# PS 211: Independent-Samples *t* Test

We use an independent-samples *t* test when comparing two samples in a between-groups (between-subjects) experimental design. In other words, there are different people in each group. Different people experience each level of the independent variable.

Example: We conduct an experiment to see whether the price of a product influences how much we like it. We randomly assign 9 people who drink wine to taste what they are told is a:

- $10 bottle (4 tasters)
- $90 bottle (5 tasters)

In reality, both bottles are the same (but the participants are not told this until after the study). Participants are asked to rate the quality of the wine from 1 to 5.

Our data:

- $10 group ratings: 1.5, 2.3, 2.8, 3.4 (Mean = 2.5)
- $90 group ratings: 2.9, 3.5, 3.5, 4.9, 5.2 (Mean = 4.0)

**Step 1:** Identify populations (groups), the distribution, and assumptions.

Populations: *What are the two groups we are comparing?*

Distribution: *Scores, means, mean differences, differences in means?*

Assumptions:
*Is the data numeric? Do we have any reason to believe this data wouldn't be normally distributed? Was assignment across groups random?*

**Step 2:** State the null and research hypotheses.

**Step 3:** Determine characteristics of the comparison distribution.

The independent-samples *t* test formula is as follows:

$$t = \frac{(M_{Group1} - M_{Group2})}{SE_{difference}}$$

What is the *mean* and *standard error* of the comparison distribution? Which of these do we already know?

**Step 3a:** Compute the standard error of the comparison distribution.
*Because we are looking at 2 independent samples with different sample sizes, we calculate estimates for the SE for each sample, and then add them together.*

To do this, first we find the **corrected** variance for each sample (i.e., our estimate of the population variance from a sample). Variance is just the standard deviation squared ($SD^2$). Write the formula for the corrected variance:

Use the tables below and calculate the corrected variance for each sample. Use a calculator! *Hint:* Compute the mean of the first column to get M.

Group 1: $10 Bottle

| Data from Timepoint 1 | Difference Score (X - M) | Squared Deviations $(X - M)^2$ |
|---|---|---|
| 1.5 | | |
| 2.3 | | |
| 2.8 | | |
| 3.4 | | |

Corrected variance ($SD^2$) for Group 1:

Group 2: $90 Bottle

| Data from Timepoint 1 | Difference Score (X - M) | Squared Deviations $(X - M)^2$ |
|---|---|---|
| 2.9 | | |
| 3.5 | | |
| 3.5 | | |
| 4.9 | | |
| 5.2 | | |

Corrected variance ($SD^2$) for Group 2:

Now, pool the corrected variances:
First, calculate the degrees of freedom for each sample:

$10 Group:
$90 Group:

Calculate the total degrees of freedom:

"Weight" the variance of each group by multiplying them by the ratio of sample df / total df:

This is the pooled variance! You will need this later for the effect size formula.

Convert the pooled variance from $SD^2$ to $SE^2$ for each sample.

Add the $SE^2$ from each sample together.

Calculate the square root of your summed $SE^2$ to get a final estimate of standard error for the distribution of *differences between means:*

Now you have your SE for the *t* test!

**Step 4:** Determine critical values, or cutoffs.
*Identify your t critical value for a two-tailed test at alpha = 0.05. Use the total df to find the cutoff!*

| | One-Tailed Tests Alpha Level | | | Two-Tailed Tests Alpha Level | | |
|---|---|---|---|---|---|---|
| *df* | 0.10 | 0.05 | 0.01 | 0.10 | 0.05 | 0.01 |
| 1 | 3.078 | 6.314 | 31.821 | 6.314 | 12.706 | 63.657 |
| 2 | 1.886 | 2.920 | 6.965 | 2.920 | 4.303 | 9.925 |
| 3 | 1.638 | 2.353 | 4.541 | 2.353 | 3.182 | 5.841 |
| 4 | 1.533 | 2.132 | 3.747 | 2.132 | 2.776 | 4.604 |
| 5 | 1.476 | 2.015 | 3.365 | 2.015 | 2.571 | 4.032 |
| 6 | 1.440 | 1.943 | 3.143 | 1.943 | 2.447 | 3.708 |
| 7 | 1.415 | 1.895 | 2.998 | 1.895 | 2.365 | 3.500 |

**Step 5:** Calculate the test statistic. Plug all of your numbers into the *t* statistic formula:

**Step 6:** Make a decision. Compare your calculated *t* statistic to your critical value. Decide to reject or fail to reject the null hypothesis.

Next, **calculate the 95% confidence interval.**
Write out the CI formula:

Plug in your numbers to the CI formula:

Check that the CI makes sense:

**Calculate the appropriate effect size for this study.**

Write out the effect size formula. *For the independent-samples t test effect size estimate, we use the pooled standard deviation. You can find this by taking the square root of the pooled variance you calculated above:*

Plug in your numbers to the effect size formula:

Interpret the effect size: