

Chapter 5: *t* test for independent samples

***This chapter corresponds to chapter 10 of your book (“t(ea) for Two”).*

What it is: The *t* test for independent samples is used to determine whether the means of two groups are significantly different. It is called a *t* test for *independent* samples because you use it when you are comparing two groups that are composed of different people (i.e., groups that are independent of each other).

When to use it: Per the flow chart on page 173 of Salkind (2008), you would use the *t* test for independent samples when:

- (1) you are examining differences between groups (as opposed to examining the relationship between two variables) and
- (2) the participants in the study were only *t* tested once (as opposed to repeatedly) and
- (3) you are comparing two groups (as opposed to three or more groups)

Questions asked by the *t*-test for independent samples: Do the means of two groups differ from each other?

Examples of research questions that would use an independent *t* test:

- Do men and women have different average amounts of self-esteem?
- Does the number of physical symptoms differ among groups of heart disease patients receiving medication versus receiving a placebo?
- Do rats learn a maze faster with rewards or punishments?

Using SPSS to Calculate an independent *t* test (dataset: Chapter5 example1.sav)

Imagine you want to examine the effects of two different types of movies on people’s moods. You bring participants to your lab and randomly assign people to either watch an action movie or a comedy movie. After watching a 10 minute clip from the film you have the participants complete a measure of positive mood. You then enter the data in SPSS.

Now follow the “Famous Eight Steps”:

1. *Statement of the null and research hypotheses*

Null H_0 : $\mu_{\text{Action}} = \mu_{\text{Comedy}}$

The average amount of positive mood is equal between people who watch a comedy move and people who watch an action movie.

Research H_1 : $\bar{X}_{\text{Action}} \neq \bar{X}_{\text{Comedy}}$

The average amount of positive mood is not equal between people who watch a comedy move and people who watch an action movie.

2. Set the level of risk at $p < .05$

3. Selection of the appropriate t test statistic

Again using the flowchart on page 173 of Salkind (2008) we see that the t test for independent samples is the appropriate test statistic because we are comparing the means (of positive mood) between two independent groups (action movie and comedy group). Again, the groups in this example are *independent* because they are composed of different people. If each person watched both movies and completed the measure of positive mood more than once (i.e. after each movie), then we would use a different test (the t test for dependent samples, to be covered in the next chapter).

4. Computation of the test statistic

Open the dataset “Chapter5 example1.sav”. Take a moment to familiarize yourself with the data. Note how data for this type of analysis should be entered.

1) Each participant has one row in the data

2) One column is used to indicate which group the participant was in.

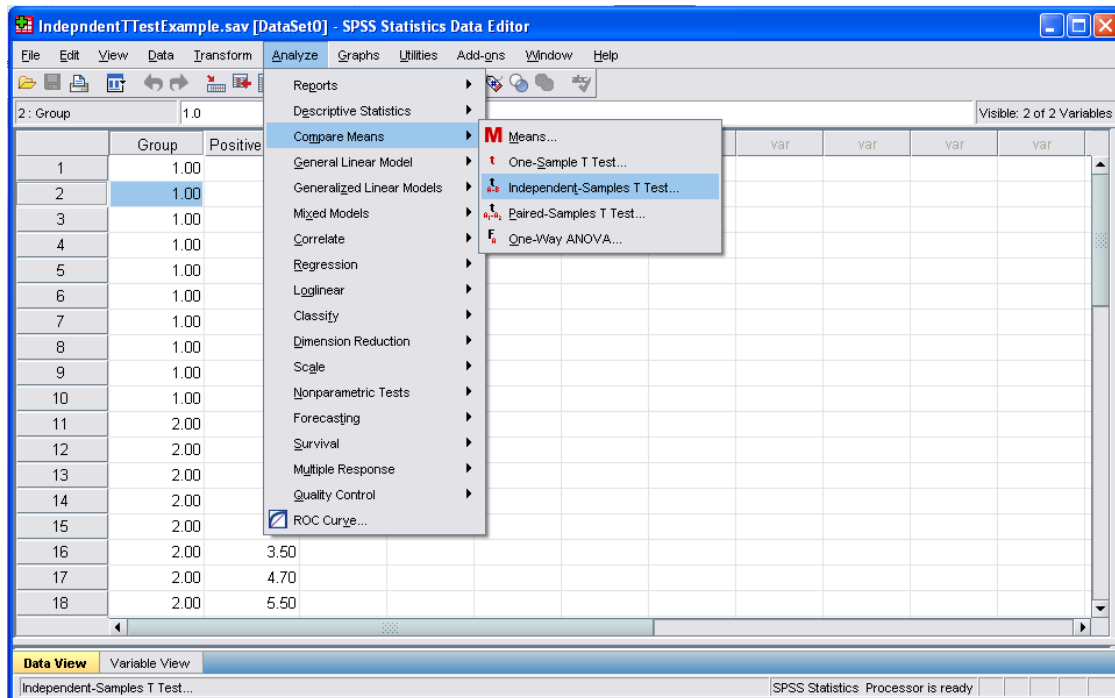
Note that you can use any numbers you want to differentiate between your two groups. For our example, we'll use a 1 to represent the action movie group and a 2 to represent the comedy movie group.

3) Another column indicates each participant's score on the positive mood measure. For our example, the positive mood measure can range from 1-6, with higher numbers representing more positive mood.

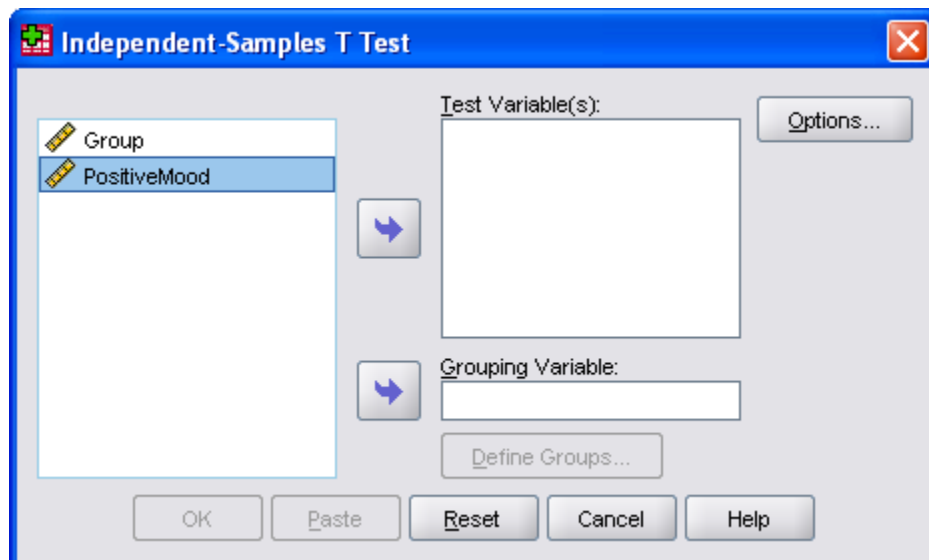
The data should look something like this in SPSS:

	Group	PositiveMood
1	1.00	3.20
2	1.00	3.40
3	1.00	2.80
4	1.00	2.70
5	1.00	4.20
6	1.00	3.10
7	1.00	3.60
8	1.00	4.00
9	1.00	2.90
10	1.00	2.70
11	2.00	4.20
12	2.00	4.50
13	2.00	5.10
14	2.00	5.20
15	2.00	4.80
16	2.00	3.50
17	2.00	4.70
18	2.00	5.50

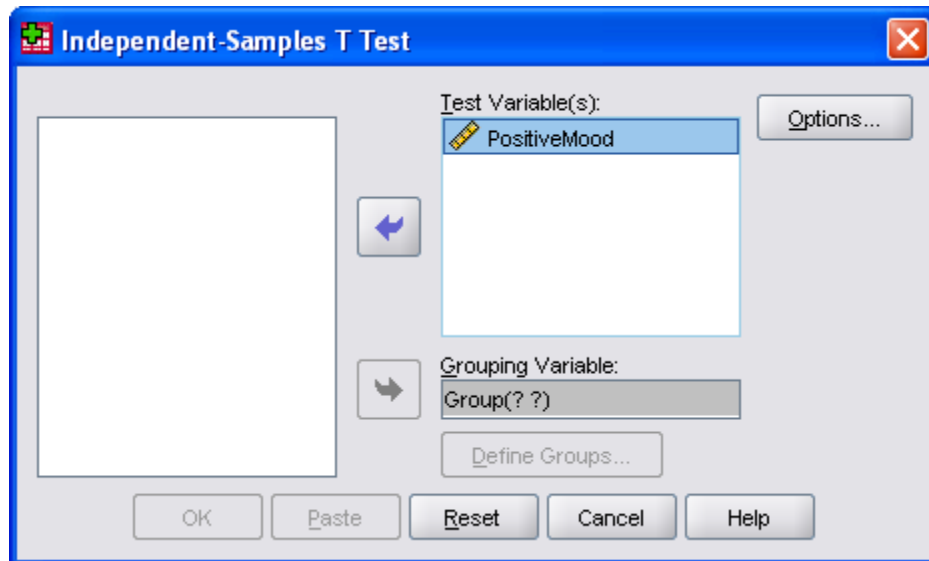
We will use SPSS to compute the t test statistic for us. To do so, click on the “Analyze” drop-down menu, highlight “Compare Means”, and then click on “Independent Samples T Test”, as pictured below.



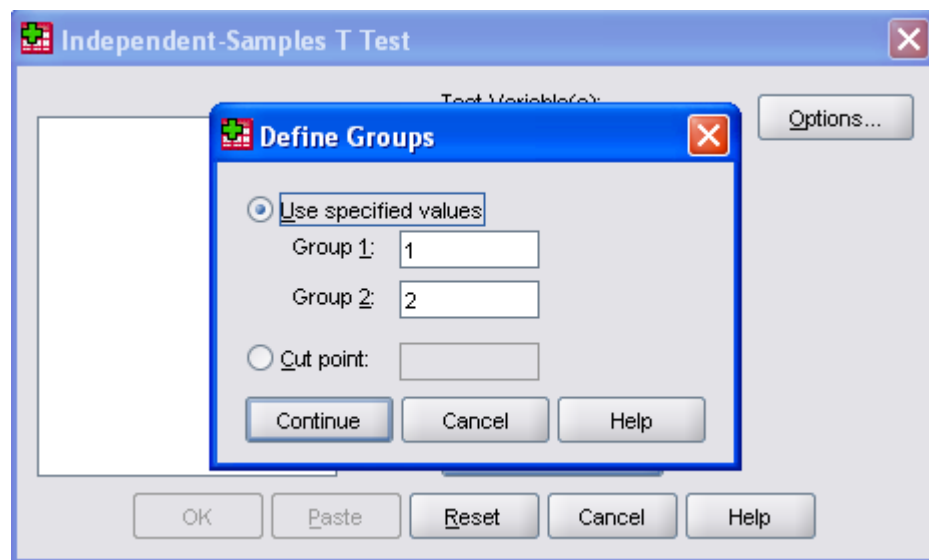
The following pop-up window will appear:



Highlight the name of the variable that designates which group the participants were in (Group) and click the arrow to place it in the “grouping variable” box. Next, highlight the name of the variable that designates each participant’s score on the positive mood measure (PositiveMood) and click on the arrow to place it in the “test variable(s)” box. Your screen should look like the picture below:



Next, you must define the groups. This tells SPSS what numbers you used to designate your groups in the data set. To do this, click “Group(? ?)”, then click the “Define Groups...” button. This will bring up the Define Groups pop-up window. Now, enter the numbers you used to designate your groups in the two boxes next to “group 1” and “group 2”. Recall that for our example, we used a 1 for the action movie group and a 2 for the comedy movie group. Your screen should look like the picture below:



Finally, click continue, and then click OK. Now navigate to the output window to find your results. The output will look like this:

Group Statistics

Group	N	Mean	Std. Deviation	Std. Error Mean
PositiveMood 1.00	10	3.2600	.53375	.16879
2.00	10	4.3200	.96816	.30616

This box gives you important summary statistics (the group sample sizes, means, and standard deviations) that will be helpful when you write up your results.

Independent Samples T test

	Levene's T 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
PositiveMood Equal variances assumed	3.422	.081	-3.032	18	.007	-1.06000	.34960	-1.79449	-.32551
Equal variances not assumed			-3.032	14.008	.009	-1.06000	.34960	-1.80978	-.31022

This tells you whether the variances between the two groups differ. **See part A of the next section for more info.**

Use the results of Levene's test to tell you which line to use here. **See part B of the next section.**

You can ignore this part of the output.

Interpreting the Output

The second table you see (“Independent Samples T test”) includes all of the critical pieces of information we are looking for to determine whether or not we can reject the null hypothesis. There’s a lot of information here - so let’s break this table down:

A. “Levene’s T test for Equality of Variances”

- a. The purpose of this t test is to determine whether the variances between the two groups are significantly different from each other. This is important because one of the assumptions of a standard independent test is that the 2 groups have equal variance.
- b. The null hypothesis for Levene’s t test is that the variances are equal, so:
 - i. If the p-value (the number listed in the “Sig.” column) is greater than .05, you can assume your variances are indeed equal.
 - ii. If the p-value is less than .05 for this t test, this suggests that the variances are not equal and that the data violates the assumption.
- c. Violating the assumption of equal variances will not affect your obtained value, but may affect the p-value associated with it. SPSS will give you two sets of results – one that assumes equal variance and one that does not. Thus, you use the outcome of Levene’s T test to tell you which set of output to use.

B. “t test for Equality of Means”

- a. Use the outcome of Levene’s t test to determine which line to use in the next part of the output.

If the p-value (Sig.) for Levene’s T test was greater than .05 -> USE THE TOP LINE (equal variances assumed); if the p-value (Sig.) for Levene’s T test was less than .05 -> USE THE BOTTOM LINE (equal variances not assumed).

Because the p-value of Levene’s T test in our example is greater than .05 (it is .081), we will use the top line (equal variances assumed). The selected part of the output we need to determine our main results is shown here:

t	df	Sig. (2-tailed)
-3.032	18	.007

- b. The “t” column tells us our exact obtained value: -3.03. This is the number we would get if we calculated t by hand using the formula on page 174.

Note: Recall that it is arbitrary which group we called “group 1” and which group we called “group 2” – this means that the negative sign has no meaning in this particular analysis.

The “df” column tells us our degrees of freedom: 18. Recall, the degrees of freedom for an independent samples t–t test is $n_1 - 1 + n_2 - 1$.

The “sig. (2-tailed)” column tells us the exact p-value associated with our obtained value and degrees of freedom: .007.

Now, back to the eight steps:

5. Determination of the value needed for rejection of the null hypothesis

If we were doing this example by hand, then this is the point when we would look at the table of critical values for t (Salkind, 2008, pgs 333-334). Recall that we look up the critical value to tell us the *smallest* value of t needed to reject the null hypothesis. The critical value is the t that corresponds to a p of .05 for that degrees of freedom. Because p gets smaller as t gets bigger, we know that if our obtained value is bigger than that critical value, then the p is less than .05. However, SPSS gives us an exact p -value! This means we don't have to find the critical value on our own when we use SPSS.

6. Comparison of the obtained value and the critical value is made

Because SPSS gives us a p -value, all we have to do now is see whether that p -value given to us (in the output) is greater or less than .05 (the level of risk we are willing to take). In this example, the output tells us that the p -value for our t test is .007 (which is less than .05). Put another way, this means there is only a .7% chance that we would obtain this pattern of results if the null hypothesis was true and there was no difference in mood between people who watch action movies and comedy movies.

7/8. Making a Decision

Because our p -value (.007) is less than .05, we reject the null hypothesis and conclude that there is a significant difference between the groups.

Interpretation of the Findings

Now you report your results. Here's an example of how these results would be reported in a journal article:

A t -test for independent samples revealed a significant difference in positive mood between participants that watched clips from different movie genres ($t_{(18)} = -3.03$, $p < .05$). Participants who watched a comedy movie reported significantly greater positive mood ($M = 4.32$, $SD = .97$) than participants who watched an action movie ($M = 3.26$, $SD = .53$).

For someone unfamiliar with stats, you might say:

Comedy movies appear to put people in better moods than action movies.

Practice Problem # 1 for SPSS (answer in Appendix)

A researcher wants to know whether violent video games influence aggression. She recruited 10 people, 5 played Grand Theft Auto for 20 minutes (Group 1), and the other 5 played Pac Man (Group 2). She then measured aggressive tendencies (higher scores represent more aggression). Use SPSS and the following data set to determine whether there is a significant difference in aggression between the two groups.

Group	Aggression
1	5.3
1	5.6
1	4.5
1	2.3
1	3.0
2	4.2
2	5.2
2	5.3
2	6.4
2	2.8

- A. What is the null and research hypothesis (in both words and statistical format)?
- B. What is the level of risk associated with the null hypothesis?
- C. What is the appropriate test statistic and **WHY**?
- D. What is the obtained value for the t test and what is its associated p-value? Is the difference between the two groups statistically significant?
- E. What do you conclude about the effect of video game type on aggression? Write up your results as you would for a journal article.
- F. Write up your results as you would for an intelligent person who doesn't know stats.

Practice Problem #2 for Hand Calculation (answer in Appendix)

A researcher is examining the effectiveness of a new pain relief drug. She recruits 30 people to participate in the study. 15 participants took the drug, 15 participants took a placebo. After an hour, she asked the participants how much pain they were experiencing on a 1 (no pain) to 10 (extreme pain) scale. The results for the two groups are below. Answer each of the questions below to determine if there is an effect of the drug on pain. Do all calculations by hand.

	Took Drug	Took Placebo
Mean	3.2	5.5
Standard Deviation	1.6	2.8
n	15	15

- A. What is the null and research hypothesis (in both words and statistical format)?
- B. What is the level of risk associated with the null hypothesis?
- C. What is the appropriate t test statistic and **WHY**?
- D. What is the value needed for rejection of the null hypothesis (i.e. the critical value)?
- E. What is the obtained value? Is it greater than the critical value?
- F. Can you reject the null hypothesis? What do you conclude about the effectiveness of the pain relief drug? Write up the results as you would for a journal article.
- G. Write up your results as you would for an intelligent person who doesn't know stats.

Practice Problem #3 for Hand Calculation and SPSS (answer in Appendix)

A researcher is interested in gender differences in cortisol production (a measure of stress reactions) under conditions of sleep deprivation. She asks participants to stay awake for 24 hours then measures their cortisol (higher numbers = more cortisol). Use the data below to determine if there is indeed a gender difference (Males = 0, Females = 1). *Hand calculate the analysis using the data below and then use SPSS to check your answer. Write up your results as you would for a journal article.*

Gender	Cortisol
0	5.9
0	6.3
0	4.2
0	5.5
1	4
1	3.8
1	4.5
1	5
1	4.6