The following is an excerpt from: "A Simple Guide to SPSS for Windows" by Kirkpatrick and Feeney. It is intended to provide you with a guideline to completing **Part B** of Assignment 3. You will have to use the variables for your own data set.

One-Way ANOVA

Sample Problem

Sleep researchers have hypothesized that, in a broad evolutionary sense, sleeping more poorly during periods of perceived environmental threat may have survival value. Previous research has indicated that individuals experiencing anxiety or stress exhibit reduced periods of deep sleep and increased periods of light sleep (because one can most easily be aroused by a sound in the en vironment while in light sleep). An attachment researcher conducted a study to examine the effects of anxious, avoidant, and secure attachment styles on the physiology of sleep. The investigator hypothesized that children with anxious (and perhaps avoidant) attachment styles experience more sleep disturbances than children with secure attachment styles because they feel responsible for monitoring the external environment and regulating the distance between themselves and their caregivers. These children may find it difficult to sleep when their caregivers are physically absent and may develop patterns of light sleep because of the need to be aware of the care- giver's presence at all times. Deep sleep can be experienced as threatening to the attachment bond and thus dangerous to the child. The sleep patterns of 10 secure, 10 anxious, and 10 avoidant 5-year-old children were monitored. Of primary importance to the attachment researcher was the overall percentage of time that each child spent in deep (delta) sleep. It was hypothesized that children who are insecurely attached to their primary caregivers will spend a lower percentage of time in deep (delta) sleep as compared to their secure counterparts. Following is the average amount of time that each child spent in delta sleep, expressed as a percentage of total sleep time. (For the attachment styles, 1 = secure, 2 = anxious, and 3 = avoidant.).

In this problem, we are testing the null hypothesis that, on average, the three populations of children (secure, anxious, and avoidant attachment styles) spend an equal percentage of time in deep (delta) sleep. The test of this hypothesis, sometimes referred to as the "omnibus" null hypothesis, is conducted as an F-test.

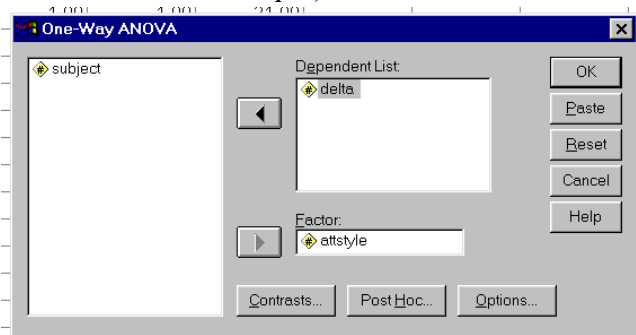|	subject	attstyle	delta	var
1	1.00	1.00	21.00	
2	2.00	1.00	21.00	
3	3.00	1.00	25.00	
4	4.00	1.00	23.00	
5	5.00	1.00	24.00	
6	6.00	1.00	23.00	
7	7.00	1.00	23.00	
8	8.00	1.00	22.00	
9	9.00	1.00	22.00	
10	10.00	1.00	22.00	
11	11.00	2.00	17.00	
12	12.00	2.00	17.00	

Post-Hoc Test

Rejection of the "omnibus" null hypothesis in ANOVA tells us only that not all population means are equal. It does not indicate which attachment groups are significantly different from which others. One way to further examine group differences is to use *post-hoc* or *a posteriori* multiple comparison tests, such as the Student-Newman-Keuls or Tukey HSD test. In our example, we use Tukey HSD tests to test for differences between all possible pairs of means.
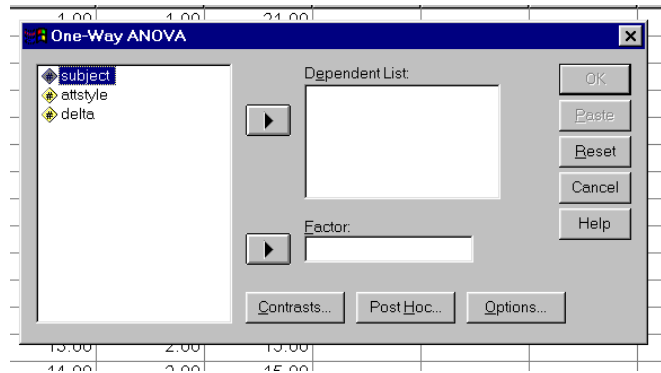
Analysis

Following the procedure outlined in Chapter 2, enter the data into the first three columns of the Data Editor and label the variables *subject*, *attstyle*, and *delta*.

Point-and-Click Method

Click on **ANALYZE** on the menu bar, and then choose **COMPARE MEANS**. From the resulting menu, choose **ONE-WAY ANOVA.** This produces a dialog box that looks like the figure to the right.

       This dialog box is very similar to that for the independent-groups *t-test,*as discussed in Chapter 8. In this dialog box, your list of variables appears in the box to the left, and you must (1) move one (or more) variables into the box labeled **"Dependent List"** to select your dependent variable(s) and (2) move *one* of your variables into the box labeled **"Factor"** to identify the groups to be compared (that is, to select the independent variable). First, click on *delta* (the dependent variable in our example) in the left-hand box to select it; then click on the upper right-arrow pointing to the **"Dependent List"** box; *delta* disappears from the left-hand box and reappears under **"Dependent List."** Next, click on *attstyle* (the independent variable in our example) to select it, and then click on the right-arrow button pointing to the **"Factor"** box to move it there. The name *attstyle* now appears under **"Factor."**

       If you wish to have SPSS print out means and other descriptive statistics along with the results of the F-test-and, of course, you do!-there is still on more step. In the dialog box illustrated above, click on **Options. ..**to bring up another dialog box. In this box, which is illustrated in the adjacent figure, click on the box under **"Statistics,"** next to **"Descriptive."** Then click on **Continue** to return to the previous dialog box.

       If you wish to conduct only the "omnibus" analysis of variance to test the hypothesis that all three population means are equal, you are done. Click on **OK** to execute the analysis. If, in addition, you wish to conduct tests of multiple comparisons, using either post-hoc tests or planned comparisons/ contrasts, follow the instructions in the corresponding sections below before clicking on **OK**.

Post-Hoc Tests.

To conduct post-hoc tests in SPSS, specify your variables, and so on, as described in the preceding section; then click on the button labeled **Post Hoc. ..**at the bottom of the dialog box illustrated in the first figure. This produces a new dialog box (see figure next page) containing a

list of available tests. For simple pairwise comparisons, the most commonly used tests are probably Student-Newman-Keuls (labeled **"S-N-K"**) and the Tukey HSD test (labeled simply **"Tukey"**). Simply click on the box(es) next to the test(s) you wish SPSS to calculate and print. Then click on Continue to return to the dialog box illustrated in the first figure , and click on **OK** to run the analysis.
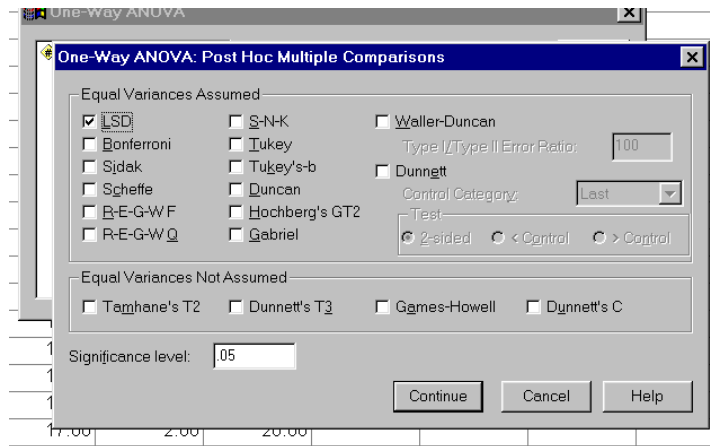
Output

The output produced by SPSS for the omnibus analysis is shown at the end of this set of instructions. After some descriptive statistics, the ANOVA results are printed. Three sources of variability are listed: **"Between Groups"** (variability due to the treatment effect: differences between groups as a result of attachment style), **"Within Groups"** (variability reflecting random error), and **"Total."** For each, SPSS reports the *degrees of freedom, sum of squares, and mean square* (sum of squares divided by degrees of freedom). The *F ratio*, calculated as the mean square between divided by the mean square within, is listed next in the table. The *F ratio* in this example equals 41.425, and its associated *p-value* ("Sig.") is reported as .000. Thus we reject the null hypothesis and conclude that the three attachment styles differ with respect to the mean amount of time that children spend in deep (delta) sleep.

Post-Hoc Tests

SPSS prints out the results of the Tukey HSD tests in two different ways, as shown after the omibus F output.

Each of the six rows of the upper table represents a comparison of two groups; for example, the first row compares Group 1 vs. Group 2. Actually, each comparison appears twice because the comparison of 1 vs. 2 (first row) is for all practical purposes the same as the comparison of 2 vs.l (third row). In any case, for each pairwise comparison of interest, SPSS prints out the difference between the means (for example, 6.70 or -6.70 for Group 1 vs. Group 2), along with a standard error, p-value ("Sig."), and confidence interval. In this example, Groups 1 and 2 are significantly different from each other (p is listed as .000, meaning it is less than .0005 and rounded off) and Groups 1 and 3 are significantly different from each other (again, p is reported as .000). However, Groups 2 and 3 do not differ from each other (p = .113).

The second part of the output presents this information in a different (and we think confusing) way, by identifying homogeneous subsets of means - that is, by showing sets of means that do not differ significantly from each other. In the left column, the groups are listed in order from that with the smallest mean (Group 2 in this case) to that with the largest mean (Group 1 in this case). To the right are two columns listing the actual means, grouped into two subsets: Subset 1 contains Groups 2 (mean = 15.90) and 3 (mean = 17.50), whereas subset 2 contains only Group 1 (mean = 22.60). This indicates that Groups 2 and 3 form a homogeneous

subset whose means are not significantly different from one another. Group 1, however, is in a different subset, indicating that its mean does differ significantly from the means of the groups in subset 1. That is, the means of the "anxious" (Group 2) and "avoidant" (Group 3) groups are not significantly different from each other, but each is significantly different from the mean of the "secure" group (Group 1).

Oneway

Descriptives

DELTA

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1.00	10	22.6000	1.26491	.40000	21.6951	23.5049	21.00	25.00
2.00	10	15.9000	2.28279	.72188	14.2670	17.5330	13.00	20.00
3.00	10	17.5000	1.43372	.45338	16.4744	18.5256	15.00	20.00
Total	30	18.6667	3.34595	.61088	17.4173	19.9161	13.00	25.00

ANOVA

DELTA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	244.867	2	122.433	41.425	.000
Within Groups	79.800	27	2.956		
Total	324.667	29			

Multiple Comparisons

Dependent Variable: DELTA

LSD

(I) ATTSTYLE	(J) ATTSTYLE	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	6.7000*	.76884	.000	5.1225	8.2775
	3.00	5.1000*	.76884	.000	3.5225	6.6775
2.00	1.00	-6.7000*	.76884	.000	-8.2775	-5.1225
	3.00	-1.6000*	.76884	.047	-3.1775	-.0225
3.00	1.00	-5.1000*	.76884	.000	-6.6775	-3.5225
	2.00	1.6000*	.76884	.047	.0225	3.1775

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

Instructions for 2 Factor ANOVA

The SPSS procedure for conducting 2-factor ANOVA's is in the General Linear Models section of the Analyze menu. For Assignment 5, you will use GLM – Univariate to examine main effects and interactions. Once you have opened the GLM-Univariate window, you will see windows for the Dependant variable and 3 types of Independent variables, Fixed, Random and Covariate. Assume that all factors in your ANOVA's are Fixed effects. (You will know when NOT to assume this.) SPSS automatically calculates F based on the correct Model by placing your Independent variables in these windows. Your F's will be calculated according to Model I. When you have placed your variables in to their correct windows, click on the Model button in the upper right hand corner – make sure "Full-factorial" is chosen and click Continue. Clicking on the Options button will allow you to chose additional outputs such as descriptive statistics and power (remember power?). Once you've set up the model and chosen your desired options, click OK. You should now have an ANOVA table to interpret. RULE-OF-THUMB. In a 2-factor ANOVA, if you have a non-significant interaction term, then you should re-run the analysis – this time do not include an interaction term in your model. You can do this by setting up the 2-factor analysis as before. This time, click on Model… and select "Custom". Under the "Build term(s)" heading, choose "Main effects" then add each main effect to the Model window. Click Continue and then OK form the main GLM window. Your output will be identical to the previous except that there will be no interaction term in you ANOVA Table AND the Interaction SS will have been divided up between the two main effects – perhaps changing your conclusions compared to the model with the interaction.

Instructions for Regression

You can do simple and multiple OLS regression in the Regression module of the Analyze menu. Simply place your Dependent and Independent variable in their appropriate windows and click OK. Your output will include an ANOVA table (telling you if X explains an appreciable amount of variability in Y), a table of parameter (slope and intercept - are these different from 0?) estimates and a table summarizing the model (r^2).
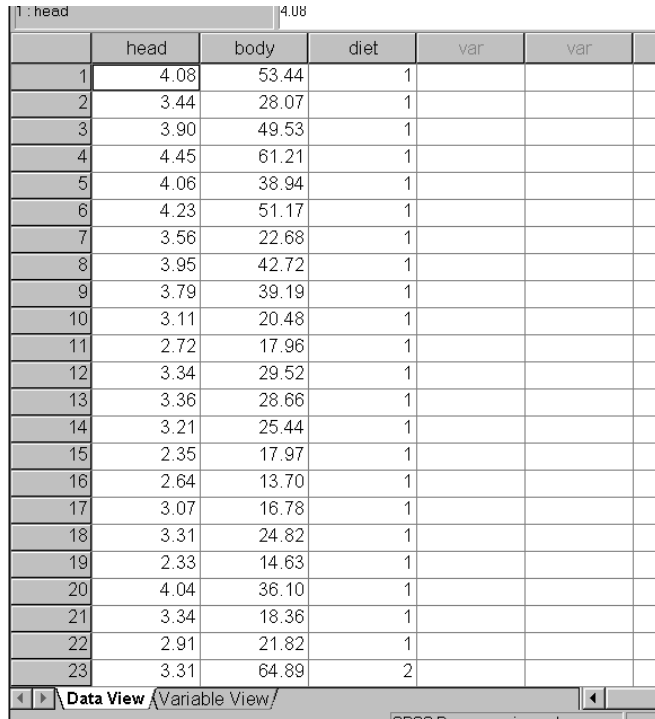
ANCOVA (ANalysis of CO-VAriance)

ANCOVA can be run in SPSS using the GLM – Univariate procedure as in the 2-factor ANOVA. The key difference requires placing one of your Independent variables (the continuous one) in the Covariate window. You will also have to construct the Model yourself by choosing Custom in the Model window. To do this, select "Interaction" in the Build term(s) window, then select each term (in the left window) and move them to the Model window. Then highlight BOTH factors (click on one then hold down the CTRL key and click on the other) and move them together – this will create the interaction term for your analysis. Click Continue then OK and you will get an output for interpretation. As in the 2-factor ANOVA, if the interaction term is non-significant, re-run your analysis without the interaction term.

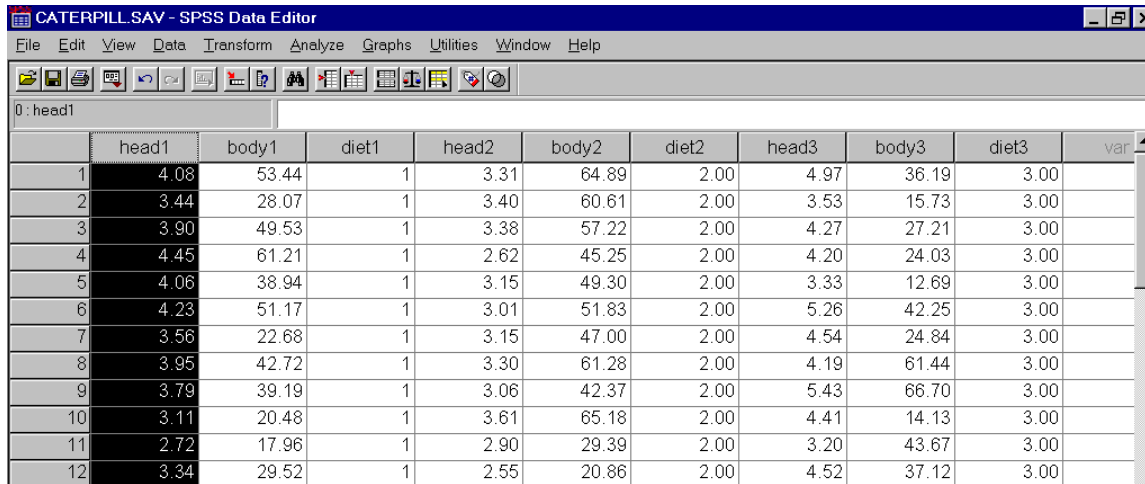**A note on scatter plots for ANCOVA.**

A typical spreadsheet that is set-up for ANCOVA will have one column for the discrete dependent variable, one column for the continuous independent variable and one column for the dependent variable. You can construct a scatter plot of the continuous dependent on the continuous independent using your discrete independent to label your points. However, your plot will likely be messy if you have more than 5 observations per category. Instead, you can use an "Overlay scatter plot". This will allow you to assign different symbols to individual points depending on which group the individual belongs to. Unfortunately, I know of no easy way to do this. Instead, you have to 'unstack' your data to make the overlay plot work. Basically you have to make separate x and y columns for each group. Below is what my spreadsheets for the *catapill* data set looked like before and after I 'unstacked' the data.

BEFORE

	head	body	diet	var	var
1	4.08	53.44	1		
2	3.44	28.07	1		
3	3.90	49.53	1		
4	4.45	61.21	1		
5	4.06	38.94	1		
6	4.23	51.17	1		
7	3.56	22.68	1		
8	3.95	42.72	1		
9	3.79	39.19	1		
10	3.11	20.48	1		
11	2.72	17.96	1		
12	3.34	29.52	1		
13	3.36	28.66	1		
14	3.21	25.44	1		
15	2.35	17.97	1		
16	2.64	13.70	1		
17	3.07	16.78	1		
18	3.31	24.82	1		
19	2.33	14.63	1		
20	4.04	36.10	1		
21	3.34	18.36	1		
22	2.91	21.82	1		
23	3.31	64.89	2		

Data View / Variable View

AFTER

CATERPILL.SAV - SPSS Data Editor

File   Edit   View   Data   Transform   Analyze   Graphs   Utilities   Window   Help

0 : head1

	head1	body1	diet1	head2	body2	diet2	head3	body3	diet3	var
1	4.08	53.44	1	3.31	64.89	2.00	4.97	36.19	3.00	
2	3.44	28.07	1	3.40	60.61	2.00	3.53	15.73	3.00	
3	3.90	49.53	1	3.38	57.22	2.00	4.27	27.21	3.00	
4	4.45	61.21	1	2.62	45.25	2.00	4.20	24.03	3.00	
5	4.06	38.94	1	3.15	49.30	2.00	3.33	12.69	3.00	
6	4.23	51.17	1	3.01	51.83	2.00	5.26	42.25	3.00	
7	3.56	22.68	1	3.15	47.00	2.00	4.54	24.84	3.00	
8	3.95	42.72	1	3.30	61.28	2.00	4.19	61.44	3.00	
9	3.79	39.19	1	3.06	42.37	2.00	5.43	66.70	3.00	
10	3.11	20.48	1	3.61	65.18	2.00	4.41	14.13	3.00	
11	2.72	17.96	1	2.90	29.39	2.00	3.20	43.67	3.00	
12	3.34	29.52	1	2.55	20.86	2.00	4.52	37.12	3.00	

You ONLY need to do this to make the plot. The ANCOVA requires the data in the BEFORE format.