Learn How to Perform an Independent Samples t-Test in SPSS

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The Two-Sample t-test, sometimes referred to as the independent samples t-test, is a fundamental statistical procedure used extensively across various disciplines, including social sciences, engineering, and market research. Its primary purpose is to determine whether a statistically significant difference exists between the means of two independent groups or populations.

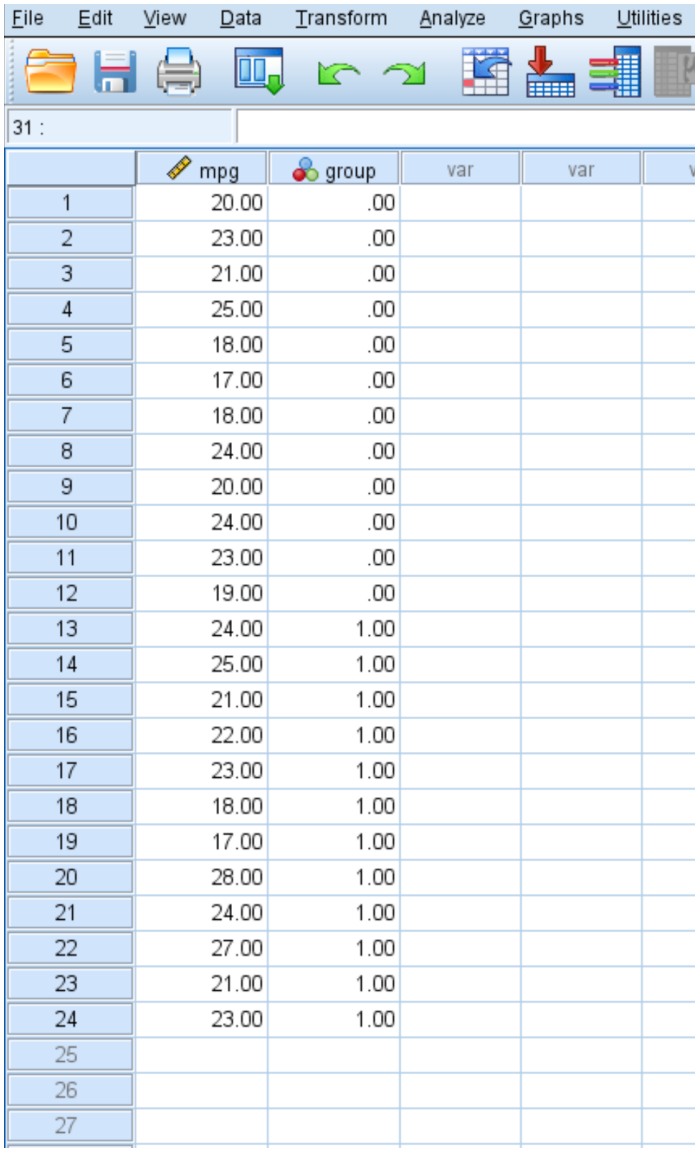
This test is crucial when comparing the effectiveness of two different treatments, the performance of two distinct product versions, or analyzing demographic differences in outcome variables. Understanding how to correctly execute and interpret this test using statistical software like SPSS (Statistical Package for the Social Sciences) is a critical skill for any data analyst or researcher. This comprehensive tutorial provides a step-by-step guide on performing and interpreting the Two-Sample t-test within the SPSS environment.

The Research Scenario and Data Setup

To illustrate the procedure, consider a practical research question: Do new fuel additives affect vehicle efficiency? Researchers are interested in determining if a recently developed fuel treatment leads to a quantifiable change in the average miles per gallon (mpg) achieved by a specific model of car. To investigate this, they designed a controlled experiment.

The experiment involved a total of 24 identical cars. These cars were randomly assigned to two groups: 12 cars received the new fuel treatment (Treatment Group), and 12 cars did not (Control Group). After a standardized testing period, the mpg was recorded for every vehicle. The goal is to compare the average mpg between these two independent groups.

The following image displays the data as entered into the SPSS Data View. Notice the grouping variable, where **0** represents the control group (no fuel treatment) and **1** represents the experimental group (fuel treatment). This structure is essential for executing the independent samples test correctly.



	mpg	group	var	var
1	20.00	.00		
2	23.00	.00		
3	21.00	.00		
4	25.00	.00		
5	18.00	.00		
6	17.00	.00		
7	18.00	.00		
8	24.00	.00		
9	20.00	.00		
10	24.00	.00		
11	23.00	.00		
12	19.00	.00		
13	24.00	1.00		
14	25.00	1.00		
15	21.00	1.00		
16	22.00	1.00		
17	23.00	1.00		
18	18.00	1.00		
19	17.00	1.00		
20	28.00	1.00		
21	24.00	1.00		
22	27.00	1.00		
23	21.00	1.00		
24	23.00	1.00		
25				
26				
27				

Formulating Hypotheses and Setting the Significance Level

Before executing any statistical test, it is essential to formally state the null hypothesis (H?) and the alternative hypothesis (H?). These hypotheses define the scope of the statistical inference and guide the final decision regarding the research question.

In this scenario, we are testing for any difference in the average miles per gallon between the two groups. Let μ? represent the true average mpg for the treatment group, and μ? represent the true average mpg for the control group. The hypotheses are constructed as follows:

H0: μ**1** = μ**2** (The average mpg between the two populations is statistically equal; the fuel treatment has no effect.)
H1: μ**1** ? μ**2** (The average mpg between the two populations is not equal; the fuel treatment has a

statistically significant effect.)

This is a two-tailed test because the alternative hypothesis specifies that the means are simply unequal (i.e., the treatment could either increase or decrease mpg). We will use a standard significance level to make our decision.

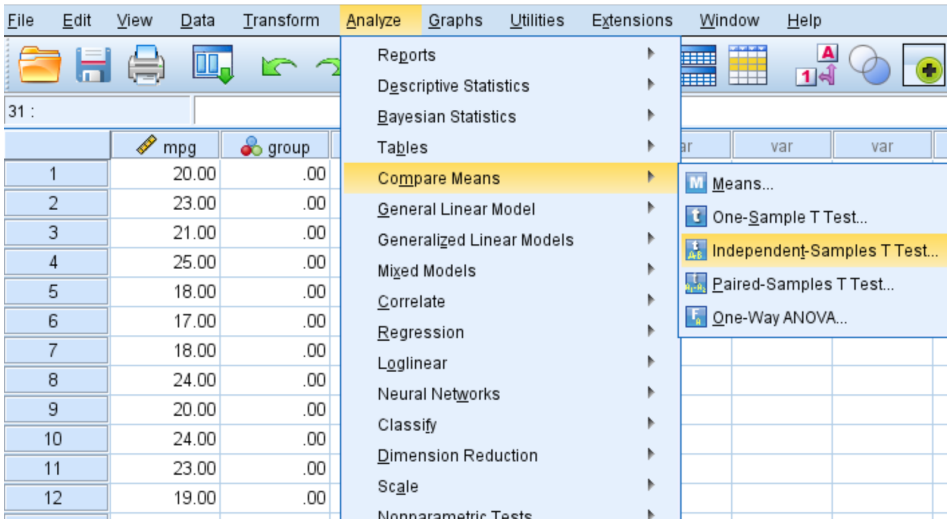
We will use a significance level of α ***= 0.05****.*

Executing the Independent-Samples T Test in SPSS

The execution of the Two-Sample t-test in SPSS is straightforward, requiring specific navigation through the menu options to correctly define the test and grouping variables.

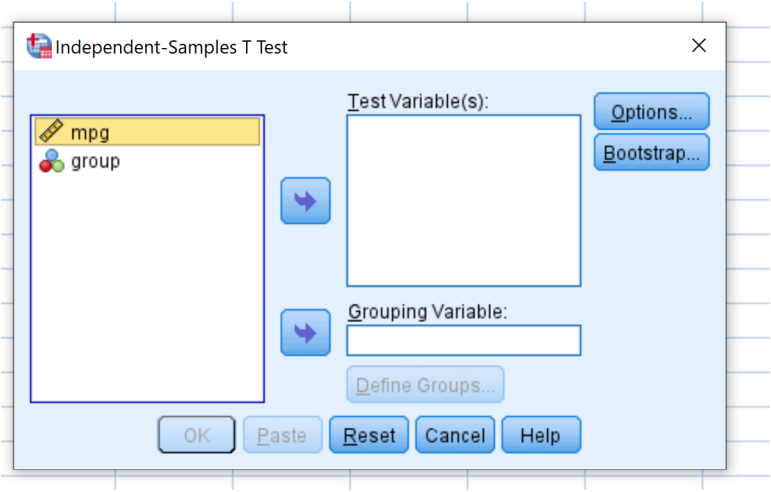
Step 1: Choose the Independent Samples T Test option.

To begin the analysis, navigate through the top menu bar. Click the **Analyze** tab, hover over **Compare Means**, and then select the **Independent-Samples T Test** option. This specific path tells SPSS that you are comparing the means of two distinct, non-related groups.

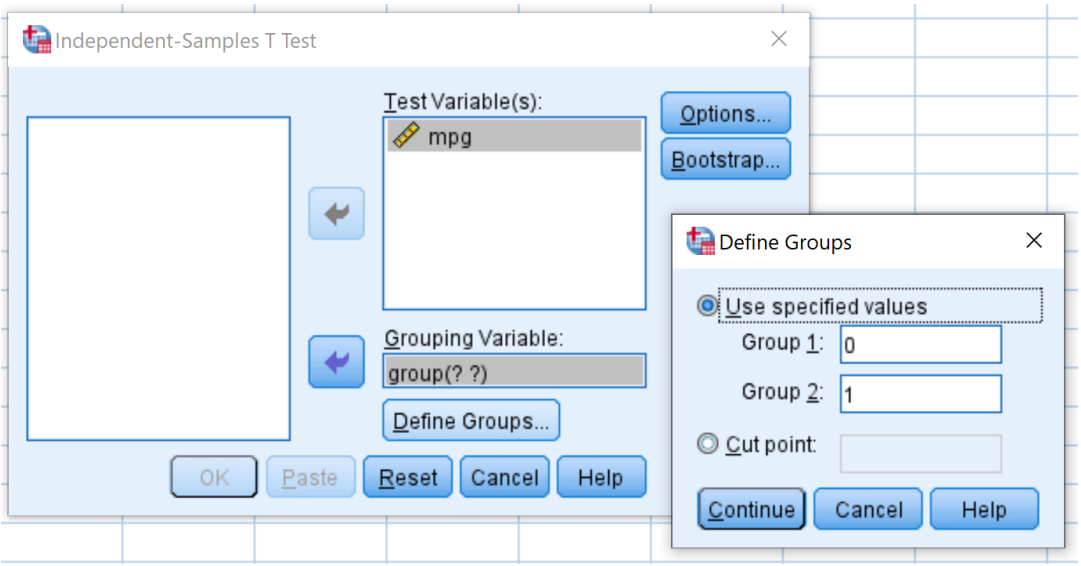


Step 2: Define Variables and Groups.

Once the **Independent-Samples T Test** dialog box appears, you must accurately define which variable is the measure being tested and which variable defines the groups. Drag the continuous variable, **mpg**, into the box labeled **Test Variable(s)**. Then, drag the categorical variable, **group**, into the box labeled **Grouping Variable**.



Since the grouping variable is numerical (0 and 1), SPSS needs clarification on what these numbers represent. Click **Define Groups**. Define Group 1 as the rows with the value **0** (Control) and define Group 2 as the rows with the value **1** (Treatment). After confirming these definitions, click **Continue** and then **OK** to run the analysis and generate the statistical output.



Interpreting the SPSS Output: Group Statistics

Upon execution, the SPSS Output Viewer displays the results, starting with the descriptive statistics provided in the **Group Statistics** table. This table summarizes the data for each independent group and provides essential context before diving into the inferential tests.

T-Test

Group Statistics

	group	N	Mean	Std. Deviation	Std. Error Mean
mpg	.00	12	21.0000	2.73030	.78817
	1.00	12	22.7500	3.25087	.93845

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
mpg	Equal variances assumed	.034	.855	-1.428	22	.167	-1.75000	1.22552	-4.29157	.79157
	Equal variances not assumed			-1.428	21.362	.168	-1.75000	1.22552	-4.29597	.79597

The first table displays the following key summary statistics for both groups:

N: The sample size for each specific group (N=12 in both cases).
Mean: The calculated average mpg of cars in each group. The difference between these means is what the t-test statistically evaluates.
Std. Deviation: The standard deviation, which measures the variability of the mpg scores around the mean within each group.
Std. Error Mean: The standard error of the mean mpg, calculated as s/√n, which estimates the precision of the sample mean relative to the true population mean.

Interpreting the SPSS Output: Independent Samples Test

The second table, the **Independent Samples Test**, contains the core inferential results. It begins with Levene's Test for Equality of Variances, which determines whether the variances of the two groups are statistically similar. This decision dictates which row of the t-test results we should use.

In this case, the significance value (Sig.) for Levene's Test is 0.906. Since this value is greater than our $\alpha = 0.05$, we conclude that the variances are equal (Equal variances assumed). Therefore, we proceed by referring to the results presented in the first row.

The key statistics for the t-test (Equal variances assumed row) are interpreted as follows:

t: The calculated test statistic, found to be **-1.428**. This value quantifies the magnitude of the difference between the group means.
df: The degrees of freedom, calculated as n? + n? - 2 = 12 + 12 - 2 = **22**.
Sig. (2-tailed): This is the calculated p-value (0.167). This is the probability of observing a difference as extreme as the one we found, assuming the null hypothesis is true.
Mean Difference: The raw difference between the two sample means (Mean? - Mean?).

Std. Error Difference: The standard error used in the calculation of the t-statistic.
95% C.I. of the Difference: This is the 95% confidence interval for the true difference between the two population means.

Conclusion and Decision Making

The final step in the hypothesis test is comparing the calculated p-value (Sig. 2-tailed) to our predetermined significance level ($\alpha = 0.05$) to decide whether to reject or fail to reject the null hypothesis (H?).

From the SPSS output (Equal variances assumed row), the calculated p-value (Sig. 2-tailed) is **0.167**.

Decision Rule: We reject the null hypothesis if the p-value is less than or equal to the significance level (α).

Since the p-value (0.167) is significantly greater than the significance level (0.05), we **fail to reject the null hypothesis**.

In conclusion, based on this two-sample t-test, we do not have sufficient statistical evidence to claim that the true mean miles per gallon is different between cars that received the new fuel treatment and cars that did not. Any observed difference in the sample averages is likely attributable to random sampling error rather than a genuine effect of the treatment.