Solutions to HW#8

Stat 145

Chapters 9 & 10   5 points

1. (A) The null hypothesis always predicts no change from what was previously known. Any observed change is assumed to be solely due to random error. In an experiment, the null hypothesis expects the independent variable to have no effect on the dependent variable. If changes in the dependent variable are observed, those changes are assumed to be solely due to random error.
   (B) Rejecting the null hypothesis does not *prove* that the null hypothesis is false. For a single experiment, rejecting the null hypothesis means that the data did not support the null hypothesis. It is difficult to ever *prove* the null hypothesis is false. However, if the null hypothesis is rejected for many experiments that examine the same phenomena, then we can be more confident that the results obtained are correct and that the null hypothesis is truly false.

2. *Practical significance* refers to how meaningful are the results to the average person. For example, a college prep course may claim that, on the average, its program significantly increases college entrance exam scores. This claim is made even though the significance is due to a small improvement in test scores and using a very large sample size. Just because the program *significantly* improves the average student's score by a few points doesn't mean that he or she is will to pay several hundred dollars for it. That's *not* practical.

3. Finding $t_{.05}$ for the one-sample *t*-test: The degrees of freedom (*df*) for the one-sample *t*-test are equal to N-1 where N is equal to the sample size. The value of $t_{.05}$ is found in the *t*-table under the .025 column for the obtained *df*.

   Finding $t_{.05}$ for the matched-pairs *t*-test: The degrees of freedom (*df*) for the one-sample *t*-test are equal to N-1 where N is equal to the number of pairs of scores (or number of subjects). The value of $t_{.05}$ is found in the *t*-table under the .025 column for the obtained *df*.

4. (A) Independent variable → Amount of biofeedback training. Two levels: None ("Before" condition) and Six weeks of training ("After" condition). Dependent variable → Number of severe headaches experienced over two weeks.
   (B) The null hypothesis expects subjects to experience the same number of headaches after the biofeedback training compared to before the training. Any observed difference is assumed to be solely due to random error and chance. The alternative hypothesis expects the number of headaches before the training to be significantly different (hopefully less) from the number of headaches reported after treatment. The observed difference will not be solely due to random error and chance but also a real effect of the biofeedback training.

(C) Statistical Conclusion: Since t_{obt} (8) = 4.09, p < .01; Reject the null hypothesis.

t-Test: Paired Two Sample for Means		
	Before	*After*
Mean	8.555556	2.888889
Variance	16.77778	5.111111
Observations	9	9
Pearson Correlation	0.250472	
Hypothesized Mean Difference	0	
df	8	
t Stat	4.093119	
P(T<=t) one-tail	0.001735	
t Critical one-tail	1.859548	
P(T<=t) two-tail	0.003471	
t Critical two-tail	2.306004	

(D) It appears that the average difference in number of severe headaches reported is not solely due to random error and chance but indicates a real effect of biofeedback training in reducing the frequency of severe headaches.

(E) A Type I error may have been made (p < .01)

5. A) Independent variable → Amount of preschool. Two levels: No preschool and two years of preschool. Dependent variable → IQ score at the end of two years.

(B) The null hypothesis expects each pair of identical twins to have the same IQ score after two years. Any observed difference in IQ scores is assumed to be solely due to random error and chance. The alternative hypothesis predicts that the kids who attend two years of preschool will have higher IQ scores compared to the kids who did not.

(C) Statistical Conclusion: Since t_{obt} (9) = 3.64, p < .01; Reject the null hypothesis.

t-Test: Paired Two Sample for Means		
	Preschool	*Home*
Mean	117.3	106.4
Variance	50.23333	118.9333
Observations	10	10
Pearson Correlation	0.512902	
Hypothesized Mean Difference	0	
df	9	
t Stat	3.635803	
P(T<=t) one-tail	0.002718	
t Critical one-tail	1.833113	
P(T<=t) two-tail	0.005436	
t Critical two-tail	2.262157	

(D) It appears that the average difference in IQ scores after two years is not solely due to random error and chance but indicates a real effect of attending preschool on improving overall intelligence scores.

6. (A) Independent variable → Type of slide shown. Two levels: pictures and nouns. Dependent variable → Number of items correctly recalled.

(B) The null hypothesis expects subjects in both conditions to correctly recall the same number of items. Any observed difference between the two groups is assumed to solely due to random error and chance. The alternative hypothesis expects the subjects in the *picture slide* condition to correctly recall more items compared to the subjects in the *noun slide* condition. The observed difference will not be solely due to random error and chance but a real difference in the effect of the type of slide shown.

(C) This is a two-sample *t*-test for independent groups.

t-Test: Two-Sample Assuming Equal Variances		
	# of Picts	*# of Nouns*
Mean	20.125	15.75
Variance	19.55357143	24.5
Observations	8	8
Pooled Variance	22.02678571	
Hypothesized Mean Difference	0	
df	14	
t Stat	1.864371647	
P(T<=t) one-tail	0.041686049	
t Critical one-tail	1.761310115	
P(T<=t) two-tail	0.083372098	
t Critical two-tail	2.144786681	

Statistical Conclusion: Since t_{obt} (14) = 1.86, p = .08; Fail to reject the null hypothesis.

(D) We cannot rule out the possibility that the observed difference in number of items correctly recalled between the picture group and noun group is solely due to random error and chance. It may be that the students are able to recall nouns just as easily as pictures. The failure to reject the null hypothesis could be due to low statistical power since each group only had eight subjects.

(E) 95% Confidence Interval for the difference between two sample means:

Formula: $\overline{X}_1 - \overline{X}_2 \pm \sqrt{\frac{SD_1^2}{n_1} + \frac{SD_2^2}{n_2}}(2.14)$ → $20.13 - 15.75 \pm \sqrt{\frac{19.55}{8} + \frac{24.5}{8}}(2.14)$

→ $4.38 \pm \sqrt{5.5}(2.14)$ → $4.38 \pm 2.35(2.14)$ → 4.38 ± 5.029

95% Confidence Interval: Lower Limit → -.649 Upper Limit → 9.409

(F) We can be 95% confident that the true difference between sample means for subjects who recalled 30 nouns (N = 8) versus subjects who recalled 30 pictures (N = 8) is in the range of -.649 items to 9.409 items.

7. (A) Independent variable → Amount of sleep deprivation. Two levels: None and 24 hours. Dependent variable → Number of correctly identified items from each slide. Ratio scale.
(B) Null hypothesis: The average number of items recalled by subjects sleep deprived for 24 hours will be the same as the average number of items recalled by subjects not sleep deprived. Any observed difference in average number of items recalled between these two groups is assumed to be solely due to random error. Alternative hypothesis: The sleep deprived group will recall a significantly smaller average number of items compared to the average number of items recalled by the group allowed to sleep 7 to 8 hours. This observed difference is not solely due to random error, but indicates a real effect of sleep deprivation.
(C) This is a two-sample *t*-test for independent groups.

t-Test: Two-Sample Assuming Equal Variances		
	Norm Sleep	*Sleep Deprived*
Mean	70.16666667	65.33333333
Variance	10.16666667	17.46666667
Observations	6	6
Pooled Variance	13.81666667	
Hypothesized Mean Difference	0	
df	10	
t Stat	2.252193677	
P(T<=t) one-tail	0.024000283	
t Critical one-tail	1.812461102	
P(T<=t) two-tail	0.048000566	
t Critical two-tail	2.228138842	

Statistical Conclusion: Since t_{obt} (10) = 2.25, p = .048; Reject the null hypothesis.

(D) It appears, on the average, subjects who were sleep deprived for 24 hours recalled fewer numbers from the slides shown compared to the subjects who were not sleep deprived. The observed difference between these averages does not appear to be solely due to random error, but suggests that sleep deprivation for 24 hours reduces the ability to correctly recall information recently shown.

Chapter 10

8. (A) The one-way or single factor chi-square test is used when you have one independent variable with at least two levels where each level contains frequency data. (B) The two-way or two-factor chi-square test is used when there are two independent variables, each with at least two levels where each cell contains frequency data.

9. The chi-square test requires the data to be of nominal scale. You can use the chi-square test to analyze interval and ratio data (after transforming the data into nominal scale), however, this would reduce statistical power.

10.

a. IV→ Color of Calculator; Levels→ Red, Blue, and Green. DV→ Frequency of color preferred; Scale→ Nominal.
b. Null hypothesis – Students will prefer all three colors equally. If any color(s) are preferred more or less compared to other colors, it is assumed that this preference is solely due to random error/chance. Alternative hypothesis – Students will not prefer all colors equally. One or more colors will be preferred more than the other colors. This difference will not be solely due to random error/chance.

c. One-Way Chi-Square Test:

OBSERVED FREQUENCIES:				
Red	Blue	Green		Total
96	82	32		210
EXPECTED FREQUENCIES:				
70	70	70		
CHI SQUARE FORMULA:				
9.657143	2.057143	20.62857		
OBTAINED CHI-SQUARE STATISTIC:				32.34286

Statistical Conclusion: Since χ^2 (2) = 32.34, $p < .001$; Reject the null hypothesis. The critical chi-square value at .05 with df=2 is 5.99.

d. Students did not prefer all three colors equally. It appears that students preferred the green colored calculators the least compared to red and blue colored calculators. The low frequency of preferring green colored calculators does not appear to be solely due to random error/chance, but suggests that, overall, students preferred red and blue over green.

11.

a. IV#1→ Preferred activity; 2 Levels→ Music and Reading. IV #2 → Brain dominance; 2 Levels → Right and Left. DV→ Frequency of preferred activity with brain dominance (4 cells/categories); Scale→ Nominal.

b. Null hypothesis – Participants' preferred activity (music or reading) is not contingent on brain dominance (right or left) . Any difference between observed and expected frequencies is solely due to random error/chance. Alternative hypothesis – Participants' preferred activity is dependent on their brain dominance. The observed frequencies will not be equal to the expected and this observation will not be solely due to random error/chance.

c. Two-way Chi-Square Test:

OBSERVED FREQUENCIES:

	Left Brain	Right Brain	
Music	48	18	**66**
Reading	35	26	**61**
	83	**44**	**127**

EXPECTED FREQUENCIES:

	Left Brain	Right Brain
Music	43.13386	22.866142
Reading	39.86614	21.133858

CHI-SQUARE FORMULA:		
	0.548973	1.0355632
	0.593971	1.1204455

Obtained Chi-Square Statistic: **3.298953**

Statistical Conclusion: Since $\chi^2(1) = 3.30$, $p = .069$; Fail to reject the null hypothesis. The critical chi-square value at .05 with df=1 is 3.84.

d. Based on the statistical test performed, choice of preferred activity is not dependent on brain dominance. The obtained differences between observed and expected frequencies may only be due to random error/chance.
e. Type II error.