Name:_____________________________
MyID:_____________________________

Assignment 11
Part I

1. 1) Dr. Alucard is interested in the auditory discrimination abilities of bats. First, he trains 21 bats to fly from a perch at one end of the experimental chamber to the food box at the other end of the room. He then constructs three different mazes of vertical wires (similar to the maze seen in the movie for the cats, but they go from floor to ceiling with a small opening to allow the bat to move through one wall of wire to the next) between the starting perch and the food box. In one maze the wires are Thick, in one maze the wires are Intermediate, and in the final maze the wires are Thin. Each maze is different (openings are in different locations). The dependent variable he decides to use is the number of times a bat hits the wires of the maze. Dr. Alucard decides to use a repeated measures design for this experiment. Why might he decide to do so? Give Dr. Alucard specific instructions as to how he should construct his experiment (how many bats he should use, how he should run each bat through the experiment, etc.).
   Solution:
1. He would use a repeated measures design to gain the greatest power.
   The first "trick" is to recognize the implications of the repeated measures design. That is, with three levels of the IV, we would use complete counterbalancing. Thus, we would need to run 6, 12, or 18 bats. Any of those numbers would work (but not all 21), though power concerns would dictate using 18.
   The 6 orders would be:
   O1 Thick Intermediate Thin
   O2 Thick Thin Intermediate
   O3 Intermediate Thick Thin
   O4 Intermediate Thin Thick
   O5 Thin Intermediate Thick
   O6 Thin Thick Intermediate
   So, the first bat might go through the mazes in O1, the second bat in O2, etc., then when you get to the 7th bat, you would start using the orders over again. The path through the maze would be changed between the runs through the maze (as the wire widths were changed). [So the bat would need to use a different flight path each time.] You'd need to think of some way to detect the # of times that the bat hits the wires (for the DV).

   2) Below are the means and a completed ANOVA source table for Dr. Alucard's experiment.

	Thin wire	Intermediate wire	Thick wire
Mean # of touches	5	1	0

source	SS	DF	MS	F
Treatments(wire width)	126	2	63	31.5
Subject	1	17		

Error	68	34	2

Does it appear that Dr. Alucard realized any advantage from using a repeated measures design in this experiment? Why or why not?
You should note that the $SS_{Subject}$ is quite small (1), so Dr. A will not have removed much in the way of individual differences. As a result, you will likely not have realized much of an advantage from the use of a repeated measures design.

2. A researcher was interested in investigating the relationship between the amount of time on task per day (no homework, ½ hour, 1 hour, 1 and ½ hours, and 2 hours) and phonological awareness of struggling readers in kindergarten. 8 kids participated in the experiment. The table below summarizes results. Answer the following questions.

Mauchly's Test of Sphericity[b]

Measure:MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[a] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
phonological	.702	7.8	5	.168	.805	1.000	.453

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
phonological	Sphericity Assumed	194.500	(1)	64.833	47.772	.000
	Greenhouse-Geisser	194.500	1.257	154.733	47.772	.000
	Huynh-Feldt	194.500	1.403	138.632	47.772	.000
	Lower-bound	194.500	1.000	194.500	47.772	.000
Error(phonological)	Sphericity Assumed	28.500	(2)	1.357		
	Greenhouse-Geisser	28.500	8.798	3.239		
	Huynh-Feldt	28.500	9.818	2.903		
	Lower-bound	28.500	7.000	4.071		

1. Complete the degree of freedoms for (1) and (2) in the table.
   See the table.
2. Is there any evidence to indicate that the assumption of sphericity has been violated? State an appropriate test statistic and a descriptive statistic.
   No. There is not enough evidence of the assumption violation: Mauchly's W=.702, p=.168.
3. Is there significant main effect of time on task on phonological awareness?
   Yes. There is significant effect of time on task on phonological awareness: F(3,21)=47.772, p=.000.
4. What is the effect size of time on task?
   The effect size of the time on task is

$$\eta^2 = \frac{SS_A}{SS_A + SS_{AxS}} = \frac{194.5}{194.5 + 28.5} = .872$$

Mauchly's Test of Sphericity[b]

Measure:MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[a] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
phonological	.702	7.8	5	.168	.805	1.000	.453

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
phonological	Sphericity Assumed	194.500	3	64.833	47.772	.000
	Greenhouse-Geisser	194.500	1.257	154.733	47.772	.000
	Huynh-Feldt	194.500	1.403	138.632	47.772	.000
	Lower-bound	194.500	1.000	194.500	47.772	.000
Error(phonological)	Sphericity Assumed	28.500	21	1.357		
	Greenhouse-Geisser	28.500	8.798	3.239		
	Huynh-Feldt	28.500	9.818	2.903		
	Lower-bound	28.500	7.000	4.071		

Part II: SPSS

For 16 consecutive days, a researcher chooses one random visitor at the zoo to follow around during their visit and records the number of minutes they each spend visiting 4 animals: monkey, elephant, meerkat, and koala. He wants to use ANOVA to determine if there are differences in the average number of minutes a person spends visiting the different animals.
The data he recorded can be found in the file zoo.sav.

1. Before running a within-subects design analysis of variance, you want to test for the assumption of sphericity. Why? (What is the result if this assumption is violated?)
   The omnibus F test will be positively biased; your Type I Error rate will be inflated. If the assumption of sphericity is violated, then you need to make adjustments in your F test.

2. Test the assumption of sphericity. Report the test statistic, related p-value, and your conclusion about whether or not the assumption of sphericity has been violated.
   Yes, the assumption has been violated. Mauchly's Test of Sphericity yields $x^2(5) = 12.96$, p=0.024.

Mauchly's Test of Sphericity[b]

Measure:MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[a]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
factor1	.389	12.957	5	.024	.651	.747	.333

3. Conduct the statistical test to determine whether or not individuals spend an equal amount of time visiting each of these 4 animals at the zoo. Report the F-statistic, degrees of freedom, p-value, and effect size associated with your test. What is your conclusion?
   Using the Huynh-Feldt adjusted degrees of freedom, we reject the null hypothesis that visitors spent an equal amount of time visiting each animal (F(2.24, 33.60)=5.229, p =0.008, Partial Eta squared = 0.258). Note: You could have also similarly used the Greenhouse-Geisser adjustment.)

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
factor1	Sphericity Assumed	313.812	3	104.604	5.229	.003	.258
	Greenhouse-Geisser	313.812	1.952	160.790	5.229	.012	.258
	Huynh-Feldt	313.812	2.240	140.100	5.229	.008	.258
	Lower-bound	313.812	1.000	313.812	5.229	.037	.258
Error(factor1)	Sphericity Assumed	900.188	45	20.004			
	Greenhouse-Geisser	900.188	29.275	30.749			
	Huynh-Feldt	900.188	33.599	26.792			
	Lower-bound	900.188	15.000	60.013			

4. From your output, show which Mean Square values were used to calculate the F-statistic for number (3).
   The mean square for the repeated measures factor A (140.10) was divided by the mean square for the interaction of subject by factor A (AxS) (26.79) to yield the F statistic of 5.229.

5. Using pairwise comparisons (Options->Display Means for Factor 1 -> Check "Compare Main Effects"-> select "Bonferonni adjustment"), describe for which animals there exists a statistically significant difference in the amount of time they are visited at the zoo.
   The meerkat is visited more often than the elephant and koala ($p = 0.041, 0.004$).
   The monkey is visited more often that the koala ($p = 0.032$).

Estimated Marginal Means

factor1

Estimates

Measure:MEASURE_1

factor1	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	10.188	.988	8.081	12.294
2	13.250	1.752	9.515	16.985
3	8.625	1.143	6.188	11.062
4	7.313	.921	5.350	9.275

Pairwise Comparisons

Measure:MEASURE_1

(I) factor1	(J) factor1	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	-3.063	1.922	.132	-7.160	1.035
	3	1.563	1.297	.247	-1.203	4.328
	4	2.875*	1.214	.032	.287	5.463
2	1	3.063	1.922	.132	-1.035	7.160
	3	4.625*	2.069	.041	.214	9.036
	4	5.938*	1.757	.004	2.192	9.683
3	1	-1.563	1.297	.247	-4.328	1.203
	2	-4.625*	2.069	.041	-9.036	-.214
	4	1.313	.884	.158	-.571	3.196

4	1	-2.875*	1.214	.032	-5.463	-.287
	2	-5.938*	1.757	.004	-9.683	-2.192
	3	-1.313	.884	.158	-3.196	.571

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

*. The mean difference is significant at the .05 level.