PSY 216
Assignment 10

1. Problem 3 from the text

   If other factors are held constant, explain how each of the following influences the value of the independent-measures t statistic and the likelihood of rejecting the null hypothesis.

   a. Increasing the number of scores in each sample.

      Increasing the number of scores in each sample decreases the size of the estimated standard error of the difference of the means. This increases the size of the observed t which makes it easier to reject H_0. In other words, increasing sample size increases statistical power.

   b. Increasing the variance of each sample.

      Increasing the variance of each sample will increase the size of the estimated standard error of the difference of the means. This decreases the size of the observer t which makes it harder to reject H_0. In other words, increased within-group variability decreases statistical power.

2. Problem 4 from the text

   Describe the homogeneity of variance assumption and explain why it is important for the independent-measures t test.

   Homogeneity of variance states that the variance in each group should be equal (or homogeneous). This is an important assumption because of the calculation of the pooled variance is based on the assumption that the two estimates of variability have been drawn from the same population. If the sample variances are estimated different population variances, then it does not make sense to pool them to get a better estimate of the single population variance.

3. Problem 8 from the text

   Two separate samples, each with n = 12 individuals, receive two different treatments. After treatment, the first sample has SS = 1740 and the second has SS = 1560. (Problem 8 from the text)

   a. Find the pooled variance for the two samples

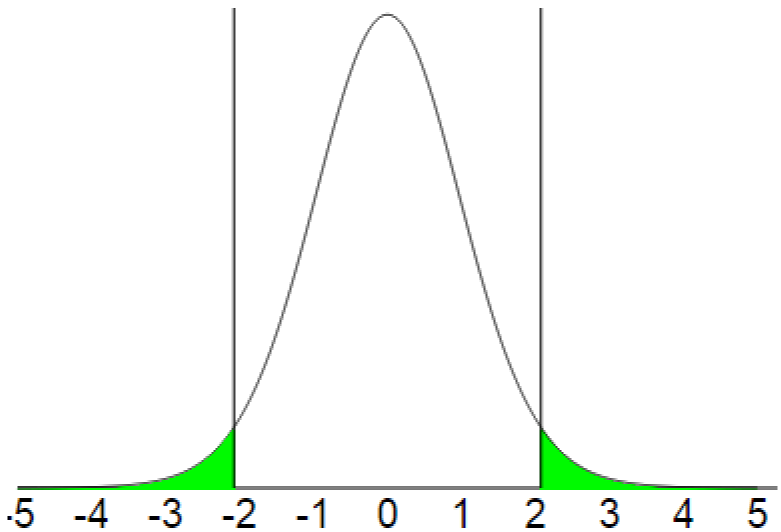
$$s_p^2 = \frac{SS_1 + SS_2}{df_1 + df_2} = \frac{1740 + 1560}{(12-1)+(12-1)} = 150$$

b. Compute the estimated standard error for the sample mean difference

$$s_{(M_1-M_2)} = \sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}} = \sqrt{\frac{150}{12} + \frac{150}{12}} = 5$$

c. If the sample mean difference is 8 points, is this enough to reject the null hypothesis and conclude that there is a significant difference for a two-tailed test at the $\alpha = .05$ level?

The critical *t* with 22 degrees of freedom (= (12 – 1) + (12 – 1)) with $\alpha = .05$ two-tailed equals 2.074.



$$t = \frac{(M_1 - M_2) - (\mu_1 - \mu_2)}{s_{(M_1-M_2)}} = \frac{8 - 0}{5} = 1.6$$

The observed *t* (1.6) is not in the tails cut off by the critical *t* (±2.074), so we cannot reject H_0.

d. If the sample mean difference is 12 points, is this enough to indicate a significant difference for a two-tailed test at the $\alpha = .05$ level?

$$t = \frac{(M_1 - M_2) - (\mu_1 - \mu_2)}{s_{(M_1-M_2)}} = \frac{12 - 0}{5} = 2.4$$

The observed *t* (2.4) is in the tails cut off by the critical *t* (±2.074), so we can reject H_0.

e. Calculate the percentage of variance accounted for (r^2) to measure the effect size for an 8-point mean difference and for a 12-point mean difference.

8-point:

$$r^2 = \frac{t^2}{t^2 + df} = \frac{1.6^2}{1.6^2 + 22} = 0.104$$

12-point:

$$r^2 = \frac{t^2}{t^2 + df} = \frac{2.4^2}{2.4^2 + 22} = 0.207$$

4. Problem 17 from the text

In 1974, Loftus and Palmer conducted a classic study demonstrating how the language used to ask a question can influence eyewitness memory. In the study, college students watched a film of an automobile accident and then were asked questions about what they saw. One group was asked, "About how fast were the cards going when they smashed into each other?" Another group was asked the same question except the verb was changed to "hit" instead of "smashed into." The "smashed into" group reported significantly higher estimates of speed than the "hit" group. Suppose a researcher repeats this study with a sample of today's college students and obtains the following results.

Estimated Speed	
Smashed into	Hit
n= 15 M = 40.8 SS = 510	n = 15 M = 34.0 SS = 414

a. Do the results indicate a significantly higher mean for the "smashed into" group? Use a one-tailed test with $\alpha = .01$.

Step 1:
$H_0: \mu_{\text{smashed into}} - \mu_{\text{hit}} \leq 0$
$H_1: \mu_{\text{smashed into}} - \mu_{\text{hit}} > 0$
$\alpha = .01$

Step 2:
$t_{critical} = 2.467$ ($\alpha = .01$, one-tailed, $df = (n_1 - 1) + (n_2 - 1) = (15 - 1) + (15 - 1) = 28$)

Step 3:

$$s_p^2 = \frac{SS_1+SS_2}{df_1+df_2} = \frac{510+414}{(15-1)+(15-1)} = 33$$

$$s_{M_1-M_2} = \sqrt{\frac{s_p^2}{n_1}+\frac{s_p^2}{n_2}} = \sqrt{\frac{33}{15}+\frac{33}{15}} = 2.0976$$

$$t = \frac{M_1 - M_2}{s_{M_1-M_2}} = \frac{40.8 - 34.0}{2.0976} = 3.24$$

Step 4:

Reject H_0 because the observed t is in the tail cut off by the critical t.

b. Compute the estimated value for Cohen's *d* to measure the size of the effect.

$$estimated\ d = \frac{M_1 - M_2}{\sqrt{s_p^2}} = \frac{40.8 - 34.0}{\sqrt{33}} = 1.18$$

c. Write a sentence demonstrating how the results of the hypothesis test and the measure of effect size would appear in a research report.

The participants who heard that the cars "smashed into" each other had a higher estimated speed of the cards (*M* = 40.8 MPH, *SD* = 6.04 MPH) than those who heard that the cars "hit" each other (*M* = 34.0 MPH, *SD* = 5.44 MPH). The mean difference was significant, $t(28) = 3.24$, $p < .01$, $d = 1.18$.

5. Problem 19 from the text

A researcher is comparing the effectiveness of two sets of instructions for assembling a child's bike. A sample of eight parents is obtained. Half of the parents are given one set of instructions and the other half receives the second set. The researcher measures how much time is needed for each parent to assemble the bike. The scores are the number of minutes needed by each participant: (Problem 19 from the text)

Instruction Set 1	Instruction Set II
8	14
4	10
8	6
4	10

a. Is there a significant difference in time for the two sets of instructions? Use a two-tailed test at the $\alpha = .05$ level of significance.

$M_1 = (8 + 4 + 8 + 4) / 4 = 6$

$SS_1 = (8 - 6)^2 + (4 - 6)^2 + (8 - 6)^2 + (4 - 6)^2 = 4 + 4 + 4 + 4 = 16$

$M_2 = (14 + 10 + 6 + 10) / 4 = 10$

$SS_2 = (14 - 10)^2 + (10 - 10)^2 + (6 - 10)^2 + (10 - 10)^2 = 32$

Step 1: State the hypothesis and select an α level

H_0: $\mu_1 - \mu_2 = 0$

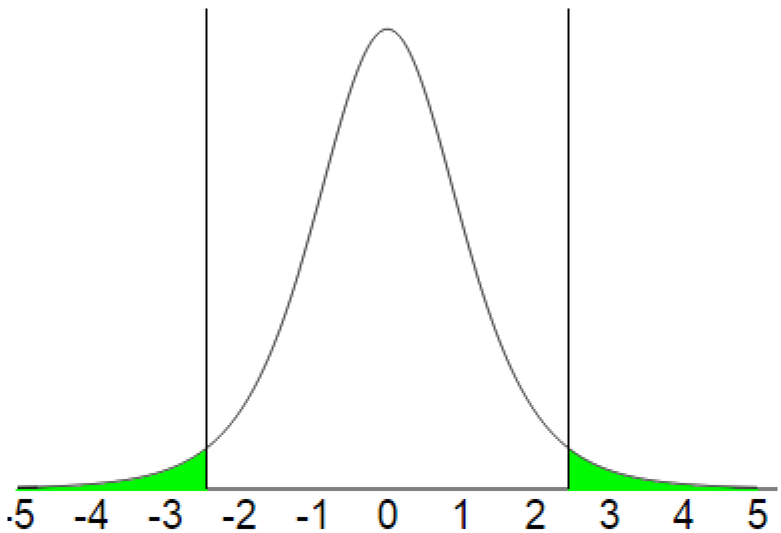
H_1: $\mu_1 - \mu_2 \neq 0$

$\alpha = .05$

Step 2: Identify the critical region

$df = (n_1 - 1) + (n_2 - 1) = (4 - 1) + (4 - 1) = 6$

Consulting a table of critical t values with 6 degrees of freedom, α = .05, two-tailed, reveals that the critical $t = \pm 2.447$



Step 3: Compute the test statistic

$$s_p^2 = \frac{SS_1 + SS_2}{df_1 + df_2} = \frac{16 + 32}{(4 - 1) + (4 - 1)} = 8$$

$$s_{(M_1 - M_2)} = \sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}} = \sqrt{\frac{8}{4} + \frac{8}{4}} = 2$$

$$t = \frac{(M_1 - M_2) - (\mu_1 - \mu_2)}{s_{(M_1 - M_2)}} = \frac{(6 - 10) - 0}{2} = -2.0$$

Step 4: Make a decision

Because the calculated t (-2.0) is not in the tails cut off by the critical t (2.477), we fail to reject H_0. That is, there is insufficient evidence to suggest that the two sets of instructions are reliably different.

b. Calculate the estimated Cohen's *d* and r^2 to measure effect size for this study.

$$estimated\ d = \frac{M_1 - M_2}{\sqrt{s_p^2}} = \frac{6-10}{\sqrt{8}} = 1.41$$

$$r^2 = \frac{t^2}{t^2 + df} = \frac{-2^2}{-2^2 + 6} = 0.4$$

6. Use SPSS with the class data set to answer the following question: Do females expect to earn a different number of points in a statistics class than males? Give H_0, H_1 and α. Sketch a t distribution and indicate the critical region(s) on the distribution and the critical t value(s). Is this a one-tailed or two-tailed test? From the SPSS output, report the following:

Step 1:
H_0: $\mu_{females} - \mu_{males} = 0$
H_1: $\mu_{females} - \mu_{males} \neq 0$
$\alpha = .05$

Steps 2 and 3:

Load the class data set into SPSS
Analyze | Compare Means | Independent Samples T Test
Move the Points Expected variable into the Test Variable(s) box
Move the Gender variable into the Grouping Variable box
Click on Define Groups
Enter 1 for Group 1 (females) and 2 for Group 2 (males) – (on Variable View, click in the intersection of the gender row (row 10) and the Label column; click on the ellipsis; the Value Labels dialog box shows the labels for each value of the variable)
Click Continue to close the Define Groups box
Click OK

Statistic	**Value**
M_{male}	273.50
M_{female}	267.96
df	36
t	-0.905

p	.371

Use the Equal variances assumed row because the Sig. value for Levene's Test for Equality of Variances (.493) is larger than α (.05).

Step 4:
Fail to reject H_0 because the *p* value (.371) is larger than α (.05)

Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Points expected	female	28	267.96	17.234	3.257
	male	10	273.50	14.554	4.603

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Points expected	Equal variances assumed	.480	.493	-.905	36	.371	-5.536	6.117	-17.942	6.870
	Equal variances not assumed			-.982	18.706	.339	-5.536	5.638	-17.349	6.278

What is the estimated value of Cohen's *d*? Is this a small, medium, or large effect?

$$s_p^2 = \frac{df_1 \cdot s_1^2 + df_2 \cdot s_2^2}{df_1 + df_2} = \frac{(28-1) \cdot 17.234^2 + (10-1) \cdot 14.554^2}{(28-1)+(10-1)} = \frac{27 \cdot 297.011 + 9 \cdot 211.819}{27+9}$$
$$= 275.713$$

$$d = \frac{M_1 - M_2}{\sqrt{s_p^2}} = \frac{267.96 - 273.50}{16.605} = -0.334$$

Small effect

What is the value of r^2?

$$r^2 = \frac{t^2}{t^2 + df} = \frac{-0.905^2}{-0.905^2 + 36} = 0.022$$

Small effect

7. Using pages 332 to 3333 in the textbook as a guide, write a sentence or two in APA format that summarizes the results of the above question.

The number of points expected in a statistics class for men (*M* = 273.50, *SD* = 14.55) and women (*M* = 267.96, *SD* = 17.23) are not reliably different, $t(36) = -0.905$, $p = .371$, $d = -0.334$.