Laboratory for Two-Factor Designs

Transition from the single-factor design to the two-factor design
1. First consider the following data set:

	Control	Experimental
Male	3 4 5 4 6	4 6 5 7 6
Female	7 6 8 7 9	8 9 7 8 9

Analyze these data (*One.Two.sav*) as a one-way ANOVA on the Group factor (ignoring Gender). Because I've input the IV info as string variables, you'll have to use the *General Linear Model -> Univariate* approach in SPSS. (Your factors are considered Fixed Factors.) Complete the source table below with info from your analysis:

Source	**SS**	**df**	**MS**	**F**	**sig.**
GROUP					
Error					
Corrected Total					

Now, think of the analysis as a two-way ANOVA by introducing Gender as a factor. Can you determine what information will stay the same and what will change as you move from a one-way ANOVA to a two-way ANOVA on the same data?

Re-compute the ANOVA as a two-way ANOVA (on Group and Gender) to complete the source table below. (Notice that the two-factor independent groups analysis requires three columns — one for each of the two independent variables and one for the dependent variable.) Again, you'll use the *General Linear Model*, but now will have two levels of the factor. With this analysis, get SPSS to print the means and a plot of your results.

Source	**SS**	**df**	**MS**	**F**	**sig.**
GROUP					
GENDER					
GROUP * GENDER					
Error					
Corrected Total					

What happens to the probability level (sig.) for the Group effect as you changed from a one-way to a two-way ANOVA of the same data? Can you articulate why you got that result?

Now, consider the data as a one-way ANOVA, but with each of the four conditions separate. That is, think of the data as occurring in four cells (Male Control, Female Control, Male Experimental, Female Experimental) that you will analyze as a one-way ANOVA. Can you predict how your source table will look? What information will stay the same as in the two-way ANOVA? What will change? Re-compute the analysis as a one-way ANOVA (using the *oneway* column as your factor) to complete the source table below.

Source	**SS**	**df**	**MS**	**F**	**sig.**
ONEWAY					
Error					
Corrected Total					

Can you connect the $SS_{Treatment}$ and $df_{Treatment}$ for this analysis to that for the two-way analysis?

Computing a Brown-Forsythe Test for Homogeneity of Variance in a Two-Way ANOVA
2. Consider a very simple data set (2x2), in the Two-Way folder called *Two-Way.BF.sav*.

A_1B_1	A_1B_2	A_2B_1	A_2B_2
1	7	5	3
2	8	6	2
3	9	7	4
2	8	6	3
1	7	5	2

a. To begin with, compute a Brown-Forsythe analysis on the data to determine the homogeneity of variance of the data. To do so requires that you first create a new column for grouping information that designates four different groups (e.g., what I've called *group*, with unique labels 11, 12, 21, 22) prior to determining the medians of the groups and computing the z-trans scores. At the same time as you compute the medians, write the means for each group.

	A_1B_1	A_1B_2	A_2B_1	A_2B_2
Median				
Mean				

To compute your Browne-Forsythe analysis, remember that you're going to need to compute *ztrans* scores and then compute a one-way ANOVA on the *ztrans* scores for each condition.

$F_{B\text{-}F}$ = . So, your conclusion would be:

b. Compute the ANOVA and interpret the results. Producing an output with means and a plot will help you in this task.

Source	**SS**	**df**	**MS**	**F**
A				
B				
A*B				
Error				
Corrected Total				

c. Given that you should have found a significant interaction, you now need to explain where the interaction came from. Does the graph of your means help you to determine the source of the interaction? Compute the appropriate post hoc analyses to allow you to fully interpret the interaction. You could approach the problem in many different ways, but let's start by comparing the simple effects of B at each level of A. First, use the ANOVA/*F* approach. Then use the critical mean difference approach (which should be faster). Note that these are post hoc comparisons, so you should be using the Tukey/Kramer approach. Note, also, that in the absence of heterogeneity, you would use the pooled error term for MS_{Error}.

	F_{Comp}	F_{Crit}
B_1 vs. B_2 at A_1		
B_1 vs. B_2 at A_2		

Critical mean difference (Tukey's HSD):

	Difference	**Critical Difference**
$\lvert A_1B_1 - A_1B_2 \rvert$		
$\lvert A_2B_1 - A_2B_2 \rvert$		

How would you interpret the interaction?

d. Estimate the effect size for the three effects here using the partial omega squared approach.

$$\hat{\omega}^2_{<effect>} = \frac{df_{effect}(F_{effect} - 1)}{df_{effect}(F_{effect} - 1) + abn}$$

$\hat{\omega}^2_{Group}$	
$\hat{\omega}^2_{Gender}$	
$\hat{\omega}^2_{GroupxGender}$	

3. Finally, look at the data from K&W p. 239, Exercise 1 (*K&W.239.1.sav*). Can you figure how you'd compute a Brown-Forsythe test on these data? I'll spare you the actual computation of *ztrans*, because it's a bit redundant with 15 levels, so it's already in the file — all you need to do is to compute the ANOVA on *ztrans*. However, you should be able to articulate how you would have computed *ztrans*.

a. Next, compute the overall ANOVA.

Source	**SS**	**df**	**MS**	**F**
SHOCK				
TASK				
SHOCK * TASK				
Error				
Corrected Total				

b. Look at the source table from your overall ANOVA. Suppose that you recomputed the ANOVA as a one-way ANOVA on Shock. Can you predict what the F-ratio would be? Re-compute the ANOVA as a one-way ANOVA on Shock Level to see if you're correct.

Source	**SS**	**df**	**MS**	**F**
Shock Level				
Residual (Error)				

c. Compute a planned comparison between the Shock 1/Hard and the Shock 5/Hard groups.

d. Write the means for each of the conditions below. Compute simple effects analyses in an effort to understand the interaction.

	Shock 1	**Shock 2**	**Shock 3**	**Shock 4**	**Shock 5**
Easy					
Medium					
Hard					

e. Use the computer to determine post hoc comparisons needed to interpret the simple effects.

f. Use the Tukey's critical mean difference approach to do the same post hoc analyses.

g. Estimate the effect size for the three effects here using the partial omega squared approach.

$$\hat{\omega}^2_{<effect>} = \frac{df_{effect}(F_{effect} - 1)}{df_{effect}(F_{effect} - 1) + abn}$$

$\hat{\omega}^2_{Shock}$	
$\hat{\omega}^2_{Task}$	
$\hat{\omega}^2_{ShockxTask}$	