

PSYC 316 – WORKSHEET 4 – ANOVA

1. How is ANOVA similar to and different from a t test?

ANOVA is similar to a t test in that the difference between means are examined. ANOVA is different in that more than two means are examined. Also, the F distribution is used instead of the t distribution.

2. What are the similarities and differences between ANOVA and regression?

Similarities include that they are both forms of the GLM (and as such use a linear model), both have continuous DVs, they both partition sums of squares, use degrees of freedom and mean square terms, look at F-ratios to test the overall model, and have the same assumptions for the most part (normality, homoscedasticity and independence).

Differences are that unlike regression the predictors code for levels of categorical variables, rather than continuous ones, and unlike regression, the predictors are uncorrelated with each other. ANOVA also breaks down the variability using different names (between group and within group rather than model and residual).

3. How would you interpret the following equation: $H_1: M_1 \neq M_2 \neq M_3$?

The above equation is a research hypothesis indicating that there is an overall difference between means in the three groups being tested. The hypothesis is non-directional because it does not posit where the differences are.

4. Describe this symbol: η^2

It is known as “omega squared”, an estimate of eta squared. Eta squared is biased because it's based purely on the sums of squares from the sample and no adjustment is made for the fact we're trying to estimate the effect size of the population. So omega squared is less biased as it uses the variance explained by the model, and the error variance.

5. What is an omnibus test?

An omnibus test refers to a test that examines the overall differences between means. ANOVA is an omnibus test.

6. What does the between-group sum of squares assess? What does the within-group sum of squares assess?

Between-group sum of squares looks at how different each group's mean is from the overall mean. Within-group sum of squares looks at how different each score in the group is from the mean of that group.

7. Define post hoc testing.

Post hoc testing means after the fact. It refers to tests done to determine where the differences lie – that were not specified a priori. For example, in ANOVA, each mean is compared to the other mean.

8. What is the difference between post hoc testing and planned comparisons?

Planned contrasts are one-directional comparisons based on hypotheses that are made BEFORE the data has been collected. They look only at specific comparisons the researcher has determined a priori. Post hocs are two directional comparisons looking at every single comparison that is possible to be made. They are essentially doing a whole bunch of t-tests. Post hocs are done to determine if some unexpected difference between two groups is statistically significant. They are more for exploratory purposes.

9. Describe the rules for choosing contrasts, and the rules for coding them.

There are three rules for choosing contrasts: 1) they must be independent, 2) there must be only 2 chunks compared, and 3) you will end up with k-1 contrasts.

There are 5 rules for coding them: 1) positive weights vs. negative weights, 2) sum of weights = 0, 3) if group not involved it gets coded as 0, 4) the weights assigned to group(s) of one chunk will be equal to the number of groups in the other chunk, and 5) if a group is singled out in a comparison, then will not be used in any subsequent contrasts.

10. What are the 4 different post hoc tests when equal variance is assumed? How do they differ? Bonferroni, Scheffe, Tukey and LSD. Bonferroni is most conservative, controlling for alpha the best, but thus has least power. LSD is least conservative, doesn't control alpha at all, but has most power. Tukey and Scheffe are both in the middle, providing some control over alpha.

11. What does "orthogonal" mean? Refers to independence of comparisons, so that the family-wise type 1 error rate is not inflated.

12. What are the assumptions of ANOVA? Distribution of errors - residuals are random/independent Homogeneity of variance – residuals have constant and equal variance Normality – residuals are normal in shape

13. You are evaluating three different teaching methods to see whether they have an effect on final exam performance. You hypothesize that the teaching method that rewards students will result in a higher exam mark than the teaching methods that punish students or are indifferent. What type of analysis should be conducted? Interpret the SPSS output below. Include a model statement.

Descriptive Statistics

Dependent Variable: ExamMark

Type of Teaching Method	Mean	Std. Deviation	N
Punish	50.0000	4.13656	10
Indifferent	56.0000	7.10243	10
Reward	65.4000	4.29987	10
Total	57.1333	8.26181	30

Tests of Between-Subjects Effects

Dependent Variable: ExamMark

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power ^a
Corrected Model	1205.067 ^b	2	602.533	21.008	.000	42.015	1.000
Intercept	97926.533	1	97926.533	3414.277	.000	3414.277	1.000
group	1205.067	2	602.533	21.008	.000	42.015	1.000
Error	774.400	27	28.681				
Total	99906.000	30					
Corrected Total	1979.467	29					

- a. Computed using alpha = .05
- b. R Squared = .609 (Adjusted R Squared = .580)

Parameter Estimates

Dependent Variable: ExamMark

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval		Noncent. Parameter	Observed Power ^a
					Lower Bound	Upper Bound		
Intercept	65.400	1.694	38.617	.000	61.925	68.875	38.617	1.000
[group=1.00]	-15.400	2.395	-6.430	.000	-20.314	-10.486	6.430	1.000
[group=2.00]	-9.400	2.395	-3.925	.001	-14.314	-4.486	3.925	.966
[group=3.00]	0 ^b

- a. Computed using alpha = .05
- b. This parameter is set to zero because it is redundant.

A one-way ANOVA should be calculated using the General Linear Model.

The Model is $Y = b_0 + b_1X_1 + E$ OR Exam Mark = Intercept + slope*Group + Error

Based on the results of the GLM, there was a significant main effect for group assignment ($F(2,27) = 21.008, p < .001$). Group assignment accounted for 58% of the variance in exam mark. Follow-up comparisons indicated that punishment (group 1) had a significantly lower exam mark ($M = 50.0, SD = 4.14$) than reward (group 3; $M = 65.4, SD = 4.3; t = -6.43, p < .001$). The indifferent group (group 2) also had a significantly lower exam mark ($M = 56.0, SD = 7.10$) than reward ($t = -3.93, p < .001$).