What is the difference between Paired and Unpaired t-tests?

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A paired t-test is a statistical test that compares the means of two related groups or samples. This means that the individuals in each group are paired or matched based on certain characteristics, such as age, gender, or pre-existing conditions. The paired t-test takes into account the individual differences within each pair and compares the mean difference between the two groups.

On the other hand, an unpaired t-test compares the means of two independent groups or samples. This means that the individuals in each group are not related or paired in any way. The unpaired t-test assumes that the groups have equal variances and compares the means of the two groups based on their overall differences.

Overall, the main difference between paired and unpaired t-tests lies in the nature of the groups being compared. Paired t-tests are used when the two groups are related or dependent, while unpaired t-tests are used when the two groups are independent. Both tests can provide valuable insights into the differences between groups, but the specific choice of test depends on the nature of the data and the research question being addressed.

Paired vs. Unpaired t-test: What's the Difference?

In statistics, there are two types of two sample t-tests:

Paired t-test: Used to compare the means of two samples when each individual in one sample also appears in the other sample.

Unpaired t-test: Used to compare the means of two samples when each individual in one sample is independent of every individual in the other sample.

Note: An unpaired t-test is more commonly called an independent samples t-test.

For example, suppose a professor wants to determine

whether or not two different studying techniques lead to different mean exam scores.

To perform a paired t-test, he could recruit 10 students and have them use one studying technique for one month and take an exam, then have them use the second studying technique for one month and take another exam of equal difficulty.

Here's what the data would look like:

Studying Technique #1

	Exam Grade
Student #1	77
Student #2	79
Student #3	83
Student #4	84
Student #5	84
Student #6	87
Student #7	89
Student #8	90
Student #9	94
Student #10	95

Studying Technique #2

	Exam Grade
Student #1	79
Student #2	84
Student #3	80
Student #4	83
Student #5	83
Student #6	82
Student #7	80
Student #8	91
Student #9	92
Student #10	87

Since each student appears in each group, the professor would perform a paired t-test to determine if the mean scores are different between the two groups.

To perform an unpaired t-test, he could recruit 20 total students and randomly split them into two groups of 10. He could assign one group to use one studying technique for one month and assign the other group to use the second studying technique for one month and have all students take the same exam.

Here's what the data would look like:

Studying Technique #1

	Exam Grade
Student #1	77
Student #2	79
Student #3	83
Student #4	84
Student #5	84
Student #6	87
Student #7	89
Student #8	90
Student #9	94
Student #10	95

Studying Technique #2

	Exam Grade
Student #11	84
Student #12	78
Student #13	80
Student #14	76
Student #15	88
Student #16	89
Student #17	92
Student #18	93
Student #19	90
Student #20	86

Since the students in one group are completely independent of the students in the other group, the professor would perform an unpaired t-test to determine if the mean scores are different between the two groups.

Assumptions

Paired and unpaired t-tests both make the following assumptions:

The data in both samples was obtained using a .The data in both samples should be roughly normally distributed.There should be no extreme outliers in either sample.

These assumptions should be checked before performing either t-test to ensure that the results of the test are reliable.

Pros & Cons

The paired t-test offers the following pros:

A smaller sample size is required. Notice that the paired t-test in the previous example only required 10 total students while the unpaired t-test required 20 total students.Each sample contains individuals with the same characteristics. The two groups are guaranteed to have individuals with equal ability, intellect, etc. because the same individuals appear in each group.

However, a paired t-test comes with the following

potential cons:

The potential for sample size reduction. If an individual drops out of the study, the sample size of *each* group is reduced by one since that individual appears in each group.The potential for order effects. refer to differences in outcomes between the two groups due to the order that treatments were presented to individuals. For example, an individual may score higher on the second exam simply due to the fact that they improved their exam-taking abilities rather than due to the studying technique.

Keep these pros and cons in mind when deciding to use a paired vs. unpaired t-test.

Check out the following tutorials to gain a better understanding of paired t-tests:

And use the following tutorials to gain a better understanding of unpaired t-tests (AKA independent samples t-tests):