

The t-Test of Differences Between Means: Independent Samples t-Test for Posttest Data

Step 1: State null hypothesis.

You have already done this in your Introduction.

Step 2: Choose a significance level.

Remember that statistical reasoning does not provide certain answers, such as yes or no. Rather, it gives answers in terms of probabilities.

If we want to reject the null hypothesis and support the research hypothesis, we have to select a probability that a true null hypothesis is being rejected. This is the probability that the mean difference we observe between participants and nonparticipants is due to chance.

Convention in the social sciences dictates the use of 0.05 level of significance. A 0.05 level of significance means a 5 percent probability that the differences occurred by chance.

The lower the p-values, the more confident you can be that the effect you are observing is due to your independent variable. Once we reject the null hypothesis, then the research hypothesis holds. We can then conclude that there is a difference between the means of the two groups. In the social sciences, you must select at least a 0.05 level of significance. It is written as $p < .05$.

Step 3: Determine the difference in means between the two groups.

Subtract the mean for the comparison group from the mean for the participants.

Step 4: Sum the scores at posttest for both groups.

This step is represented as $\sum(\text{scores})$ where \sum is the symbol for summation.

Step 5: Square the sum of the scores for both groups.

This step is straightforward. All we have to do is square the sums that were done in step 4. You will use these numbers in step 7, the sum of squares calculation.

Step 6: Square each score for both groups and sum the squared scores.

The first task is to square each person's posttest score. For example, participant 1 had a pretest score of 4. The square of 4 is 16. comparison group member 1 had a posttest score of 3. The square of 3 is 9. Once you have the squares of all the scores for each group, you add them up for each group. The sum of the squared scores is represented by the formula $\sum(\text{scores})^2$. These numbers will be used in step 7, the sum of squares calculation.

Step 7: Complete the sum of squares (SS) calculation.

The sum of squares is the sum of squared deviations from the mean.

The formula is:

$$SS = \sum (scores)^2 - \frac{(\sum (scores))^2}{n}$$

The different parts of the formula have been calculated in steps 5 and 6:

1. The first part of the formula corresponds to step 6: $\sum (scores)^2$

2. The numerator of the second part was calculated in step 5: $\frac{(\sum (scores))^2}{n}$

3. The denominator, n, represents the total number of participants.

Our next step is to insert all the numbers in the formula.

Step 8: Calculate the degrees of freedom.

The formula for degrees of freedom is $n - 1$. For our example, the group of participants consists of 50 members, so the degrees of freedom for this group = $50 - 1 = 49$. Likewise, $n - 1$ or $50 - 1$ gives 49 degrees of freedom for the comparison group. Once the degrees of freedom are calculated, we need to add them: $49 + 49 = 98$.

Step 9: Calculate the combined variance.

At this point we need to know the variance because it is part of the t-test formula.

The formula is:

$$Variance = \frac{\text{sum of squares}}{\text{degrees of freedom}} = \frac{SS}{df}$$

Since we have two groups, this step involves adding the two sums of squares calculated in step 7 and dividing by the combined degrees of freedom calculated in step 8.

Step 10: Use the t-test formula.

The formula for the t-test is:

$$t = \frac{\text{Mean}_{(participants)} - \text{Mean}_{(comparison)}}{\sqrt{\text{CombinedVariance} \left(\frac{1}{n_{participants}} + \frac{1}{n_{comparison\ group}} \right)}}$$

Step 11: Compare the calculated t-value with the critical t-value found in the table.

Our next step is to compare this t-value with the value found in the table “Critical Values of the t-Distribution.”

Critical t-Value Table

This table contains the significant levels for one and two tailed t-tests. (A tail is either end of a normal distribution curve, negative or positive.) To use a one-tailed test we would really need to have a strong reason to believe before the test about the direction our difference would be going.

The left column of the table contains the degrees of freedom. To use the table:

1. Locate the degrees of freedom.
2. Go to the right and find the intersect value at the 0.5 level of significance for a two-tailed test.
3. The intersect number is the critical value.
4. To reject the null hypothesis, the calculated t-value in step 10 must be greater than the critical value.

	Critical Value
Degrees of Freedom	
1	6.314
2	2.920
3	2.353
4	2.132
5	2.015
6	1.943
7	1.895
8	1.860
9	1.833
10	1.812
11	1.796
12	1.782
13	1.771
14	1.761
15	1.753
16	1.746
17	1.740

18	1.734
19	1.729
20	1.725
21	1.721
22	1.717
23	1.714
24	1.711
25	1.708
26	1.706
27	1.703
28	1.701
29	1.699
30	1.697
40	1.684
60	1.671
120	1.658
∞	1.645