Laboratory for Comparisons

Purpose: This lab is intended to give you experience computing simple and complex comparisons, using a calculator and SPSS.

We'll work with the K&W51 data set (Sleep Deprivation and a Vigilance Task). In fact, it will be easier to use the K51.sav data set with numbers used to indicate the grouping information. (Remember, 1 = 4hrs, 2 = 12hrs, 3 = 20hrs, and 4 = 28hrs.)

1. *Contrasts*

You need to learn to specify comparisons using contrast coefficients. Basically, a 0 says, "don't include this group in the comparison." A non-zero coefficient indicates that the group is included in the comparison, with the sign of the coefficient indicating what's being compared. Your coefficients must sum to 0. For an experiment such as K&W51, what would each of the contrasts below indicate:

Contrast	Comparison Indicated
0, 1, 0, -1	
1, 0, 0, -1	
1, 1, 0, -2	
3, -1, -1, -1	

2. *Simple Comparisons*

The first two contrasts above denote simple comparisons (compare the means for two samples in your experiment). There are six possible simple comparisons for the data set above (1 vs. 2, 1 vs. 3, 1 vs. 4, 2 vs. 3, 2 vs. 4, and 3 vs. 4). [Of course, those comparisons translate into 4hrs vs. 12 hrs, etc.] First, in the table below, indicate the coefficients for each of the six simple comparisons, then use the formula below (4.4) to compute an estimate of ψ for each comparison.

$$\hat{\psi} = \sum (c_j)(\bar{Y}_j)$$

Next compute $SS_{Comparison}$ and then $MS_{Comparison}$ using the formula below (4.5). (Note that $SS_{Comparison}$ will always equal $MS_{Comparison}$, because for comparisons $df = 1$.)

$$SS_{\psi} = \frac{n(\hat{\psi})^2}{\sum c_j^2}$$

Comparison	1 = 4hrs	2 = 12hrs	3 = 20hrs	4 = 28hrs	ψ	$MS_{Comparison}$
1 vs. 2						
1 vs. 3						
1 vs. 4						
2 vs. 3						
2 vs. 4						
3 vs. 4						

You can now compute the $F_{Comparison}$ for each of the comparisons above. For now, we'll assume that we haven't violated the homogeneity of variance assumption. Thus, we'll use the pooled variance from the $MS_{S/A}$ in the overall ANOVA (150.458).

Comparison	$MS_{Comparison}$	MS_{Error}	$F_{Comparison}$
1 vs. 2		150.458	
1 vs. 3		150.458	
1 vs. 4		150.458	
2 vs. 3		150.458	
2 vs. 4		150.458	
3 vs. 4		150.458	

Now use SPSS (Analyze -> Compare Means -> One-Way ANOVA) to compute the first two comparisons (1 vs. 2 and 1 vs. 3) using the Select Cases.. procedure (at the bottom of the Data menu). Note that SPSS will be computing F using the MS_{Error} from just the two groups involved in the comparison. To compute the $F_{Comparison}$ using the MS_{Error} from the overall ANOVA (pooled variance approach), you'd just take the $MS_{Comparison}$ from the analysis of the two groups and divide it by the MS_{Error} from the omnibus analysis (all four groups). Alternatively, you could take the average of the four group variances (which will yield the same value). Enter the appropriate information below. Note the way the F varies, depending on the error term you choose.

	$MS_{Comparison}$	MS_{Error}	F
1 vs. 2 (Separate)			
1 vs. 3 (Separate)			
1 vs. 2 (Pooled)		150.458	
1 vs. 3 (Pooled)		150.458	

Finally, use SPSS to compute all 6 simple comparisons using the Contrasts button in the One-Way ANOVA window. Note that the SPSS output produces output presuming homogeneity of variance (top) and making no assumptions about homogeneity of variance (bottom). We'll learn more about those funky fractional *df* later. Note, also, that the analysis is in terms of t. However, if you remember that $t^2 = F$, then you can convert each of those contrast comparisons into F ratios to see how they compare with your earlier computations.

2. Complex Comparisons

There are a number of complex comparisons that you might compute on K&W51. First, determine the appropriate coefficients for the comparisons shown below. Then compute the $MS_{Comparison}$ using the appropriate formulas.

	1 (4hr)	2 (12hr)	3 (20hr)	4 (28hr)	ψ	$MS_{Comparison}$
1&2 vs. 3						
1&3 vs. 2						
1&2&3 vs. 4						

You can now compute the *F* for each of these complex comparisons:

	$MS_{Comparison}$	MS_{Error}	*F*
1&2 vs. 3 (Pooled)		150.458	
1&3 vs. 2 (Pooled)		150.458	
1&2&3 vs. 4 (Pooled)		150.458	

Now use SPSS to compute each of these comparisons as separate ANOVAs. To set up these ANOVAs, you'll need to use Transform -> Recode. Note that now SPSS will be computing *F* using a MS_{Error} that is simply inappropriate. To compute the $F_{Comparison}$ using the MS_{Error} from the overall ANOVA (pooled variance approach), you'd just take the $MS_{Comparison}$ from the SPSS output and divide it by the MS_{Error} from the original overall SPSS analysis. Do so below. Your *F* ratios should be identical to those computed above.

	$MS_{Comparison}$	MS_{Error}	*F*
1&2 vs. 3 (Pooled)		150.458	
1&3 vs. 2 (Pooled)		150.458	
1&2&3 vs. 4 (Pooled)		150.458	

Finally, use the Contrasts button in One-Way ANOVA to compute these same comparisons. Except for the fact that you're seeing *t* tests (so you need to square them), the analyses should be identical.

3. *Orthogonality*

Determining whether or not two comparisons are orthogonal to one another is simple. Determining an entire set of orthogonal comparisons is not as simple, especially as the number of levels of the IV becomes large. Below you will find a set of comparisons for an experiment with 5 levels. Determine which of the comparisons are orthogonal. You should know right away that the comparisons are not all orthogonal to one another, right?

	Group 1	Group 2	Group 3	Group 4	Group 5
Comparison 1	+1	+1	-1	-1	0
Comparison 2	+1	0	0	0	-1
Comparison 3	0	+1	-1	0	0
Comparison 4	+1	0	0	-1	0
Comparison 5	0	0	0	+1	-1
Comparison 6	+2	0	-1	0	-1

Comparison Pair	**Sum**	**Ortho?**	**Comparison Pair**	**Sum**	**Ortho?**
1 & 2			3 & 4		
1 & 3			3 & 5		
1 & 4			3 & 6		
1 & 5			4 & 5		
1 & 6			4 & 6		
2 & 3			5 & 6		
2 & 4					
2 & 5					
2 & 6					

As I point out in the notes on Ch. 4, for an experiment with 4 levels (as in K&W51), one set of orthogonal comparisons would be:

Comparison 1	1	0	-1	0
Comparison 2	0	1	0	-1
Comparison 3	1	-1	1	-1

Use SPSS to compute these three comparisons (or at least the $SS_{Comparison}$) for K&W51, then check to ensure that the sum of the *SS* for the three comparisons equals the $SS_{Treatment}$ from the overall ANOVA (3314.25). Compute the actual *F*-ratios for the comparisons for later use (assuming homogeneity of variance).

Comparison	**SS**	**F**
Comparison 1		
Comparison 2		
Comparison 3		
Total		XXXXXXXXX