# Paired vs Unpaired Test: Differences, Assumptions and Hypotheses

Two-sample t-tests are statistical tests used to compare the means of two populations. Also known as Student’s t-tests, their results are used to determine if there is a significant difference between the mean of two samples that is unlikely to be due to sampling error or random chance.  
  
Student’s t-tests are further broken down into two categories: paired t-tests and unpaired t-tests. These statistical tests are commonly used in research in the fields of biology, business, and psychology.  
  
This article will explain when it is appropriate to use a paired t-test versus an unpaired t-test, as well as the hypothesis and assumptions of each.

**What is a paired t-test?**

A paired t-test (also known as a dependent or correlated t-test) is a statistical test that compares the averages/means and standard deviations of two related groups to determine if there is a significant difference between the two groups.

●       A significant difference occurs when the differences between groups are unlikely to be due to sampling error or chance.

●       The groups can be related by being the same group of people, the same item, or being subjected to the same conditions.

Paired t-tests are considered more powerful than unpaired t-tests because using the same participants or item eliminates variation between the samples that could be caused by anything other than what’s being tested.

**What are the hypotheses of a paired t-test?**

There are two possible hypotheses in a paired t-test.

●       The **null hypothesis** (H0) states that there is no significant difference between the means of the two groups.

●       The **alternative hypothesis** (H1) states that there is a significant difference between the two population means, and that this difference is unlikely to be caused by sampling error or chance.

**What are the assumptions of a paired t-test?**

●       The dependent variable is normally distributed

●       The observations are sampled independently

●       The dependent variable is measured on an incremental level, such as ratios or intervals.

●       The independent variables must consist of two related groups or matched pairs.

**When to use a paired t-test?**

Paired t-tests are used when the same item or group is tested twice, which is known as a repeated measures t-test. Some examples of instances for which a paired t-test is appropriate include:

●       The before and after effect of a pharmaceutical treatment on the same group of people.

●       Body temperature using two different thermometers on the same group of participants.

●       Standardized test results of a group of students before and after a study prep course.

**What is an unpaired t-test?**

An unpaired t-test (also known as an independent t-test) is a statistical procedure that compares the averages/means of two independent or unrelated groups to determine if there is a significant difference between the two.

**What are the hypotheses of an unpaired t-test?**

The hypotheses of an unpaired t-test are the same as those for a paired t-test. The two hypotheses are:

●       The null hypothesis (H0) states that there is no significant difference between the means of the two groups.

●       The alternative hypothesis (H1) states that there is a significant difference between the two population means, and that this difference is unlikely to be caused by sampling error or chance.

**What are the assumptions of an unpaired t-test?**

●       The dependent variable is normally distributed

●       The observations are sampled independently

●       The dependent variable is measured on an incremental level, such as ratios or intervals.

●       The variance of data is the same between groups, meaning that they have the same standard deviation

●       The independent variables must consist of two independent groups.

**When to use an unpaired t-test?**

An unpaired t-test is used to compare the mean between two independent groups. You use an unpaired t-test when you are comparing two separate groups with equal variance.  
  
Examples of appropriate instances during which to use an unpaired t-test:

●       Research, such as a pharmaceutical study or other treatment plan, where ½ of the subjects are assigned to the treatment group and ½ of the subjects are randomly assigned to the control group.

●       Research during which there are two independent groups, such as women and men, that examines whether the average bone density is significantly different between the two groups.

●       Comparing the average commuting distance traveled by New York City and San Francisco residents using 1,000 randomly selected participants from each city.

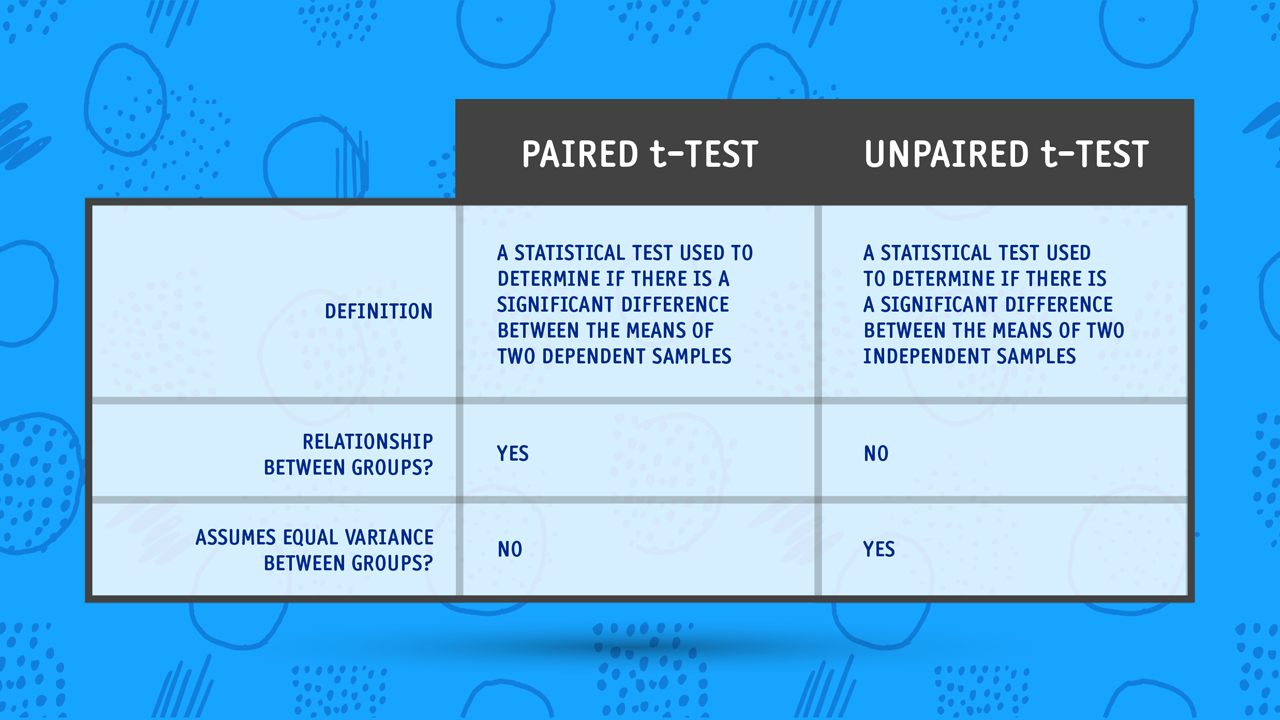
In the case of unequal variances, a Welch’s test should be used.

**Paired vs unpaired t-test**

The key differences between a paired and unpaired t-test are summarized below.

1. A paired t-test is designed to compare the means of the same group or item under two separate scenarios. An unpaired t-test compares the means of two independent or unrelated groups.
2. In an unpaired t-test, the variance between groups is assumed to be equal. In a paired t-test, the variance is not assumed to be equal.

**Paired vs unpaired t-test table**

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