Laboratory Exercise for the Three-Factor Independent Groups Design

1. For the first part of this exercise, we will use the data set for an exercise from Maxwell & Delaney's text (M&D.325.sav). Note that the book excerpt steps you through the analysis of the data set. You should read the excerpt, both to get a sense of the nature of the study, and to determine the flow of analyses that the authors suggest.

a. Before you compute an ANOVA on these data, it probably makes sense to compute a Brown-Forsythe test on the data. The process is a bit cumbersome, but not all that difficult. First, I would give each group (Dummy) a unique label (1-12), then compute the median on each group. Then I would compute the *ztrans* score for each participant. The Brown-Forsythe source table would look like:

ANOVA

ZTRANS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	293.500	11	26.682	.627	.799
Within Groups	2553.000	60	42.550		
Total	2846.500	71			

With $F = .627$, it's clear that you would have little concern about heterogeneity of variance. Alternatively, of course, we could have SPSS compute the Levene test on these data, with a similar result:

Test of Homogeneity of Variances

HYPERTNS

Levene Statistic	df1	df2	Sig.
.770	11	60	.668

Note that M&D talk about the importance of assessing homogeneity of variance in the process of determining the appropriate error term for analyses (p. 328).

b. The first step in the flow chart is to determine if the three-way interaction is significant. To that end, compute the overall ANOVA. Your results should look like the source table below:

Tests of Between-Subjects Effects

Dependent Variable: HYPERTNS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Corrected Model	13194.000[b]	11	1199.455	7.656	.000	84.217	1.000
Intercept	2450898.00	1	2450898.00	15644.030	.000	15644.030	1.000
DIET	5202.000	1	5202.000	33.204	.000	33.204	1.000
BIOFDBK	2048.000	1	2048.000	13.072	.001	13.072	.945
DRUG	3675.000	2	1837.500	11.729	.000	23.457	.992
DIET * BIOFDBK	32.000	1	32.000	.204	.653	.204	.073
DIET * DRUG	903.000	2	451.500	2.882	.064	5.764	.543
BIOFDBK * DRUG	259.000	2	129.500	.827	.442	1.653	.185
DIET * BIOFDBK * DRUG	1075.000	2	537.500	3.431	.039	6.862	.623
Error	9400.000	60	156.667				
Total	2473492.00	72					
Corrected Total	22594.000	71					

a. Computed using alpha = .05

b. R Squared = .584 (Adjusted R Squared = .508)

• But wait! Before you continue with a routine analysis of these data, let's take a minute to think about the analysis. You have 12 conditions in this study (2x2x3). That means that you could think about this study as a single factor experiment with 12 levels. If you were to compute such a one-way ANOVA on these data, what would your source table look like?

Source	***SS***	***df***	***MS***	***F***
Treatment				
Error				

• When you compare the two source tables, you should see how the *df* tell you something important about the nature of the analysis. How does the three-way ANOVA relate to the one-way ANOVA?

• OK, as long as you've come this far, let's try another thought exercise. Suppose that you were to re-analyze these data as a two-way ANOVA on Biofeedback and Drug (ignoring Diet). Can you predict what your two-way ANOVA would look like?

Source	***SS***	***df***	***MS***	***F***

Enough already! Back to the routine analysis of these data…

c. Given the significant interaction, your next step would be to look at particular two-way interactions (e.g., the *A x B* interaction a individual levels of *C*, p. 330). What I would do first is to generate some graphs. The general rule that I suggest for two-way ANOVAs is to place the variable with the greater number of levels on the x-axis. For a three-way ANOVA, I suggest that you choose the variable with the fewest number of levels as the one you use to generate the graphs, because that will give you the smallest number of figures to compare. M&D have chosen to look at the Biofeedback x Drug interaction at each level of Diet, which produces the two graphs seen on p. 336 (Fig. 8.3). Note that SPSS will produce the same graphs, though they are crude. Generate the graphs for this data set. If you are interested in publication-quality graphs, you'll have to turn to special-purpose graphing software.

• The first analysis (a simple interaction test) would be to compute the Biofeedback x Drug interaction for Diet Absent. The second analysis would be to compute the Biofeedback x Drug interaction for Diet Present. Compute both those analyses and write the necessary summary data below. Of course, given the results of the Brown-Forsythe test, you'd likely use the pooled error term from the overall ANOVA to compute the *F*'s for these analyses, so enter that value and compute your *F*-ratios. From one perspective, of course, these are post hoc comparisons, so one might argue that some correction would be appropriate (i.e., Tukey's test). However, it's clear from M&D's text (p. 331) that they are using an uncorrected F_{Crit} to determine the significance of the results. Note that K&W also compute their subsequent analyses of such complex designs without correcting the error term. Of course, using the more conservative Tukey test, the two interactions might not be significant.

	Source	***SS***	***df***	***MS***	***F***
Diet Absent	Biofeedback x Drug				
Diet Present	Biofeedback x Drug				
	Error				

Enter the means from your analyses below:

	Diet Absent			Diet Present		
	Drug X	Drug Y	Drug Z	Drug X	Drug Y	Drug Z
Biofeedbk						
No Biofeed						

d. Focusing on the Diet Absent data (which produced an interaction between Biofeedback x Drug), you would now approach the analysis as you would any two-way ANOVA that had produced an interaction. That is, you need to try to determine what has produced the observed interaction (so that you could report it as part of your interpretation of the three-way interaction). One approach is detailed in the M&D excerpt, which would be to look at the simple effects. You should be able to generate all the *F*'s seen in their Table 8.16. Alternatively, you could take the Tukey's Critical Mean Difference approach, even though it is more conservative. Given that we're interpreting a three-way interaction (even though we're only looking at the 6 means from the Diet Absent group right now), with $\alpha_{FW} = .05$ I would use a $q = 4.81$ (12 treatments and 60 df_{Error}). Thus, $HSD = 24.58$, so any means that differ by 24.58 or more would be considered to be significantly different. With $\alpha_{FW} = .10$, I would use $q = 4.42$, so $HSD = 22.59$. Of course, you should use the α_{FW} that makes the most sense to you. In the space below, interpret the Biofeedback x Drug interaction for the Diet Absent condition.

e. Next, you'd turn your attention to the Diet Present data (which produced *no* interaction between Biofeedback x Drug). With no interaction present, you'd focus your attention on the two "main effects" to see if either of them is significant. Can you generate the values seen in M&D's Table 8.18? If so, then you should have a good understanding of their interpretation of these effects (p. 334). Write a brief summary of these results below.

f. You're now ready for a "complete" interpretation of the three-way interaction. But that's fairly easy, right? All that you'd say is yadda-yadda$_d$ HOWEVER yadda-yadda$_e$. That is, you'd just relate your interpretation of the interaction for the Diet Absent data and then say, however, for the Diet Present data…and then relate your interpretation of those data.

2. For the second part of this laboratory, consider an experiment that looks at Age (Child vs. Adult), Type of Reader (Good vs. Average vs. Poor), and Reading Matter (Easy vs. Moderate vs. Difficult). Thus, it is a 2x3x3 independent groups design with n = 10. The DV is the number of key concepts/ideas correctly recalled, with 30 concepts/ideas within each passage.

a. Suppose that the data from this study turned out as in the data set *Reading1.sav*. Analyze and interpret the data as completely as you can. Figures might help in your interpretation.

To allay any concerns you might have about heterogeneity in your data, I've computed the Brown-Forsythe test for you. The source table is seen below. Of course, you need to be comfortable computing this analysis yourself, but I figured that I'd save you some time here.

ANOVA

ZTRANS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15.644	17	.920	.624	.870
Within Groups	239.000	162	1.475		
Total	254.644	179			

b. Suppose that the data from this study turned out as in the data set *Reading2.sav*. Analyze and interpret the data as completely as you can. Figures will definitely help here! The Brown-Forsythe test is seen below.

ANOVA

ZTRANS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.400	17	.376	.323	.995
Within Groups	189.100	162	1.167		
Total	195.500	179			