A quick review

- What is the main thing that differentiates between whether we will use a z or a t test statistic?
- What are the differences between the types of t tests that we have discussed so far?
  - Single sample t test vs Paired sample t test

Independent Samples t test

- This is used for when our experiment compares the responses of two different groups
  - Males vs females
  - Younger vs older
  - Californians vs Texans
- Notice that someone cannot be in both groups
- In some cases, the groups are organized in a way where someone could be in both groups, but the experimenters have chosen to run it between samples and not within samples

For example

- A memory experimenter wanted to determine which mode of presentation helped memory more
  - Visual presentation (seeing the words)
  - Auditory presentation (hearing the words)
- There are two ways to run this experiment
  - How could this experiment be run with just one group (within subjects)?
  - How could this experiment be run with two groups (between subjects)?
- What are the advantages and disadvantages of each?

In general

- This t test is just like the other two we’ve already done
  - Mean difference
  - Standard error

It is more complex

- The numerator is still easy
  - Just subtract the mean of one sample from the mean of the other sample
  \[ t = \frac{M_X - M_Y}{S_{\text{difference}}} \]
- The denominator is more difficult
  - Remember the main idea with a t statistic is that we use the sample SD to estimate the population SD
  - How do we do that when we have two samples (group 1 and group 2)?
A walkthrough

• Let’s compare male heights to female heights (in inches)
  • Males: 70, 72, 68, 69, 71
  • Females: 69, 71, 64, 62, 63, 67
• Notice that there are different numbers of subjects in each group
  • We can deal with that with independent samples t tests

Next

• Calculate the needed statistics
  • Mean of group 1 = $M_X = 70$
  • Mean of group 2 = $M_Y = 66$

What about the standard error?

• First we need the variance of each of our samples
  • Remember that variance is just SD squared

$$s_X^2 = \frac{\sum (X - M_X)^2}{N - 1}$$

$$s_Y^2 = \frac{\sum (Y - M_Y)^2}{N - 1}$$

• $s_X^2 = 2.5$
• $s_Y^2 = 12.8$

Now

• We need to put the variances together
  • Pooled variance
  • Since our samples have a different number of subjects, they will contribute different amounts to the pooled variance
  • The larger sample should contribute more

$$s_{pooled}^2 = \left( \frac{df_X}{df_{total}} \right) s_X^2 + \left( \frac{df_Y}{df_{total}} \right) s_Y^2$$

• $s_{pooled}^2 = 8.22$

So, now we have the variances

• We just need to turn them into standard errors

$$s_{M_X}^2 = \frac{s_{pooled}^2}{N_X} = \frac{8.22}{5} = 1.64$$

$$s_{M_Y}^2 = \frac{s_{pooled}^2}{N_Y} = \frac{8.22}{6} = 1.37$$
Nearly done!

\[ s^2_{\text{difference}} = s^2_X + s^2_Y \]

1.64 + 1.37 = 3.01 = \( s^2_{\text{difference}} \)

\[ s_{\text{difference}} = \sqrt{s^2_{\text{difference}}} \]

\[ \text{sqrt}(3.01) = 1.73 = s_{\text{difference}} \]

Step 4: Determine the critical values

- \( df = 9 \) (notice we used the total \( df \), which is the sum of the other two \( dfs \))
- Notice it is NOT \( N_{\text{total}} - 1 \)
- But instead \( df_{\text{total}} = df_X + df_Y = 4 + 5 = 9 \)
- \( t = 2.26 \) is our cutoff for a two tailed test

Step 5: Calculate \( t \)

\[ t = \frac{M_X - M_Y}{s_{\text{difference}}} \]

- \( (70 - 66) / 1.73 = 4 / 1.73 = 2.31 \)
- Step 6: Make a decision
  - 2.31 > 1.83, so we would reject the null hypothesis here

What about effect size?

\[ d = \frac{(M_X - M_Y)}{s_{\text{pooled}}} \]

- \( d = (70 - 66) / \text{sqrt}(8.22) = 4 / 2.87 = 1.4 \)
- Remember that any effect size over .8 is considered large, so this one would be very large

Try this one

- Reaction times for elderly people are often slower than those of younger populations. For this reason, some politicians have suggested laws restricting driving privileges of the elderly. In a study, researchers brought in elderly subjects (over age 65) and younger subjects (between age 20 and 30) and had them push a button as quickly as possible when a light flashed. The average reaction time for each subject is shown on the next slide.

These are reaction times (in ms)

<table>
<thead>
<tr>
<th>Elderly subjects</th>
<th>Younger</th>
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- Complete the six steps for this experiment