

Independent t -test

The t -test assesses whether the means of two groups, or conditions, are statistically different from one other. They are reasonably powerful tests used on data that is parametric and normally distributed.

t -tests are useful for analysing simple experiments or when making simple comparisons between levels of your independent variable. The two most common variants of the t -test are:

- The **independent t -test**, which is used when you have two separate groups of individuals or cases in a between-participants design (for example: male vs female; experimental vs control group).
- The **repeated-measures t -test** (also known as the paired-samples or related t -test), which is used when participants provide data for each level or condition of the independent variable in a within-participants design (for example, before and after an intervention).

For this tutorial we will focus on the independent t -test. There is another tutorial for the repeated-measures t -test. The reason for separating them is that the data files are setup differently, and they produce different types of output.

The following example demonstrates what happens after you have created the data file. See the earlier tutorial on *Adding Variables* to see how to create your own file.

Worked Example: Doing an Independent t -test in Jamovi

This tutorial will walk you through how to run and interpret an independent t -test. The example is based on a study by Shotland and Straw (1976), who were interested in how the perceived relationship between a couple fighting may affect the likelihood of somebody intervening.

To test this, participants were split into **two groups** and asked to watch a video of two people fighting. The videos were identical, except for one crucial line.

1. One group sees the victim shouting: "leave me alone, I don't know you".
2. While the other group sees her saying: "leave me alone, I should never have married you".

Participants were then asked to rate how willing they would be to intervene on a scale of 1–5.

This is what the data looks like in Jamovi.

Variables Data Analyses Edit			
Exploration T-Tests ANOVA Regression Frequencies Factor			
ID_No	Group	Willingness_Score	
1	1 Perceived Relationship	Strongly Disagree	
2	2 Perceived Relationship	Disagree	
3	3 Perceived Relationship	Neither Agree Nor Disagree	
4	4 Perceived Relationship	Strongly Disagree	
5	5 Perceived Relationship	Strongly Disagree	
6	6 Perceived Relationship	Disagree	
7	7 Perceived Relationship	Strongly Disagree	
8	8 Perceived Relationship	Strongly Disagree	
9	9 Perceived Relationship	Strongly Disagree	
10	10 Perceived Relationship	Neither Agree Nor Disagree	
11	11 Perceived Relationship	Strongly Disagree	
12	12 Perceived Relationship	Strongly Disagree	
13	13 Perceived Relationship	Disagree	
14	14 Perceived Relationship	Strongly Disagree	
15	15 Perceived Relationship	Strongly Disagree	
16	16 Perceived Relationship	Strongly Disagree	
17	17 Perceived Relationship	Disagree	
18	18 Perceived Relationship	Disagree	
19	19 Perceived Relationship	Neither Agree Nor Disagree	
20	20 Perceived Relationship	Disagree	
21	21 Perceived Strangers	Strongly Disagree	
22	22 Perceived Strangers	Disagree	
23	23 Perceived Strangers	Strongly Disagree	
24	24 Perceived Strangers	Disagree	
25	25 Perceived Strangers	Neither Agree Nor Disagree	
26	26 Perceived Strangers	Disagree	
27	27 Perceived Strangers	Neither Agree Nor Disagree	
28	28 Perceived Strangers	Agree	
29	29 Perceived Strangers	Neither Agree Nor Disagree	
30	30 Perceived Strangers	Disagree	
31	31 Perceived Strangers	Neither Agree Nor Disagree	

For an independent *t*-test the data file should have *at least* two columns: one for the independent variable, and one for the dependent variable.

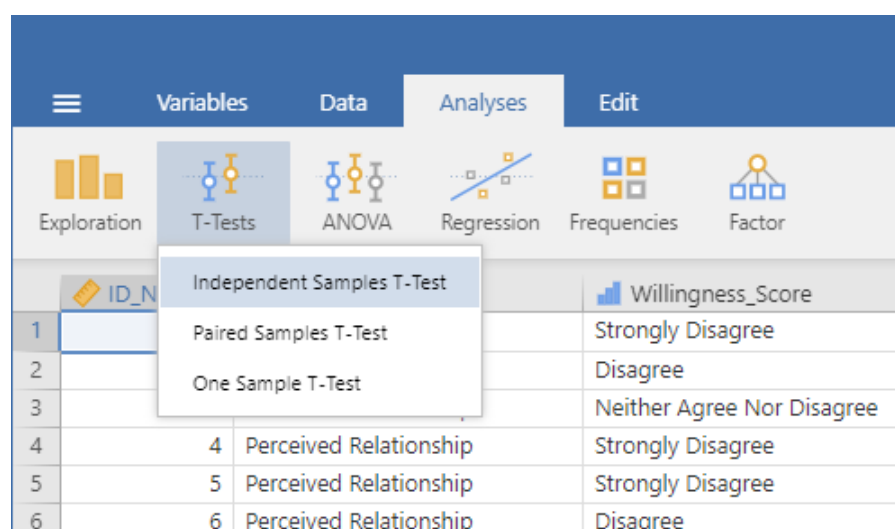
Each column represents a different variable, and each row contains the data from one participant. The different columns display the following data:

- The **ID_No** variable refers to the ID number assigned to each participant. We use 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.

- The variable **Group** tells you which experimental condition participants are in. This is our *Independent Variable*. In this example, participants were split into two groups:
 1. Perceived Relationship
 2. Perceived Strangers
- **Willingness_Score** is a self-report rating of how willing participants would be to intervene in the fight they witnessed. This is our *Dependent Variable*. In our example this score is rated using a 5-point Likert scale ranging from Strongly Disagree to Strongly Agree, with Strongly Agree indicating the likelihood of intervention.

As mentioned at the beginning of this tutorial, the independent *t*-test compares the scores of two groups on a certain variable. In this case, we want to compare the willingness scores of the two experimental groups.

To start the Independent *t*-test analysis, click on Analyses, select T-Tests and click “Independent Samples T-test”.



This brings up the Independent Samples T-test dialog box.

Independent Samples T-Test

Variables: ID_No, Group, Willingness_Score

Dependent Variables:

Grouping Variable:

Tests

☒ Student's

☐ Bayes factor

Prior: 0.707

☐ Welch's

☐ Mann-Whitney U

Hypothesis

☒ Group 1 $\neq$ Group 2

☐ Group 1 $>$ Group 2

☐ Group 1 $<$ Group 2

Missing values

☒ Exclude cases analysis by analysis

☐ Exclude cases listwise

Additional Statistics

☐ Mean difference

☐ Confidence interval 95 %

☐ Effect size

☐ Confidence interval 95 %

☐ Descriptives

☐ Descriptives plots

Assumption Checks

☐ Homogeneity test

☐ Normality test

☐ Q-Q plot

Here we can see all our variables from the data file displayed in the box on the left.

To tell Jamovi what we want to analyse we need to move our variables to the correct boxes on the right.

First, **SELECT** the Willingness_Score in the left-hand box and **CLICK** on the arrow to move it to the right-hand box titled Dependent Variables.

Then, **SELECT** the Group variable in the left-hand box and **CLICK** on the arrow to move it to the right-hand box titled Grouping Variables.

Before running the *t*-test, we will want to check Homogeneity using the Levene's test. To do this, go to **Assumption checks** and select:

- Homogeneity test.

Independent Samples T-Test

ID_No

→

Dependent Variables

Willingness_Score

→

Grouping Variable

Group

Tests

☒ Student's
☐ Bayes factor

Prior 0.707

☐ Welch's
☐ Mann-Whitney U

Hypothesis

☒ Group 1 ≠ Group 2
☐ Group 1 > Group 2
☐ Group 1 < Group 2

Missing values

☒ Exclude cases analysis by analysis
☐ Exclude cases listwise

Additional Statistics

☐ Mean difference

☐ Confidence interval 95 %

☐ Effect size

☐ Confidence interval 95 %

☐ Descriptives
☐ Descriptives plots

Assumption Checks

☒ Homogeneity test
☐ Normality test
☐ Q-Q plot

Results

Independent Samples T-Test

	Statistic	df	p
Willingness_Score Student's t	-2.33*	38.00	0.025

Note. H_a H₀ Perceived Relationship ≠ H₀ Perceived Strangers

* Levene's test is significant (p < .05), suggesting a violation of the assumption of equal variances

Assumptions

Homogeneity of Variances Test (Levene's)

	F	df	df2	p
Willingness_Score	5.01	1	38	0.031

Note. A low p-value suggests a violation of the assumption of equal variances

[3]

References

[1] The Jamovi project (2022). *jamovi*. (Version 2.3) [Computer Software]. Retrieved from <https://www.jamovi.org>.

The output on the right-hand side will update, depending on which boxes we select.

Assumptions

Homogeneity of Variances Test (Levene's)				
	F	df	df2	p
Willingness_Score	5.01	1	38	0.031

Note. A low p-value suggests a violation of the assumption of equal variances

[3]

The **second** table in the output window, titled **Assumptions**, shows us the result of Levene's test for equality of variances. This test is significant ($p = .031$, which is less than .05), meaning that equal variances cannot be assumed.

Because of this, when we run the independent t -test, we should use Welch's correction for unequal variances.

To run Welch's t -test, unselect Student's under **Tests** and select Welch's. Then make sure that under **Additional Statistics** you've selected

- Mean difference
- Effect size
- Descriptives

Lastly, we need to go to the **Hypothesis section** and specify whether we have a two-tailed (non-directional) or one-tailed (directional) hypothesis.

Two-tailed: If your hypothesis is that there will be a difference between the groups, but you do not specify which group you expect to have higher scores than the other, then your hypothesis is two-tailed as either group scoring significantly higher than the other would support your hypothesis. That is, the difference can be in two directions. For a two-tailed hypothesis you would choose:

Hypothesis
☒ Group 1 $\neq$ Group 2
☐ Group 1 $>$ Group 2
☐ Group 1 $<$ Group 2

(Which means Group 1 *will not be equal to* Group 2.)

One-tailed hypothesis: If your hypothesis is that there will be a particular difference between the groups (for example, that those who perceive the couple as strangers would be more likely to intervene) then your hypothesis is one-tailed, as only significantly higher scores from that one group over the other group would support your hypothesis. For a one-tailed hypothesis you need to select one of the options below, specifying the direction of your prediction (Group 1 will have higher [$>$] scores than Group 2, or Group 1 will have lower [$<$] scores than Group 2).

☐ Group 1 $>$ Group 2
☐ Group 1 $<$ Group 2

In the current example, our hypothesis is that the perceived relationship between the people fighting will have an effect on participants' willingness to intervene. As there is no specific direction to this hypothesis, this is two-tailed. Therefore, we select this box:

Hypothesis

- ☒ Group 1 $\neq$ Group 2
- ☐ Group 1 $>$ Group 2
- ☐ Group 1 $<$ Group 2

Once this has all been done your selection should mirror the image below, and the output will update on the right-hand side of the window.

The screenshot shows the SPSS 'Independent Samples T-Test' dialog box on the left and the 'Results' output window on the right.

Independent Samples T-Test Dialog:

- Dependent Variable(s): Willingness_Score
- Grouping Variable: Group
- Tests: ☒ Welch's (Prior: 0.707), ☐ Student's, ☐ Bayes factor, ☐ Mann-Whitney U
- Hypothesis: ☒ Group 1 $\neq$ Group 2, ☐ Group 1 $>$ Group 2, ☐ Group 1 $<$ Group 2
- Missing values: ☒ Exclude cases analysis by analysis, ☐ Exclude cases listwise
- Additional Statistics: ☒ Mean difference, ☐ Confidence interval 95%, ☒ Effect size, ☐ Confidence interval 95%, ☒ Descriptives, ☐ Descriptives plots
- Assumption Checks: ☒ Homogeneity test, ☐ Normality test, ☐ Q-Q plot

Results Output:

Independent Samples T-Test

	Statistic	df	p	Mean difference	SE difference	Effect Size		
Willingness_Score	Welch's t	-2.33	31.58	0.026	-0.75	0.32	Cohen's d	-0.74

Note: H₀: μ Perceived Relationship = μ Perceived Strangers

Assumptions

Homogeneity of Variances Test (Levene's)

	F	df	df2	p
Willingness_Score	5.01	1	38	0.031

Note: A low p-value suggests a violation of the assumption of equal variances [3]

Group Descriptives

	Group	N	Mean	Median	SD	SE
Willingness_Score	Perceived Relationship	20	1.60	1.00	0.75	0.17
	Perceived Strangers	20	2.35	2.00	1.23	0.27

The output

So, what does the output show you? Let's look at the tables one at a time.

Group Descriptives:

We are going to look at the third and final box in our output first, as it provides us with descriptive statistics for the groups. It is always useful to inspect this box before you look at anything else, as it allows you to gain initial insight into the pattern of your data.

Group Descriptives

	Group	N	Mean	Median	SD	SE
Willingness_Score	Perceived Relationship	20	1.60	1.00	0.75	0.17
	Perceived Strangers	20	2.35	2.00	1.23	0.27

In this table you can see that the mean willingness score for participants in the perceived relationship condition is **1.60**, and **2.35** in the perceived strangers condition. In addition, you can see from the standard deviations that the variation in the data (i.e. spread of scores) is a little wider for the strangers group (**SD=1.23**) than the relationship group (**SD=0.75**). It is standard practice to report these descriptive statistics when reporting your results.

So, by looking at your means you can see that, on average, participants who thought the fighting couple were in a relationship with one another were less likely to be willing to intervene than those who thought the couple were strangers.

But how should you interpret the difference between the means? To find out whether this observed difference between the scores is statistically significant, you next need to look at the first table in our output, titled: Independent Samples T-Test.

Independent Samples T-test:

The first table in our output gives us our *t*-test statistics. We will go through all the columns and statistics that you will need to understand and write up your independent samples *t*-test.

Independent Samples T-Test

Independent Samples T-Test

		Statistic	df	p	Mean difference	SE difference	Effect Size
Willingness_Score	Welch's t	-2.33	31.58	0.026	-0.75	0.32	Cohen's d -0.74

Note. $H_0: \mu \text{ Perceived Relationship} = \mu \text{ Perceived Strangers}$

Statistic (t-test statistic): This is the value of *t*-test statistic that Jamovi has calculated. The *t*-value may be negative or positive, depending on our groups. In this case, it is negative because one group (Perceived relationship) had a lower mean than our other group (Perceived strangers). If our Perceived relationship

group had a higher mean than our Perceived stranger group, then the t -value would be positive (but still have the same numeric value of 2.33). While you should report whether the value is positive or negative, the important thing here is the size (or magnitude) of t . The larger the value of t , the smaller the probability that the results occurred by chance.

Df – Degrees of Freedom: You will come across degrees of freedom in most statistical tests. It is a value we use to represent the size of the sample or samples used in a statistical test, and it needs to be reported.

The way that degrees of freedom are calculated varies for different statistical tests, but they must be calculated correctly before a test result can be checked for significance. Don't worry too much about this, as Jamovi automatically calculates the value for you, but it might be useful to note that with independent t -tests the df is always close to the total number of participants.

P (Significance): The significance columns give us the significance value (or p -value) for our test. If the value is smaller than .05, then the result is statistically significant. If it is larger, so statistically non-significant, then we reject our hypothesis in favour of the null hypothesis, which is that there is no difference between the two groups.

Effect size – Cohen's d : To measure effect size for the independent t -test, we generally use Cohen's d . This is calculated by taking the difference between the group means and dividing it by the average standard deviation of the groups. The magnitude of the effect size can tell you how much of an effect your experimental manipulation has had.

Cohen (1988) suggested that values of 0.8 or greater can be seen as large effect sizes; values of 0.5 to 0.79 are medium effect sizes, and values of 0.2 to 0.49 are small effect sizes. Values smaller than 0.2 are very small.

When reporting Cohen's d , ignore whether the value is positive or negative, and simply report the number itself after the t -test statistics (in this case $d = .074$).

Writing up your t-test results

Independent Samples T-Test

Independent Samples T-Test							
		Statistic	df	p	Mean difference	SE difference	Effect Size
Willingness_Score	Welch's t	-2.33	31.58	0.026	-0.75	0.32	Cohen's d -0.74

Note. $H_a: \mu$ Perceived Relationship $\neq \mu$ Perceived Strangers

When writing up the results of your t-test you need to report whether the test was significant following this formula:

$$t(df) = t \text{ value}, p = p \text{ value}, d = \text{Cohen's } d \text{ value}$$

...where you insert the relevant numbers from our table into the formula. For this example, we have found that the t-test is significant as the p-value is less than 0.05 ($p < .05$). This is reported as:

$$t(31.58) = -2.33, p = .026, d = .074$$

Alternatively, Cohen's d can be commented on separately:

$$t(31.58) = -2.33, p = .026. \text{ There was a medium effect size } (d = .074).$$

Putting it all together

When interpreting and writing up your findings you need to use information from the different tables provided in your output, and finish by clearly interpreting your results. For example:

Step One: Describe the pattern of your data using the means and standard deviations. In this case you could say something like:

Results showed participants who saw a relationship between the couple had lower willingness scores ($M = 1.60, SD = .75$) than those who did not ($M = 2.35, SD = 1.23$).

Step Two: Use both words and numbers to formally report whether this difference is *significant*, and comment on the effect size:

An independent t-test found this pattern to be significant, $t(31.58) = -2.33, p < .05$.
There was a medium effect size ($d = .074$).

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 the perceived relationship between the victim and perpetrator affects participants' willingness to intervene, supporting our hypothesis.

What next?

Now you have learned how to carry out an independent t -test using Jamovi, why not try downloading the data file from this tutorial to see if you can produce the same output on your own? Remember, practice makes perfect.