Name:______________________________
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Assignment 8
Part I

The following item is selected from the textbook (Keppel & Wickens).

1. (12.2 in textbook). Consider the data in the numerical example in Table 11.8.
   a. Test the significance of the simple effects of factor B.
   b. Show that the total sum of squares associated with the three simple effects equals the sum of SS_B and SS_{AxB}

   Table 11.8

	1-hour deprivation			24-hour deprivation		
	Control (a_1b_1)	Drug X (a_2b_1)	Drug Y (a_3b_1)	Control (a_1b_2)	Drug X (a_2b_2)	Drug Y (a_3b_2)
	1	13	9	15	6	14
	4	5	16	6	18	7
	0	7	18	10	9	6
	7	15	13	13	15	13
AB_{jk}	12	40	56	44	48	40
$\sum Y^2$	66	468	830	530	666	450
$\overline{Y}_{jk}$	3.00	10.00	14.00	11.00	12.00	10.00
s_{jk}	3.162	4.761	3.916	3.916	5.477	4.082
s_{Mjk}	1.581	2.381	1.958	1.958	2.739	2.041

Solution:
Rearrange Table 11.8:
Factor B= hours of deprivation
Factor A=Groups

Factor A	Factor B: 1-hour deprivation	Factor B: 24-hour deprivation	mean
Control (a_1)	3	11	7
Drug x(a_2)	10	12	11
Drug Y(a_3)	14	10	12
mean	9	11	

a. Test the significance of simple effects of factor B.
   1) Simple effect of factor B at Control Group level (a_1)

$$SS_{B\text{ at }a1} = n\sum_j(\overline{Y}_{j1} - \overline{Y}_{A_1}) = 4*[(3-7)^2 + (11-7)^2] = 128$$

$df_{B\text{ at }a1}$=2-1=1

$MS_{B\ at\ a1}$=128

$$[AB] = \frac{\sum (AB_{jk})^2}{n} = \frac{12^2 + 44^2 + 40^2 + 48^2 + 56^2 + 40^2}{4} = 2680$$

$$[Y] = \sum Y_{ijk}^2 = 66 + 468 + 830 + 530 + 666 + 450 = 3010$$

$SS_{S/AB}$ =[Y]-[AB]=3010-2680=330

$df_{S/AB}$=ab(n-1)=2*3(4-1)=18

$MS_{S/AB}$=330/18=18.3333

To calculate the F ratio, we assume that the assumption of homogeneity is met, so we use the error term of $MS_{S/AB}$.

$F_{B\ at\ a1}$= $MS_{B\ at\ a1}$/ $MS_{S/AB}$=128/18.3333=6.98

2) Simple effect of factor B at Drug X level (a_2)

$$[\text{B at } a_2] = n\sum_j \overline{Y}_{j2}^{\,2} = 4(10^2 + 12^2) = 976$$

$$[\text{T at } a_2] = bn\sum_j \overline{Y}_{A2}^{\,2} = 2*4*(11^2) = 968$$

$SS_{B\ at\ a2}$= [B at a_2] – [T at a_2] = 976-968=8

$df_{B\ at\ a2}$=2-1=1

$MS_{B\ at\ a2}$=8

$MS_{S/AB}$=330/18=18.3333

$F_{B\ at\ a2}$= $MS_{B\ at\ a2}$/ $MS_{S/AB}$=8/18.3333=0.4364

3) Simple effect of factor B at Drug Y level (a_3)

$$[\text{B at a3}] = n\sum_j \overline{Y}_{j3}^{\,2} = 4(14^2 + 10^2) = 1184$$

$$[\text{T at } a_3] = bn\sum_j \overline{Y}_{A3}^{\,2} = 2*4*(12^2) = 1152$$

$SS_{B\ at\ a3}$= [B at a_3] – [T at a_3] = 1184-1152=32

$df_{B\ at\ a3}$=2-1=1

$MS_{B\ at\ a3}$=322

$MS_{S/AB}$=330/18=18.3333

$F_{B\ at\ a3}$= $MS_{B\ at\ a3}$/ $MS_{S/AB}$=32/18.3333=1.7455

b. Show that the total sum of squares associated with the three simple effects equals the sum of SS_B and SS_{AxB}

Solution:

$SS_{B\ at\ a1}$+ $SS_{B\ at\ a2}$+ $SS_{B\ at\ a3}$=128+8+32=168

$$[\text{B}] = \frac{\sum B_k^{\,2}}{an} = \frac{108^2 + 132^2}{3*4} = 2424$$

$$[\text{T}] = \frac{T^2}{abn} = \frac{240^2}{3*2*4} = 2400$$

SS_B=[B]-[T]=2424-2400=24

[A]= $\frac{\sum A_j^{\ 2}}{bn} = \frac{56^2 + 88^2 + 96^2}{2*4} = 2512$

[AB]= $\frac{\sum (AB_{jk})^2}{n} = \frac{12^2 + 44^2 + 40^2 + 48^2 + 56^2 + 40^2}{4} = 2680$

SS_{AxB}=[AB]-[A]-[B]+[T]=2680-2512-2424+2400=144

SS_B+ SS_{AxB}=24+144=168

2. Use the following design matrix to write the null hypothesis for the contrast, simple, or main effect which would be tested to answer the following questions:

   a) Is there a main effect for Factor A?
   b) For individuals receiving level 2 of Factor B, is there a difference between levels 1 and 3 of Factor A?
   c) Across levels of Factor A is there a difference between levels of Factor B?
   d) Is there a simple effect for Factor A at level 1 of Factor B?
   e) For individuals in the level 4 of Factor A, is there a difference between levels of Factor B?

	a_1	a_2	a_3	a_4	
b_1	$\bar{Y}_{.11}$	$\bar{Y}_{.12}$	$\bar{Y}_{.13}$	$\bar{Y}_{.14}$	$\bar{Y}_{.1.}$
b_2	$\bar{Y}_{.21}$	$\bar{Y}_{.22}$	$\bar{Y}_{.23}$	$\bar{Y}_{.24}$	$\bar{Y}_{.2.}$
	$\bar{Y}_{..1}$	$\bar{Y}_{..2}$	$\bar{Y}_{..3}$	$\bar{Y}_{..4}$	$\bar{Y}_{...}$

Solution:

Use the following design matrix to write the null hypothesis for the contrast, simple, or main effect which would be tested to answer the following questions:

a) Is there a main effect for Factor A? $H_0: \mu_{..1} = \mu_{..2} = \mu_{..3} = \mu_{..4}$

b) For individuals receiving level 2 of Factor B, is there a difference between levels 1 and 3 of Factor A? $H_0: \mu_{.21} = \mu_{.23}$

c) Across levels of Factor A is there a difference between levels of Factor B? $H_0: \mu_{.1.} = \mu_{.2.}$

d) Is there a simple effect for Factor A at level 1 of Factor B?
$H_0: \mu_{.11} = \mu_{.12} = \mu_{.13} = \mu_{.14}$

e) For individuals in the level 4 of Factor A, is there a difference between levels of Factor B? $H_0: \mu_{.14} = \mu_{.24}$

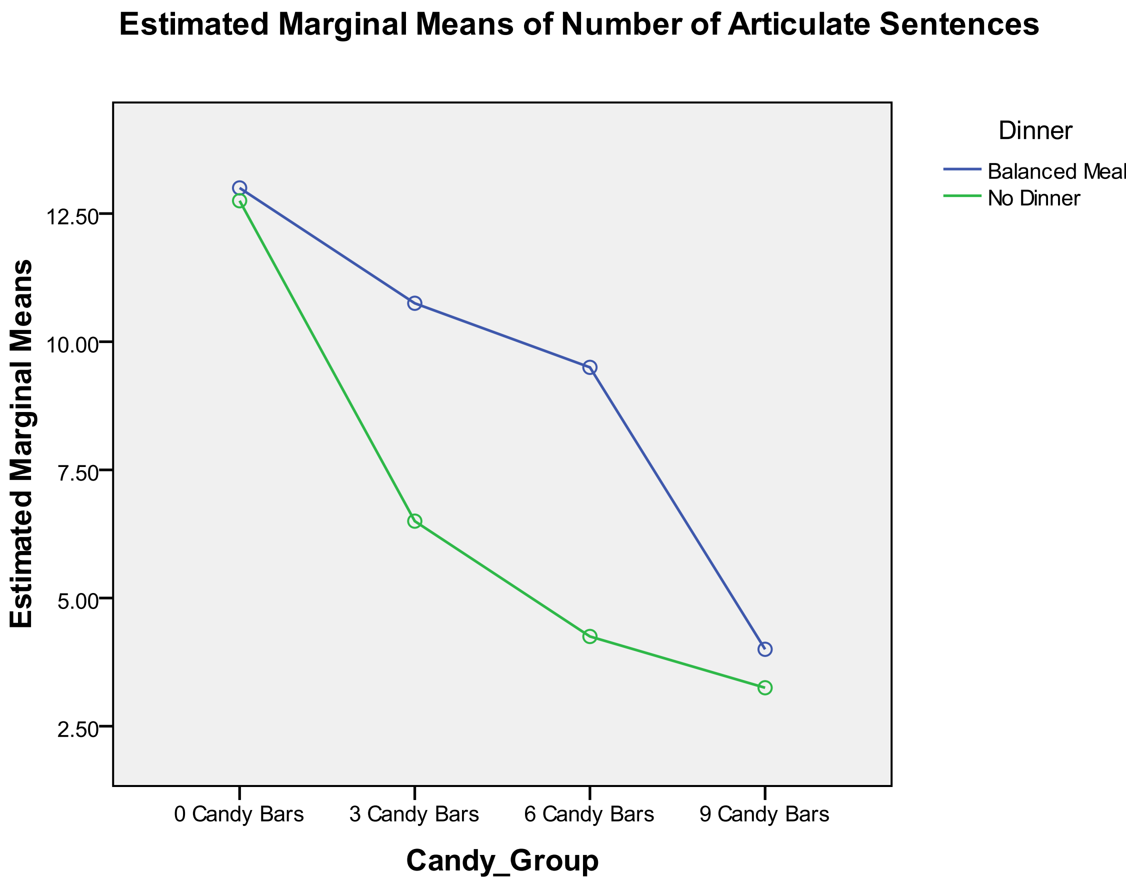
3. a) For number 2, part b, are you testing a main effect, simple effect or a contrast?
   b) For number 2, part c, are you testing a main effect, simple effect or a contrast?
   c) For number 2, part e, are you testing a main effect, simple effect or a contrast?

   Solution:
   a) For number 2, part b, are you testing a main effect, simple effect or a contrast?
      Contrast
   b) For number 2, part c, are you testing a main effect, simple effect or a contrast?
      Main
   c) For number 2, part e, are you testing a main effect, simple effect or a contrast?
      Simple

Part II: SPSS

A researcher is interested in examining the impact of Halloween candy consumption on children's verbal fluency. He believes the effect will depend on whether children were forced to eat dinner prior to trick-or-treating. There are four levels of candy consumption: 0, 3, 6, and 9 candy bars (Factor A) and two levels of dinner: none vs. balanced meal (Factor B). Four children were randomly assigned to each group. After the children's respective 'treatment' condition was issued, the number of coherent sentences each child uttered during a 30 minute period was recorded.

1) Conduct a Two-way ANOVA
   a. Provide a verbal description of your means plot



[There appears to be an interaction between the independent variables; differences in verbal fluency between levels of 'candy consumption' may depend on whether or not the children ate dinner]

b. Provide the Interaction F value, df, p value, and effect size

[$F(3,24)=3.437$, $p=.033$, $\eta_p^2=.301$]

Tests of Between-Subjects Effects

Dependent Variable:Number of Articulate Sentences

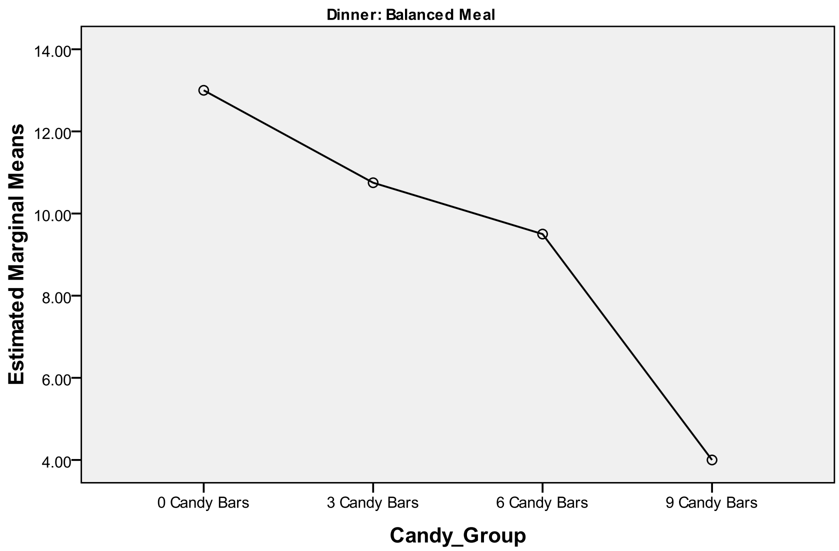
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	449.000[a]	7	64.143	17.695	.000	.838
Intercept	2048.000	1	2048.000	564.966	.000	.959
Candy_Group	356.500	3	118.833	32.782	.000	.804
Dinner	55.125	1	55.125	15.207	.001	.388
Candy_Group * Dinner	37.375	3	12.458	3.437	.033	.301
Error	87.000	24	3.625			

Total	2584.000	32				
Corrected Total	536.000	31				

R Squared = .838 (Adjusted R Squared = .790)

2) When a child eats a balanced meal, is there a relationship between candy consumption and verbal fluency? (Report the findings of this simple effect)

Estimated Marginal Means of Number of Articulate Sentences



To test the simple effect, the data file was split by 'dinner'. This allowed for the production of two One Way ANOVA tables (one for 'balanced meal' and one for 'no dinner'). You were asked to interpret the output for 'balanced meal'. The data file was labeled so that a 'balanced meal' was b_1 and 'no dinner' was b_2. To get the F ratio, you had to divide $MS_{A \text{ at } b1}$ by $MS_{s/AB}$ from the full factorial table—58.563/3.625 = 16.155. Next, you use Excel to find the p value ('=FDIST(16.155,3,24)' = .00000585). If you want to calculate the effect size, remember to use the appropriate Sums of Squares
$\eta_p^2 = SS_{A \text{ at } b1}/(SS_{A \text{ at } b1} + SS_{S/AB}) = 175.688/(175.688 + 87.000) = .669$

Therefore…**[The null hypothesis is rejected; when children eat a balanced meal, significant differences still exist between the levels of Halloween candy consumed and their verbal fluency. Furthermore, at this level of 'dinner', approximately 67% of the variation in verbal fluency is attributable to level of candy consumed. F (3,24) = 16.155, p<.001, η_p^2 = .669).]**

3) If you were to continue the analysis, provide the contrast coefficients for comparing 0 candy bars consumed to all other levels of candy consumption.

Both answers will be accepted. However, when we compare the control to every other level, we are performing 3 separate contrasts.
[1, -1, 0, 0] compares the control (0 candy bars) to level 2 (3 candy bars)
[1, 0, -1, 0] compares the control to level 3 (6 candy bars)
[1, 0, 0, -1] compares the control to level 4 (9 candy bars)

When we compare the control to the AVERAGE of all other levels:
[1, -.333, -.333, -.333]
This is the first contrast in a 'Helmert' contrast. It compares 'level 1 vs. later'. The next two contrasts that complete the 'Helmert' are [0, 1, -.5, -.5]—'level 2 vs. later' and [0, 0, 1, -1]—'level 3 vs. later'.

a. What will the results of the simple comparison be 'conditional on'? In other words, describe what the contrast results will tell us.

[Contrasts for Simple Effects or 'Simple Comparisons' are always conditional on the level of the factor you are testing at. For this example, the result of each contrast (whether differences among group means are significant) will be conditional on the fact that children ate a balanced meal prior to trick-or-treating.]