables.



Interpreting the SPSS Output Tables

The SPSS output for the paired samples t-test typically consists of three distinct tables: Paired Samples Statistics, Paired Samples Correlations, and the final Paired Samples Test. Careful examination of all three tables is necessary for a complete and accurate interpretation of the results.

Paired Samples Statistics

The first table provides essential descriptive statistics for both variables, allowing the researcher to immediately quantify and visualize the difference between the two conditions before proceeding to the inferential test. This summary is crucial for understanding the raw data characteristics.

N: This column indicates the sample size of each group, confirming that 12 pairs (cars) were included in the analysis.
Mean: This is the arithmetic average mpg for cars in each group. We can observe that the mean mpg for Pair 2 (post-treatment) is slightly higher than for Pair 1 (pre-treatment), suggesting a potential positive effect of the fuel additive.
Std. Deviation: This measures the spread or variability of the mpg scores around the mean for each group. Lower standard deviations suggest more consistent performance within the group.
Std. Error Mean: This is an estimate of the standard deviation of the sampling distribution of the mean, calculated as the standard deviation divided by the square root of N (s/√n). It is used

primarily in calculating confidence intervals.

Paired Samples Correlations

The second table quantifies the linear relationship between the two paired variables. This correlation coefficient (r) is a key diagnostic statistic in paired designs, as it confirms the degree of dependency between the two measurements.

A high, statistically significant correlation (P-value < 0.05 in the correlation table) indicates that the two measurements are highly related, which is precisely why the paired t-test is appropriate. If the correlation were weak or non-significant, the benefits of using a paired design (i.e., reduced error variance) would be minimal. In our example, a strong positive correlation would suggest that the cars that performed well initially (mpg1) also tended to perform well after treatment (mpg2), regardless of the overall treatment effect.

Analyzing the Core Paired Samples Test Results

The third and most critical table, the Paired Samples Test, contains the inferential statistics required to test the null hypothesis. This table focuses on the mean difference score and determines if it is statistically significant.

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	mpg1	21.0000	12	2.73030	.78817
	mpg2	22.7500	12	3.25087	.93845

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	mpg1 & mpg2	12	.604	.037

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	mpg1 - mpg2	-1.75000	2.70101	.77971	-3.46614	-.03386	-2.244	11	.046

The crucial elements within this table are:

Mean Difference: This is the average of the difference scores (mpg1 - mpg2) across all 12 cars. A negative mean difference, as observed in this output, indicates that mpg2 (with treatment) was generally higher than mpg1 (without treatment).

t-statistic: The test statistic, found to be **-2.244**. This value represents the ratio of the observed mean difference to the standard error of the mean difference. Essentially, it tells us how many standard errors the mean difference is away from zero. A larger absolute value of t indicates a greater likelihood of statistical significance.

df (Degrees of Freedom): The degrees of freedom for the paired t-test are calculated as the number of pairs minus one (#pairs - 1). Here, df = 12 - 1 = **11**. This value is essential for consulting the t-distribution table to find the critical t-value.

Sig. (2-tailed): This is the calculated p-value, which corresponds to the probability of observing a t-statistic as extreme as -2.244 (or more extreme) if the null hypothesis were true. The p-value obtained is **.046**.

The decision rule is based on comparing the p-value to the chosen significance level (α). Since the calculated p-value of 0.046 is less than the conventional alpha level of 0.05, we must reject the null hypothesis (H0). This provides sufficient statistical evidence to conclude that the true mean mpg is significantly different between cars that receive the fuel treatment and those that do not.

Drawing Conclusions and Reporting the Findings

The final step in any statistical analysis is to synthesize the findings and report them clearly and concisely, typically adhering to established standards such as those set by the American Psychological Association (APA).

Interpreting the Confidence Interval

The Paired Samples Test output also provides a 95% Confidence Interval (CI) for the true difference in population means. In this example, the interval is (-3.466, -.034). Crucially, because this interval does not contain zero, it reinforces the decision to reject the null hypothesis. If zero were contained within the interval, it would suggest that a mean difference of zero is plausible, leading to a failure to reject H0. Since both the lower bound (-3.466) and the upper bound (-.034) are negative, we are 95% confident that the fuel treatment results in an increase in mpg.

Reporting the Results (APA Style Example)

When reporting the results, it is essential to include the type of test performed, the sample size, the t-statistic, the degrees of freedom, and the precise p-value. This allows readers to independently evaluate the statistical decision.

Here is an example of how to formally report the results of the paired samples t-test:

A paired t-test was conducted on 12 cars to determine if a new fuel treatment led to a difference in mean miles per gallon.

Results showed that the mean mpg was statistically significantly different between the two groups ($t = -2.244$, $df = 11$, $p = .046$) at a significance level of 0.05. The mean mpg with the treatment (M =) was higher than the mean mpg without the treatment (M =).

A 95% confidence interval for the true difference in population means resulted in the interval of (-3.466, -.034), indicating that the true increase in mpg due to the treatment lies between 0.034 and 3.466 mpg.

The successful execution and interpretation of the Paired Samples t-test in SPSS confirm that the fuel treatment had a statistically significant, positive effect on the mileage of the tested vehicles.