Chapter 14
Hypothesis Tests:
Two Independent Samples

PSY 295 - Oswald

Violent Videos – Again!

- Bushman (1998) Violent videos and aggressive behavior
  - Doing the study Bushman’s way – almost
- Bushman had two independent groups
  - Violent video versus educational video
  - We want to of aggressive words between groups

Major Points

- An example
- Distribution of differences between means
- Heterogeneity of Variance
- Nonnormality
- Effect size
- Confidence limits

The Data

<table>
<thead>
<tr>
<th>Condition</th>
<th>$\bar{X}$</th>
<th>$s$</th>
<th>$s^2$</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Violent video</td>
<td>7.10</td>
<td>4.40</td>
<td>19.36</td>
<td>100</td>
</tr>
<tr>
<td>NonViolent video</td>
<td>5.65</td>
<td>3.20</td>
<td>10.24</td>
<td>100</td>
</tr>
</tbody>
</table>
Analysis

• We still have means of 7.10 and 5.65, but both of these are .
• We want to test .
  – Not between a sample and a population mean

Analysis--cont.

• How are sample means distributed if \( H_0 \) is true?
• Need of differences between means
  – Same idea as before, except statistic is \( \bar{X}_1 - \bar{X}_2 \)
  – …and the null hypothesis is

Sampling Distribution of Mean Differences

• Mean of sampling distribution is \( \mu_1 - \mu_2 \)
• Standard deviation of sampling distribution (standard error of mean differences) =

\[
S_{\bar{X}_1 - \bar{X}_2} = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}
\]

Sampling Distribution of Mean Differences

• Distribution approaches as \( N \) increases.
• Later we will modify this to the variances across groups.
Analysis--cont.

- Same basic formula as one-sample t, but with accommodation for

\[ t = \frac{\bar{X}_1 - \bar{X}_2}{s_{\bar{X}_1 - \bar{X}_2}} = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s^2_1}{n_1} + \frac{s^2_2}{n_2}}} \]

- Note parallels with earlier t
- You have \( \bar{X}_1 \) and \( \bar{X}_2 \), not population parameters, so

Our Data

\[
t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s^2_1}{n_1} + \frac{s^2_2}{n_2}}} = \frac{7.10 - 5.65}{\sqrt{\frac{19.36}{100} + \frac{10.24}{100}}} = \frac{1.45}{1.45} = 2.66
\]

Degrees of Freedom

- Each group has 100 subjects, or \( N - 1 = 100 - 1 = 99 \) df
- Total df = \( n_1 - 1 + n_2 - 1 = n_1 + n_2 - 2 \) = \( 100 + 100 - 2 = 198 \) df
- So if \( \alpha = .05 \) and if we have a two-tailed alternative hypothesis, then

- (What if \( \alpha = .05 \) and \( H_1 \) is one-tailed?)

Conclusions

- \( t_{obt} = 2.66 \) and \( t_{crit} = \pm 1.97 \)
- Since
- Conclude that those who watch violent videos aggressive words than those who watch nonviolent videos.
Assumptions

- Two major assumptions
  - Both groups are sampled from populations with the same variance
  - Assumption of
  - Both groups are sampled from normal populations
  - Assumption of normality
    - Frequently violated with

Pooling Variances

- If we assume both population variances are homogeneous (equal), then the
  is a better estimate.

\[
s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}
\]

\[
= \frac{99(19.36) + 99(10.24)}{99 + 99 - 2} = \frac{29304}{198} = 14.8
\]

Pooling Variances

- Substitute \( s_p^2 \) in place of separate variances in the formula for \( t \).
- Will not change the result if
- Do not pool if one variance more than the other.
  - Rule of thumb for

Variances

- Refers to case of population variances.
- We it the sample variances.
- We adjust \( df \) and look \( t \) up in tables for adjusted \( df \).
- Minimum \( df = \).
  - (Most software calculates optimal \( df \)
Standardized Effect Size for Two Groups

- Extends what we already know.
- We can often simply express the effect as the difference between means (1.45).
- However, the standardized effect size, $d$, gives the group mean difference relative to the size of the similar to what the does for the difference of (score – mean).
- Use the standard deviation from?

Cont.

Standardized Effect Size for Two Groups

- Use either standard deviation or their pooled average.
- We will pool the standard deviations in this example, because.
- (In other examples you might want to use the standard deviation of the, because the experimental manipulation affects not only the mean but the standard deviation.)
- Pooled SD = square root of $\sqrt{14.8} = 3.85$

Cont.

Confidence Limits

$CI_{95} = (\bar{X}_1 - \bar{X}_2) \pm t_{0.025} \hat{\sigma}_{\bar{X}_1 - \bar{X}_2}$

$= (7.1 - 5.65) \pm 1.96 \times \sqrt{2.53}$

$= 1.45 \pm 1.96 \times 5.44 = 1.45 \pm 1.07$

$= 0.38 < \mu < 2.53$

Cont.
Confidence Limits

- \( p = .95 \) that interval (based on the sample estimate of the mean difference) includes the true value of \( \mu_1 - \mu_2 \).
- Probability that \( \mu_1 - \mu_2 \) falls in the interval, but \( \mu_1 - \mu_2 \).

Computer Example

- SPSS reproduces the \( t \) value and the confidence limits.
- All other statistics are the same as well.
- Note different \( df \) depending on homogeneity of variance.
- Don’t pool if heterogeneity
  - and modify degrees of freedom

Review Questions

(These are NOT the only questions you need to know)

- Why do you suppose it makes a difference whether we compare a sample and a population mean or two sample means?
- What do we know about the sampling distribution of differences between means?
Review Questions

(These are NOT the only questions you need to know)

• What do we mean by “the standard error of differences between means?”
• How do we calculate the degrees of freedom with two groups?
• What are the underlying assumptions?
• What does it mean to “pool” the variances?

• When would we not pool the variances?
• What is the difference between how we calculate confidence limits with one or with two means?
• What does the text mean by modifying the \( df \) when we have heterogeneity of variance?