Proportion Differences

A most common research question arises when an investigator has obtained two sample proportions. One asks whether or not the two sample proportions are really different considering that they are based on observations drawn randomly from a population. For example, a school nurse observes during the flu season that 13 eighth grade students are absent due to flu symptoms while only 8 of the ninth grade students are absent. The class sizes of the two grades are 110 and 121 respectively. The nurse decides to test the hypothesis that the two proportions (.118 and .066) do not differ significantly using the OpenStat program. The first step is to start the Proportion Differences procedure by clicking on the Statistics menu, moving the mouse to the Comparisons option and the clicking on the Proportion Differences option. The specification form for the test then appears. We will enter the required values directly on the form and assume the samples are independent random samples from a population of eighth and ninth grade students.

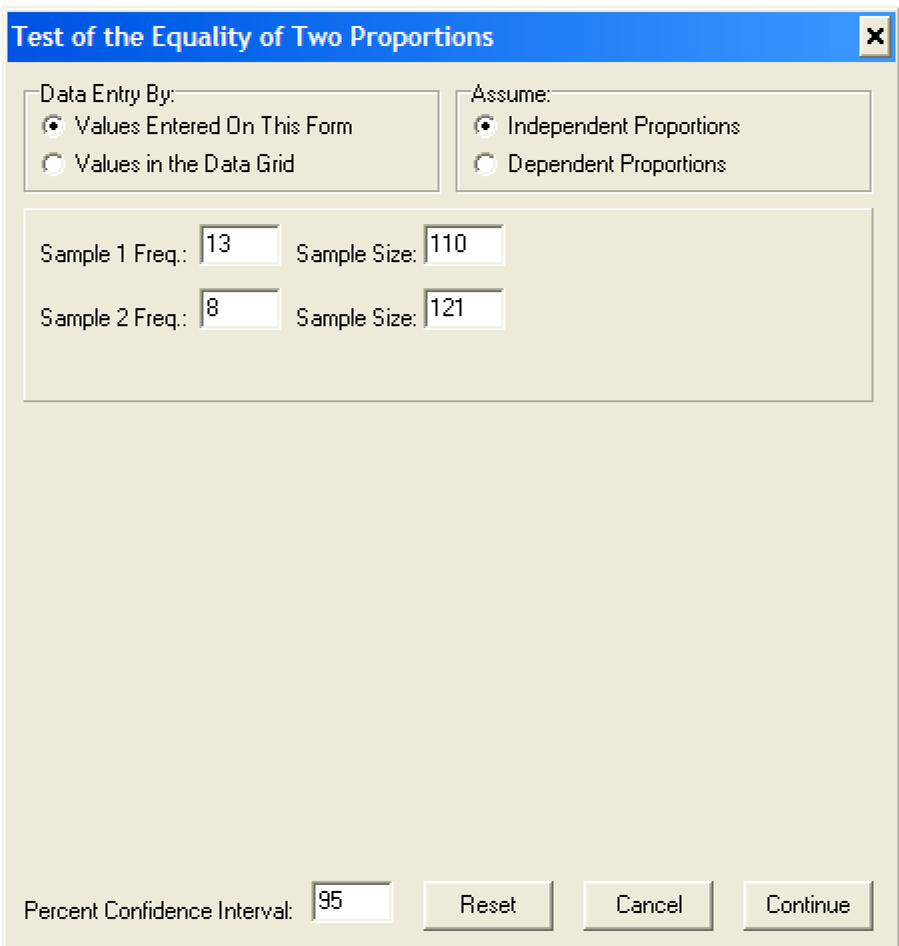


Figure 1 Testing Equality of Two Proportions

When the nurse clicks the Continue button the following results are shown in the Output form:

```
COMPARISON OF TWO PROPORTIONS

Test for Difference Between Two Independent Proportions

Entered Values
```

```
Sample 1: Frequency =    13 for   110 cases.
Sample 2: Frequency =     8 for   121 cases.
Proportion 1 =     0.118, Proportion 2 =     0.066, Difference =     0.052
Standard Error of Difference =     0.038
Confidence Level selected = 95.0
z test statistic =     1.375 with probability = 0.0846
z value for confidence interval =  1.960
Confidence Interval: (   -0.022,    0.126)
```

The nurse notices that the value of zero is within the 95% confidence interval as therefore accepts the null hypothesis that the two proportions are not different than that expected due to random sampling variability. What would the nurse conclude had the 80.0% confidence level been chosen?

If the nurse had created a data file with the above data entered into the grid such as:

CASE/VAR	FLU	GROUP
CASE 1	0	1
CASE 2	1	1
I.--		
CASE 110	0	1
CASE 111	0	2

CASE 231 1 2

then the option would have been to analyze data in a file.

In this case, the absence or presence of flu symptoms for the student are entered as zero (0) or one (1) and the grade is coded as 1 or 2. If the same students, say the eighth grade students, are observed at weeks 10 and 15 during the semester, than the test assumptions would be changed to Dependent Proportions. In that case the form changes again to accommodate two variables coded zero and one to reflect the observations for each student at weeks 10 and 15.

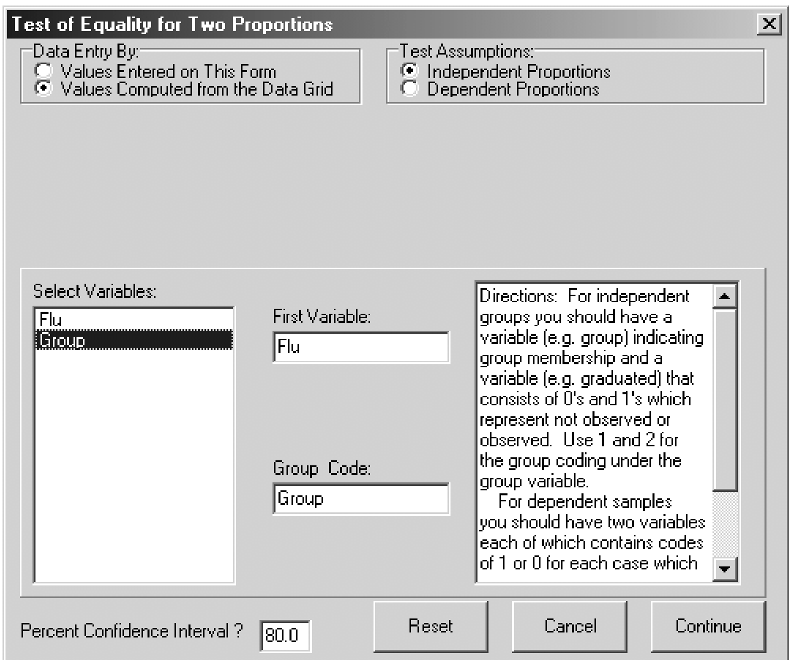


Figure 2 Testing Equality of Two Independent Proportions (Grid Data)

Correlation Differences

When two or more samples are obtained, the investigator may be interested in testing the hypothesis that the two correlations do not differ beyond that expected due to random sampling variation. This test may be performed by selecting the correlation differences procedure in the comparison sub-menu of the statistics menu. The following form then appears:

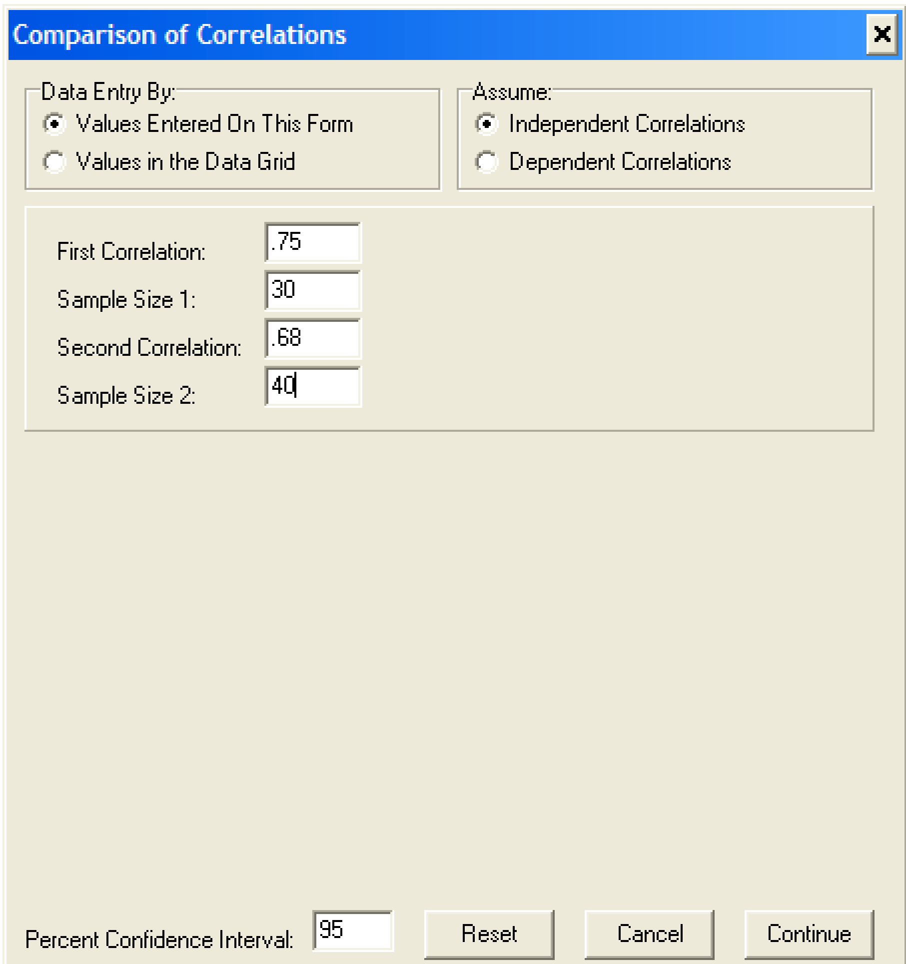


Figure 3 Test of Difference Between Two Independent Correlations

Notice that the form above permit the user to enter the correlations directly on the form or to compute the correlations for two groups by reading the data from the data grid. In addition, the form permits the user to test the difference between correlations where the correlations are dependent. This may arise when the same two variables are correlated on the same sample of subjects at two different time periods or on samples which are "matched" on one or more related variables. As an example, let us test the difference between a correlation of .75 obtained from a sample with 30 subjects and a correlation of .68 obtained on a sample of 40 subjects. We enter our values in the "edit" fields of the form and click the continue button. The results appear below:

```
COMPARISON OF TWO CORRELATIONS
```

```
Correlation one =  0.750
Sample size one = 30
Correlation two =  0.680
Sample size two = 40
Difference between correlations =  0.070
Confidence level selected = 95.0
z for Correlation One =  0.973
z for Correlation Two =  0.829
z difference =  0.144
Standard error of difference =  0.253
z test statistic =  0.568
Probability > |z| =  0.285
z Required for significance =  1.960
Note: above is a two-tailed test.
Confidence Limits = (-0.338, 0.565)
```

The above test reflects the use of Fisher's log transformation of a correlation coefficient to an approximate z score. The correlations in each sample are converted to z's and a test of the difference between the z scores is performed. In this case, the difference obtained had a relatively large chance of occurrence when the null hypothesis is true (0.285) and the 95% confidence limit brackets the sample difference of 0.253. The Fisher z transformation of a correlation coefficient is

$$z_r = \frac{1}{2}\log_e\left(\frac{1+r}{1-r}\right)$$

The test statistic for the difference between the two correlations is:

$$z_r = \frac{\left(z_{r_1} - z_{r_2}\right) - \left(z_{\rho_1} - z_{\rho_2}\right)}{\sigma_{\left(z_{r_1} - z_{r_2}\right)}}$$

where the denominator is the standard error of difference between two independent transformed correlations:

$$\sigma_{\left(z_{r_1} - z_{r_2}\right)} = \sqrt{\left(\frac{1}{n_1 - 3}\right)\left(\frac{1}{n_2 - 3}\right)}$$

The confidence interval is constructed for the difference between the obtained z scores and the interval limits are then translated back to correlations. The confidence limit for the z scores is obtained as:

$$CI_{\%} = \left(z_{r_1} - z_{r_2}\right) + / - z_{\%}\sigma_{\left(z_{r_1} - z_{r_2}\right)}$$

We can then translate the obtained upper and lower z values using:

$$r = \frac{e^{2z_r} - 1}{e^{2z_r} + 1}$$

For the test that two dependent correlations do not differ from zero we use the following t-test:

$$t = \frac{\left(r_{xy} - r_{xz}\right)\sqrt{\left(n-3\right)\left(1+r_{yz}\right)}}{\sqrt{2\left(1 - r_{xy}^2 - r_{xz}^2 - r_{yz}^2 + 2r_{xy}r_{xz}r_{yz}\right)}}$$

Tests for Two Means

t-Tests

Among the comparison techniques the “Student” t-test is one of the most commonly employed. One may test hypotheses regarding the difference between population means for independent or dependent samples which meet or do not meet the assumptions of homogeneity of variance. To complete a t-test, select the t-test option from the Comparisons sub-menu of the Statistics menu. You will see the form below:

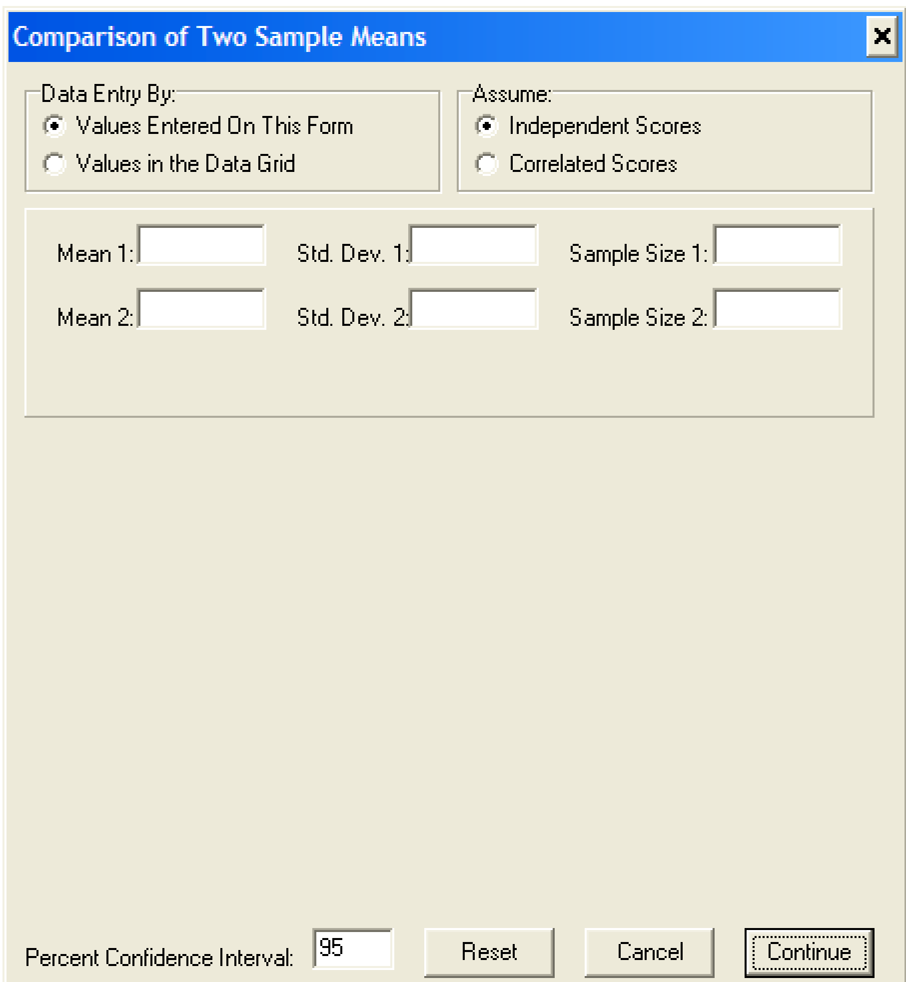


Figure 4 Dialog Form For The Student t-Test

Notice that you can enter values directly on the form or from a file read into the data grid. If you elect to read data from the data grid by clicking the button corresponding to “Values Computed from the Data Grid” you will see that the form is modified as shown below.

Figure 5 Student t-Test For Data in the Data Grid

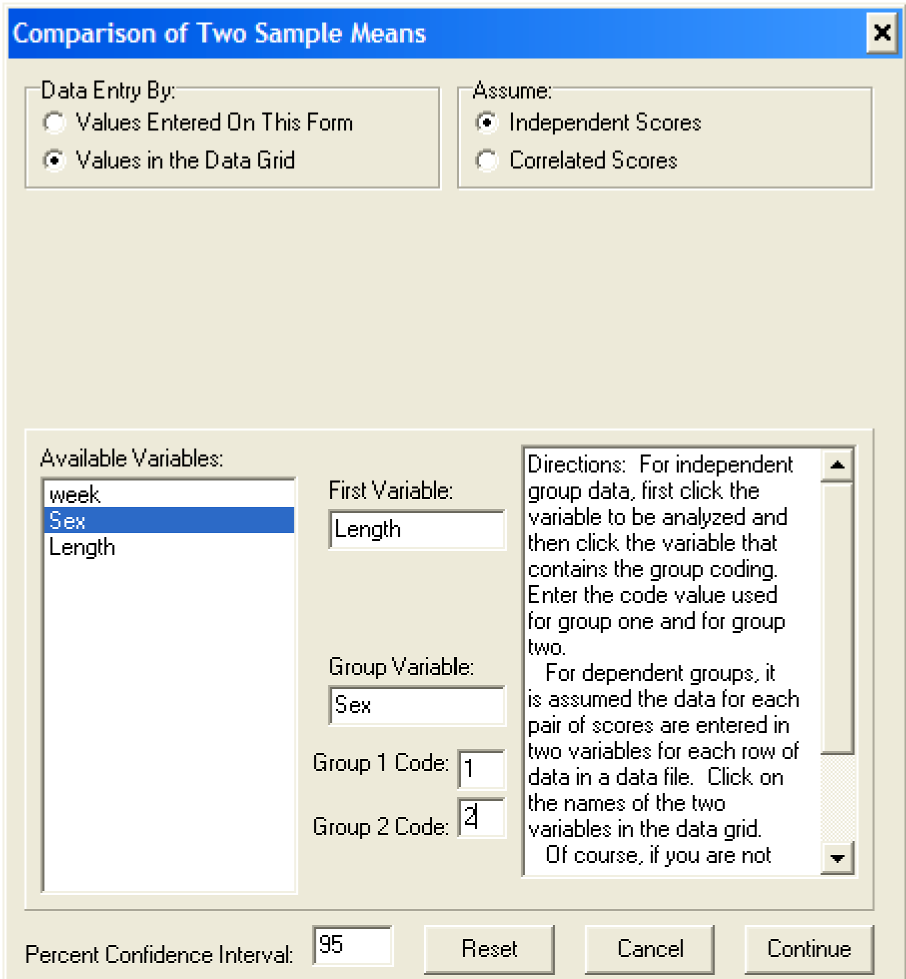


Figure 6 Student t-Test For Data in the Data Grid

We will analyze data stored in the Hinkle411.TEX file.

Once you have entered the variable name and the group code name you click the Continue button. The following results are obtained for the above analysis:

```
COMPARISON OF TWO MEANS

Variable       Mean    Variance  Std.Dev.  S.E.Mean  N
Group 1       31.00     67.74     8.23      1.68   24
Group 2       25.75     20.80     4.56      0.93   24
Assuming equal variances, t =    2.733 with probability = 0.0089 and
46 degrees of freedom
Difference =      5.25 and Standard Error of difference =     1.92
Confidence interval = (    1.38,     9.12)
Assuming unequal variances, t =    2.733 with probability = 0.0097 and
35.91 degrees of freedom
Difference =      5.25 and Standard Error of difference =     1.92
Confidence interval = (    1.35,     9.15)
```

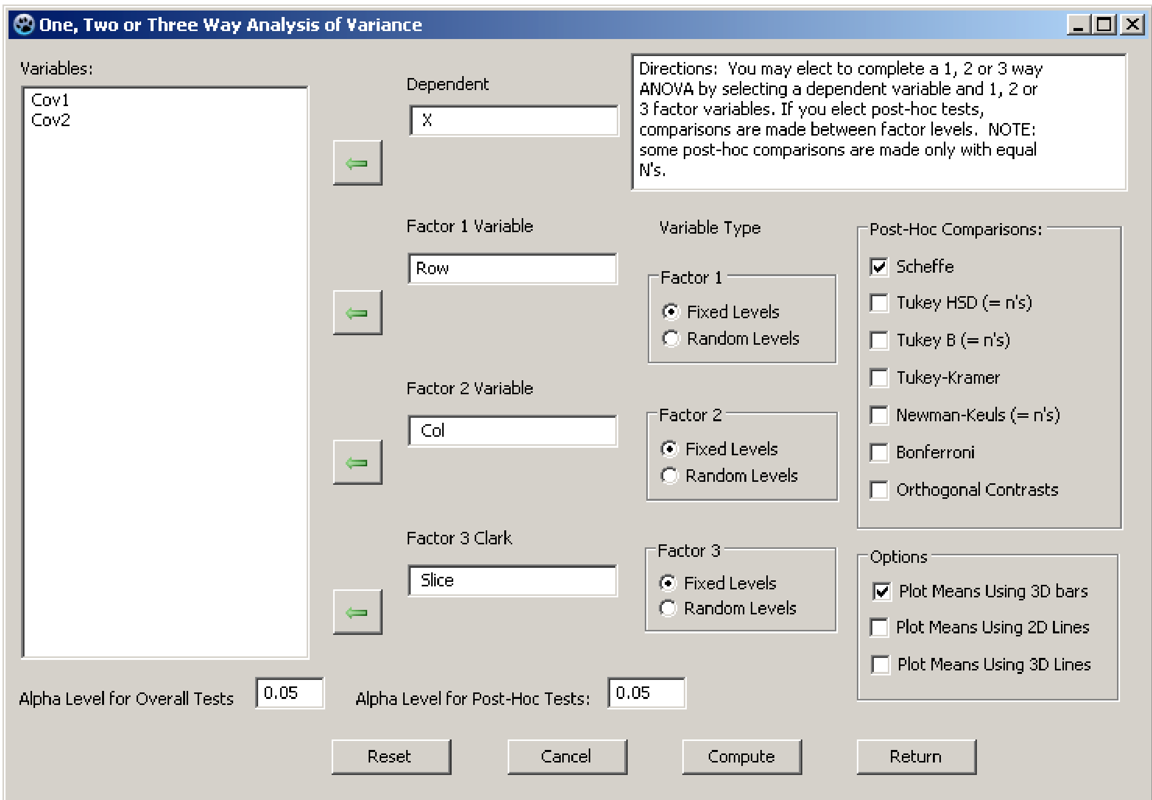
```
F test for equal variances =    3.256, Probability = 0.0032

NOTE: t-tests are two-tailed tests.
```

The F test for equal variances indicates it is reasonable to assume the sampled populations have unequal variances hence we would report the results of the test assuming unequal variances. Since the probability of the obtained statistic is rather small (0.01), we would likely infer that the samples were drawn from two different populations. Note that the confidence interval for the observed difference is reported.

What do you call a tea party with more than 30 people? A Z party!!!

One, Two or Three Way Analyses of Variance

Analysis of Variance is one of the most commonly used methods for testing hypotheses of differences among means of samples collected from one or more populations. Typically there is a dependent variable and one to three “treatments” consisting of two or more “levels”. To demonstrate this procedure, we will use a file labeled Anova2.LAZ. This file contains a dependent variable and three independent variables. The dependent variable X is a “floating point” type of variable. The three independent variables are row, column and slice and are coded as integer types of variables. We start our analysis by selecting this option and entering the variables to be analyzed. We will ignore the two “covariate” measures at this time.



Notice that each of the independent variables may be one of two types – fixed or random levels. We have also selected a “post-hoc” test as well as the option to plot means using three dimension bars. When we click the Compute button, we receive the output shown below.

Three Way Analysis of Variance

Variable analyzed: X

Factor A (rows) variable: Row (Fixed Levels)
Factor B (columns) variable: Col (Fixed Levels)
Factor C (slices) variable: Slice (Fixed Levels)

SOURCE	D.F.	SS	MS	F	PROB.> F	Omega Squared
Among Rows	1	12.250	12.250	12.250	0.002	0.083
Among Columns	1	42.250	42.250	42.250	0.000	0.304

Among Slices	2	6.500	3.250	3.250	0.056	0.033
A x B Inter.	1	12.250	12.250	12.250	0.002	0.083
A x C Inter.	2	6.500	3.250	3.250	0.056	0.033
B x C Inter.	2	6.500	3.250	3.250	0.056	0.033
AxBxC Inter.	2	24.500	12.250	12.250	0.000	0.166
Within Groups	24	24.000	1.000			
Total	35	134.750	3.850			

Omega squared for combined effects = 0.735

Note: MSErr denominator for all F ratios.

Descriptive Statistics

GROUP				N	MEAN	VARIANCE	STD.DEV.
Cell	1	1	1	3	2.000	1.000	1.000
Cell	1	1	2	3	3.000	1.000	1.000
Cell	1	1	3	3	4.000	1.000	1.000
Cell	1	2	1	3	5.000	1.000	1.000
Cell	1	2	2	3	4.000	1.000	1.000
Cell	1	2	3	3	3.000	1.000	1.000
Cell	2	1	1	3	2.000	1.000	1.000
Cell	2	1	2	3	5.000	1.000	1.000
Cell	2	1	3	3	2.000	1.000	1.000
Cell	2	2	1	3	5.000	1.000	1.000
Cell	2	2	2	3	6.000	1.000	1.000
Cell	2	2	3	3	8.000	1.000	1.000
Row	1			18	3.500	1.676	1.295
Row	2			18	4.667	5.529	2.351
Col	1			18	3.000	2.118	1.455
Col	2			18	5.167	3.324	1.823
Slice	1			12	3.500	3.182	1.784
Slice	2			12	4.500	2.091	1.446
Slice	3			12	4.250	6.386	2.527
TOTAL				36	4.083	3.850	1.962

TESTS FOR HOMOGENEITY OF VARIANCE

Hartley Fmax test statistic = 1.00 with deg.s freedom: 4 and 2.

Cochran C statistic = 0.08 with deg.s freedom: 4 and 2.

Bartlett Chi-square statistic = 0.00 with 3 D.F. Prob. larger = 1.000

COMPARISONS AMONG COLUMNS WITHIN EACH ROW

ROW 1 COMPARISONS

Scheffe contrasts among pairs of means.

alpha selected = 0.05

Group vs Group		Difference	Scheffe Statistic	Critical Value	Significant?
1	2	1.00	1.22	2.093	NO

ROW 2 COMPARISONS

Scheffe contrasts among pairs of means.
alpha selected = 0.05

Group vs Group		Difference	Scheffe Statistic	Critical Value	Significant?
1	2	-6.00	7.35	2.093	YES

COMPARISONS AMONG ROWS WITHIN EACH COLUMN

COLUMN 1 COMPARISONS

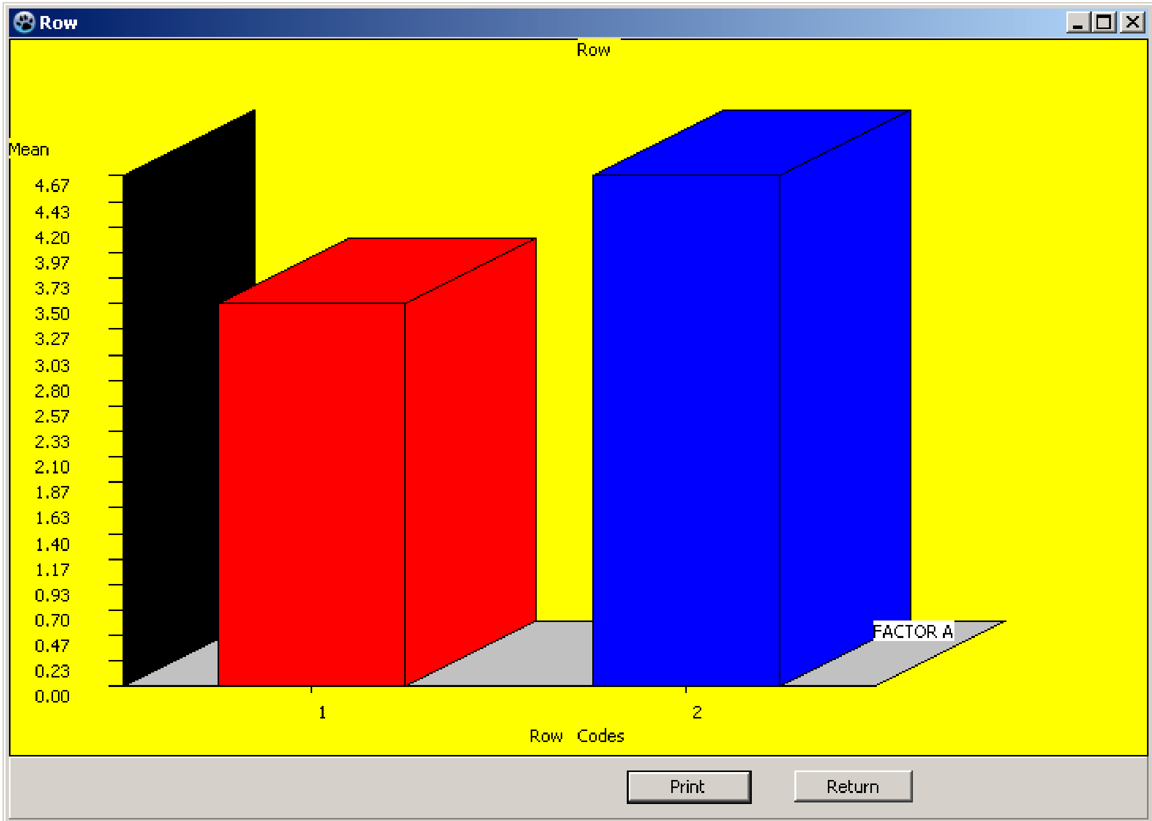
Scheffe contrasts among pairs of means.
alpha selected = 0.05

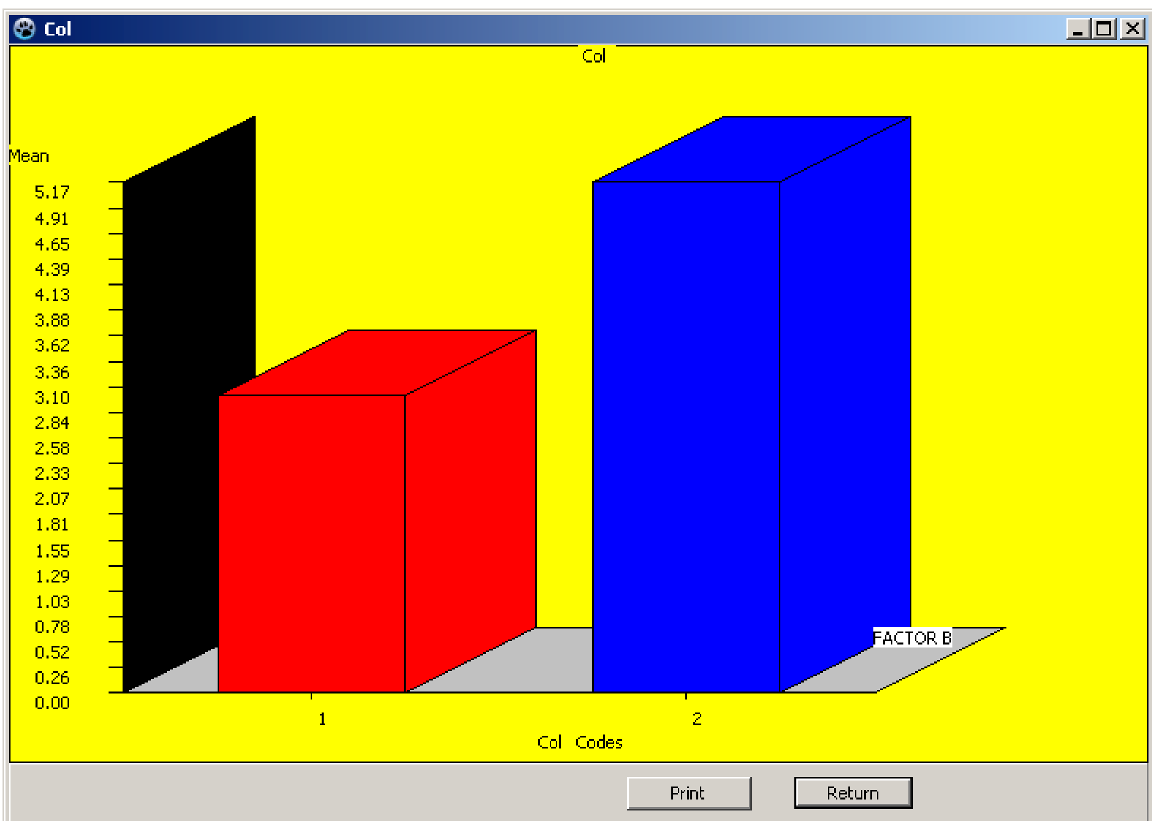
Group vs Group		Difference	Scheffe Statistic	Critical Value	Significant?
1	2	2.00	2.45	2.093	YES

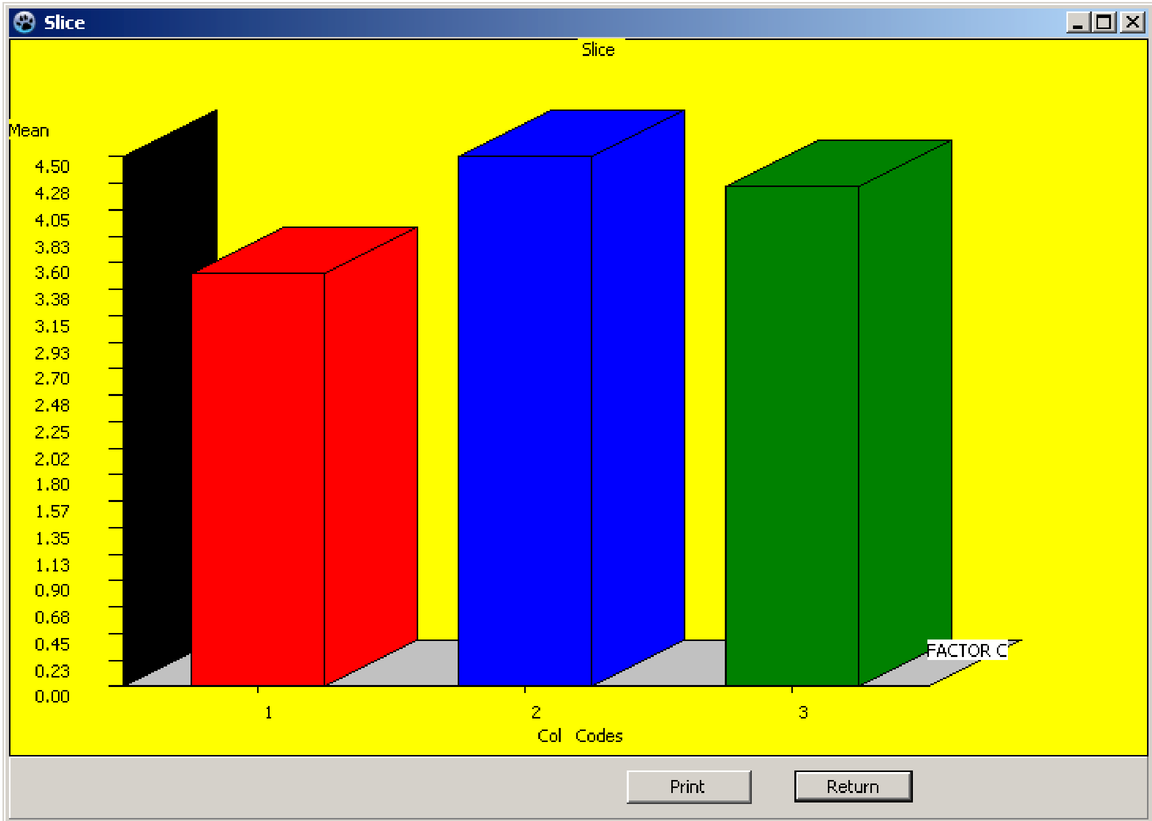
COLUMN 2 COMPARISONS

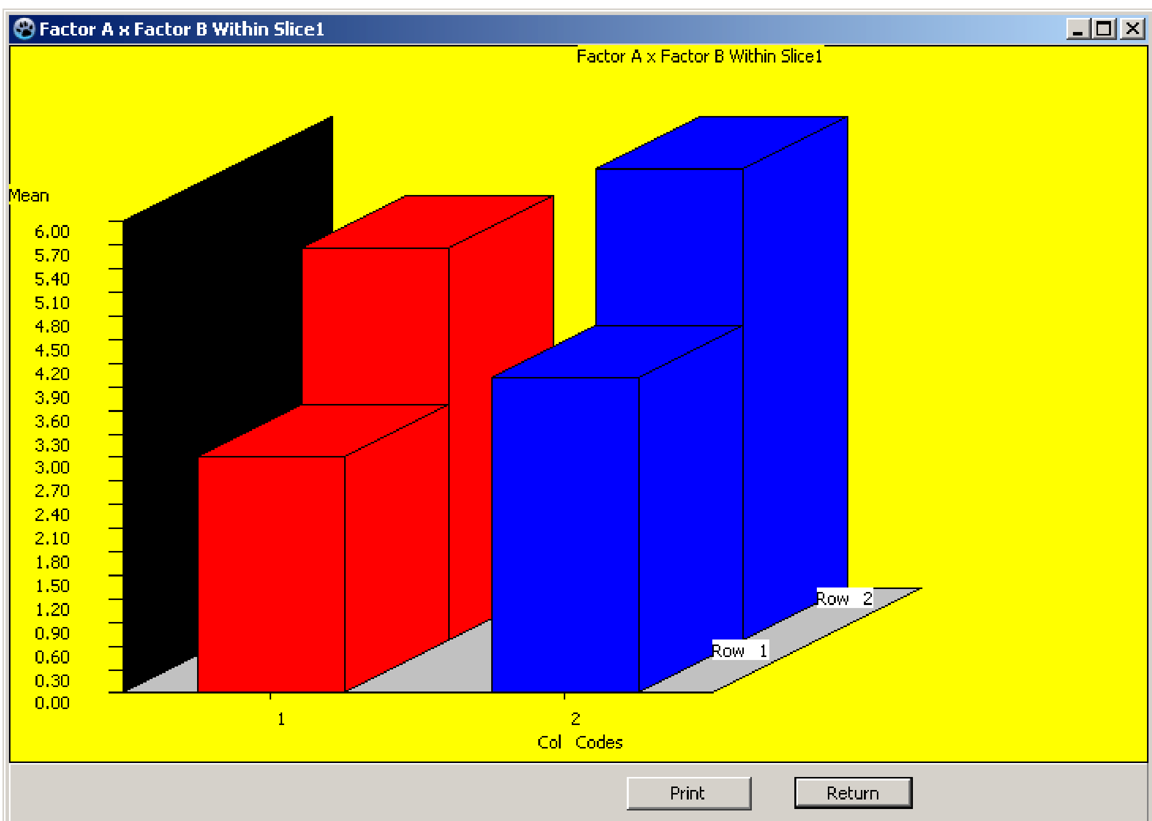
Scheffe contrasts among pairs of means.
alpha selected = 0.05

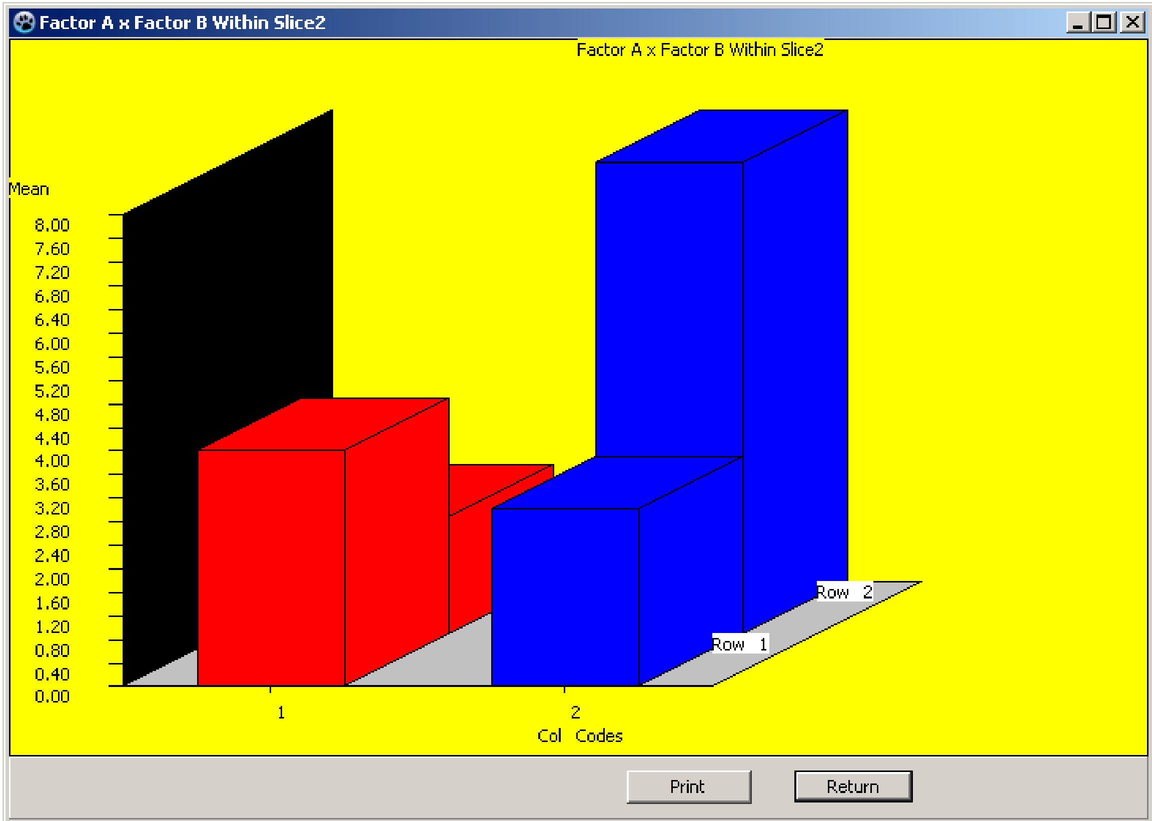
Group vs Group		Difference	Scheffe Statistic	Critical Value	Significant?
1	2	-5.00	6.12	2.093	YES

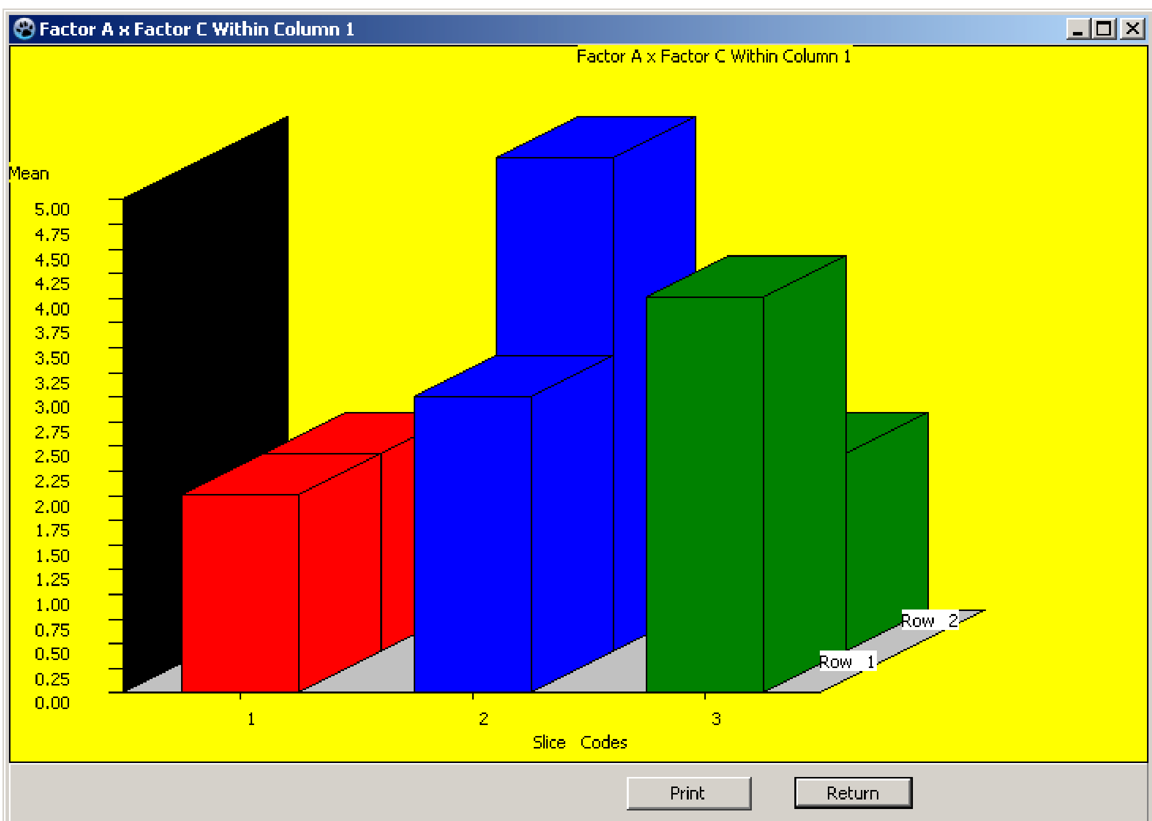

Row
Row
Mean
4.67
4.43
4.20
3.97
3.73
3.50
3.27
3.03
2.80
2.57
2.33
2.10
1.87
1.63
1.40
1.17
0.93
0.70
0.47
0.23
0.00
FACTOR A
1
2
Row Codes
Print
Return

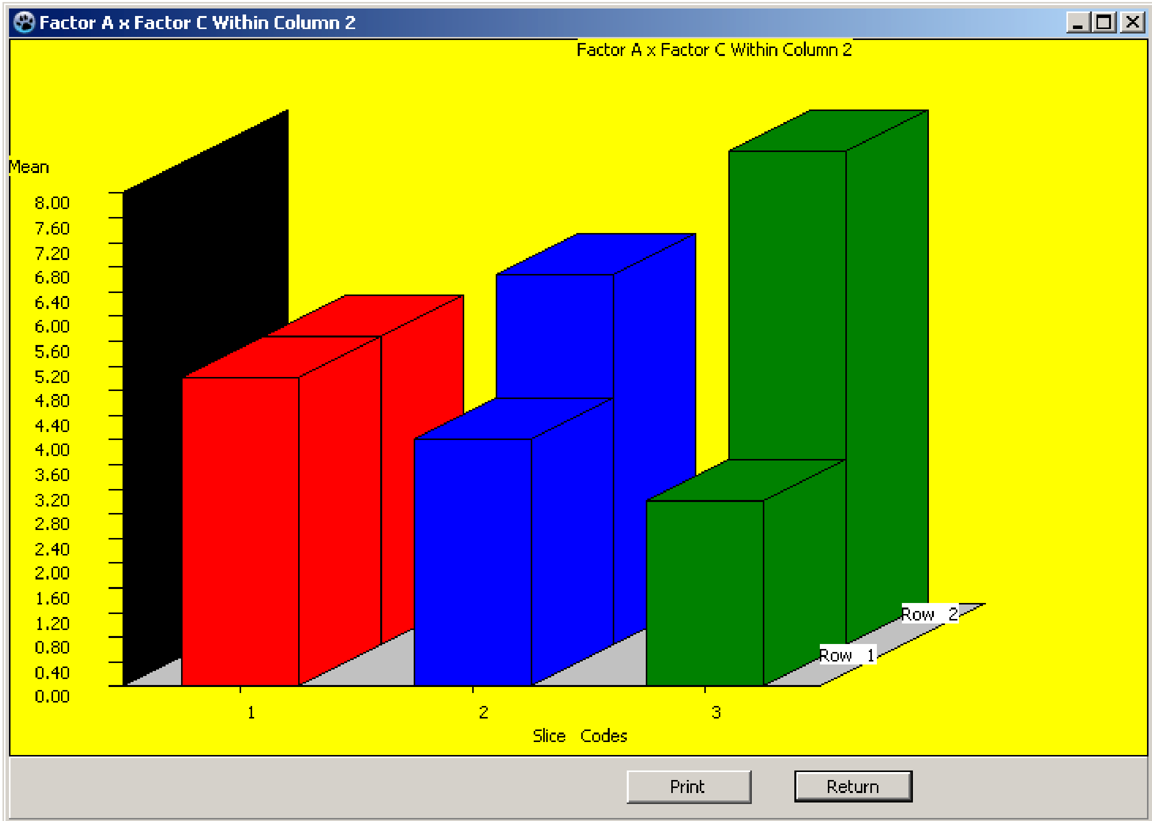

Col
Col
Mean
5.17
4.91
4.65
4.39
4.13
3.88
3.62
3.36
3.10
2.84
2.58
2.33
2.07
1.81
1.55
1.29
1.03
0.78
0.52
0.26
0.00
FACTOR B
1
2
Col Codes
Print
Return


Slice
Slice
Mean
4.50
4.28
4.05
3.83
3.60
3.38
3.15
2.93
2.70
2.48
2.25
2.02
1.80
1.57
1.35
1.13
0.90
0.68
0.45
0.23
0.00
FACTOR C
1
2
3
Col Codes
Print
Return

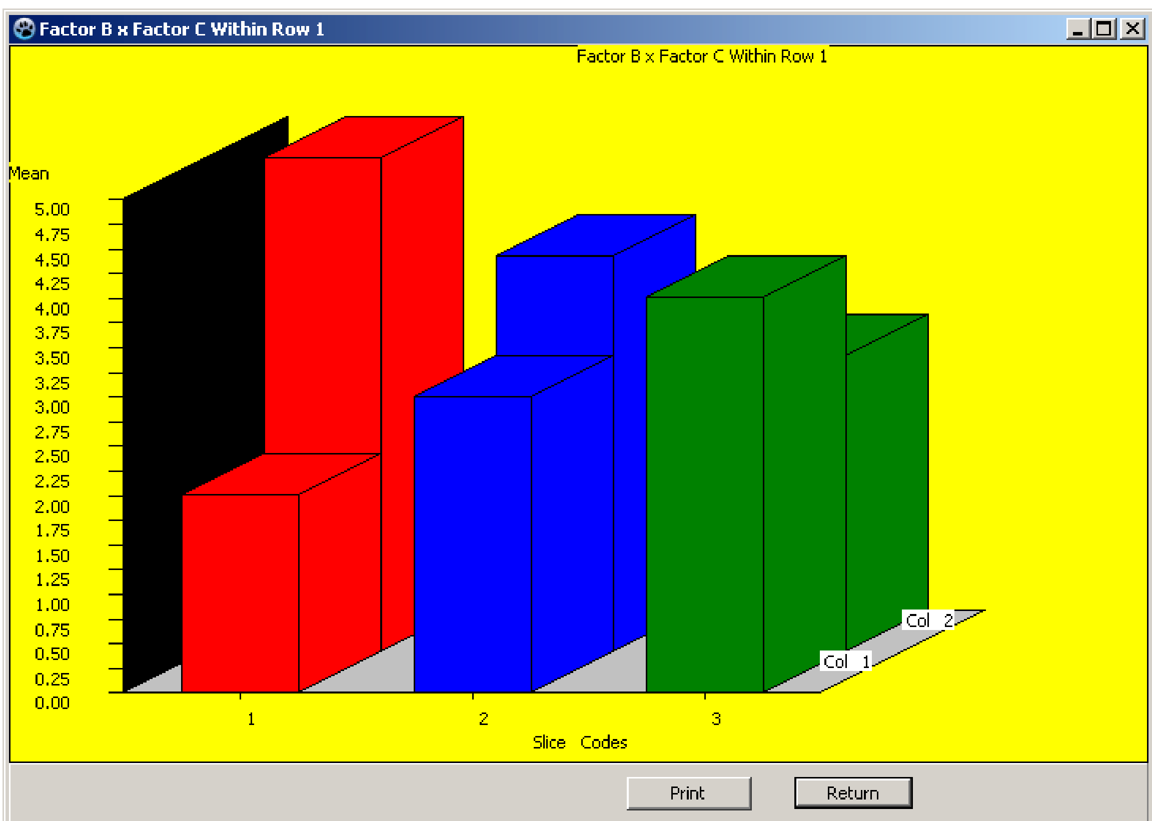

Factor A x Factor B Within Slice1
Factor A x Factor B Within Slice1
Mean
6.00
5.70
5.40
5.10
4.80
4.50
4.20
3.90
3.60
3.30
3.00
2.70
2.40
2.10
1.80
1.50
1.20
0.90
0.60
0.30
0.00
Row 2
Row 1
1
2
Col Codes
Print
Return


Factor A x Factor B Within Slice2
Factor A x Factor B Within Slice2
Mean
8.00
7.60
7.20
6.80
6.40
6.00
5.60
5.20
4.80
4.40
4.00
3.60
3.20
2.80
2.40
2.00
1.60
1.20
0.80
0.40
0.00
Row 2
Row 1
1
2
Col Codes
Print
Return

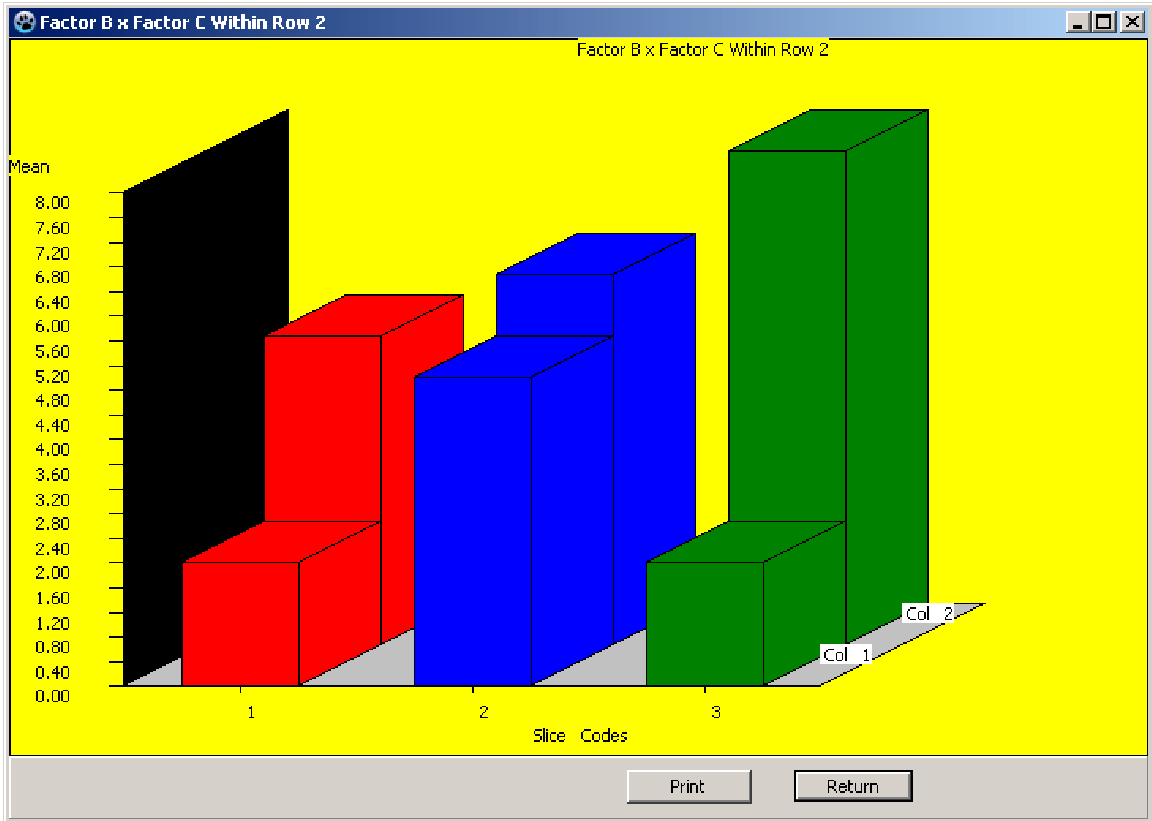

Factor A x Factor C Within Column 1
Factor A x Factor C Within Column 1
Mean
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Row 2
Row 1
1
2
3
Slice Codes
Print
Return



Factor A x Factor C Within Column 2
Factor A x Factor C Within Column 2
Mean
8.00
7.60
7.20
6.80
6.40
6.00
5.60
5.20
4.80
4.40
4.00
3.60
3.20
2.80
2.40
2.00
1.60
1.20
0.80
0.40
0.00
Row 2
Row 1
1
2
3
Slice Codes
Print
Return



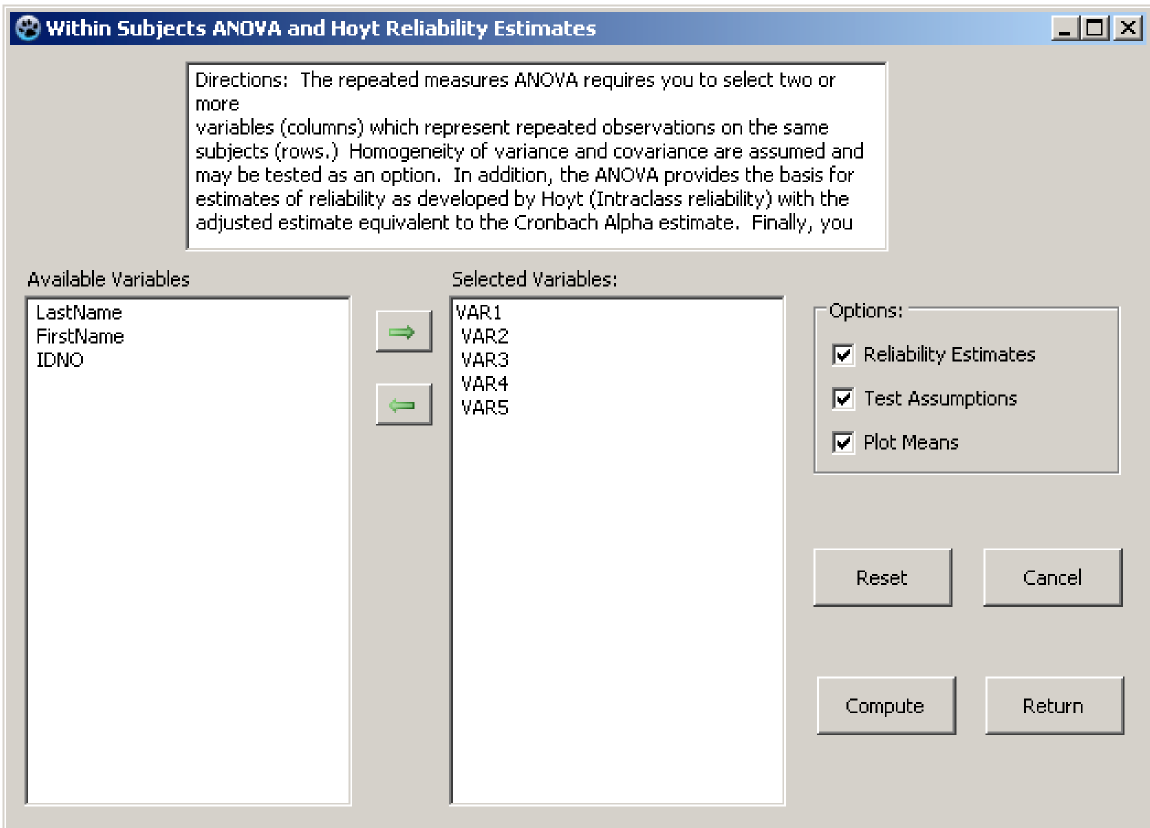
Factor B x Factor C Within Row 1
Factor B x Factor C Within Row 1
Mean
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Col 2
Col 1
1
2
3
Slice Codes
Print
Return



Factor B x Factor C Within Row 2
Factor B x Factor C Within Row 2
Mean
8.00
7.60
7.20
6.80
6.40
6.00
5.60
5.20
4.80
4.40
4.00
3.60
3.20
2.80
2.40
2.00
1.60
1.20
0.80
0.40
0.00
Col 2
Col 1
1
2
3
Slice Codes
Print
Return

Within Subjects Analysis of Variance

Multiple independent treatments may be administered to the same subjects. This design offers the advantage of lower errors by not introducing between group errors. We will use the file labeled itemdata.LAZ to demonstrate. Test items administered to subjects are essentially independent measures of the knowledge the subjects have for a certain topic. As such the analysis of variance for these repeated measures also serves as a basis for estimating the test reliability. The theory of this method was initially developed by Hoyt. Here then is the form that appears to complete the analysis. Note the options we have selected.



When we press the Compute button we obtain:

Treatments by Subjects (AxS) ANOVA Results.

Data File = C:\lazarus\Projects\LazStats\itemdat.LAZ

SOURCE	DF	SS	MS	F	Prob. > F
SUBJECTS	15	6.350	0.423		
WITHIN SUBJECTS	64	13.200	0.206		
TREATMENTS	4	3.050	0.763	4.507	0.003
RESIDUAL	60	10.150	0.169		
TOTAL	79	19.550	0.247		

TREATMENT (COLUMN) MEANS AND STANDARD DEVIATIONS

VARIABLE	MEAN	STD.DEV.
VAR1	0.875	0.342
VAR2	0.688	0.479
VAR3	0.563	0.512
VAR4	0.438	0.512
VAR5	0.313	0.479

Mean of all scores = 0.575 with standard deviation = 0.497

RELIABILITY ESTIMATES

TYPE OF ESTIMATE	VALUE
Unadjusted total reliability	0.513
Unadjusted item reliability	0.174
Adjusted total (Cronbach)	0.600
Adjusted item reliability	0.231

BOX TEST FOR HOMOGENEITY OF VARIANCE-COVARIANCE MATRIX

SAMPLE COVARIANCE MATRIX with 16 cases.

Variables

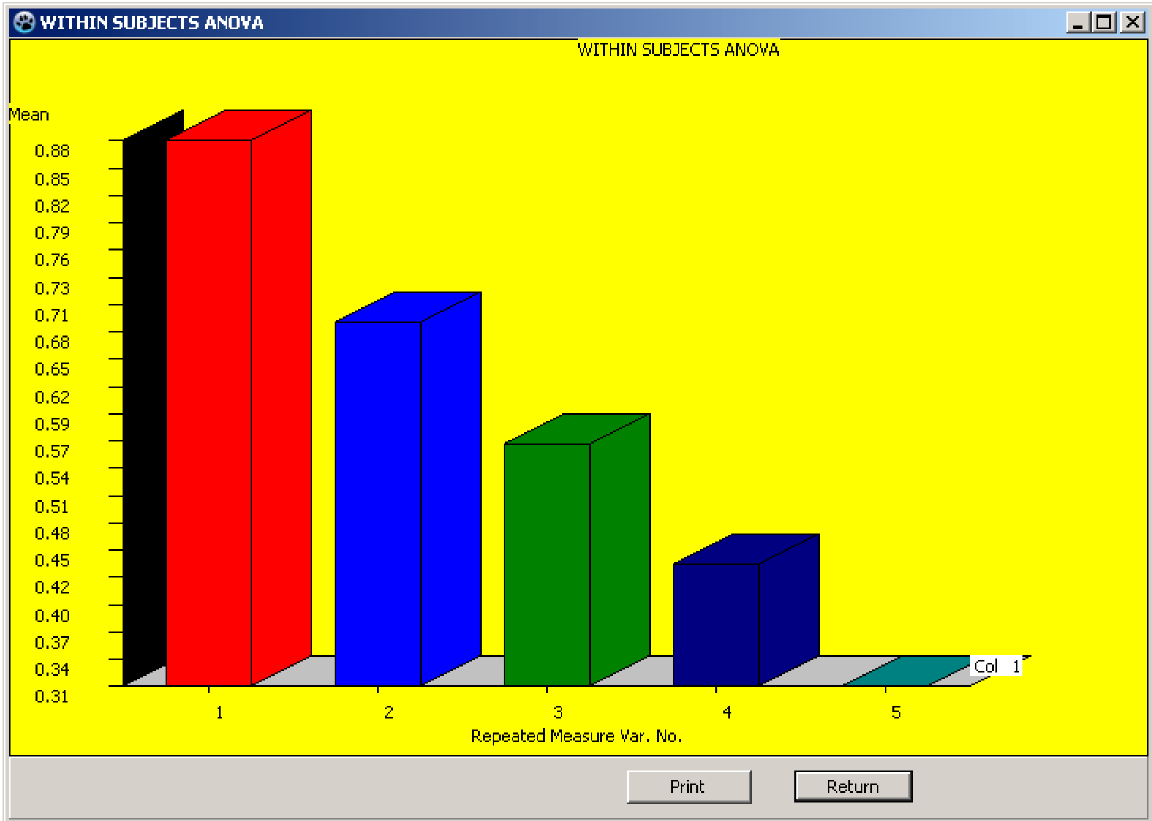
	VAR1	VAR2	VAR3	VAR4	VAR5
VAR1	0.117	0.025	0.008	-0.008	0.042
VAR2	0.025	0.229	0.121	0.079	0.037
VAR3	0.008	0.121	0.263	0.071	0.079
VAR4	-0.008	0.079	0.071	0.263	0.054
VAR5	0.042	0.037	0.079	0.054	0.229

ASSUMED POP. COVARIANCE MATRIX with 16 cases.

Variables

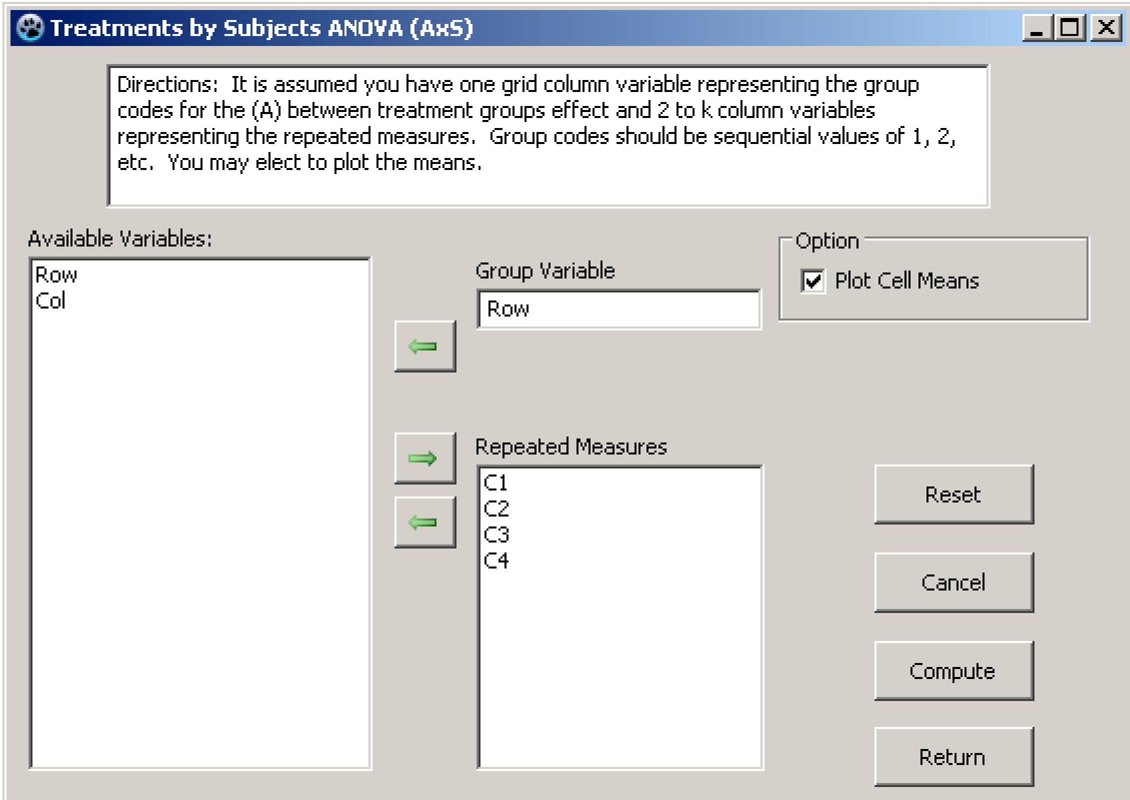
	VAR1	VAR2	VAR3	VAR4	VAR5
VAR1	0.220	0.011	0.011	0.011	0.011
VAR2	0.048	0.219	0.010	0.010	0.010
VAR3	0.048	0.046	0.219	0.010	0.010
VAR4	0.048	0.046	0.044	0.219	0.009
VAR5	0.048	0.046	0.044	0.042	0.218

Determinant of variance-covariance matrix = 0
Determinant of homogeneity matrix = 0
ChiSquare = 56.769 with 13 degrees of freedom
Probability of larger chisquare = 6.96E-007



The A by S Analysis of Variance

One can apply repeated measures to subjects in two or more separate groups. For example, we may be interested in the differences between males and females sampled from a school that have been administered a standardized achievement test. We will use the ABRDATA.LAZ file to demonstrate this analysis. Notice the variables we have selected and the options chosen:



When we click the Compute button, the following results are observed:

ANOVA With One Between Subjects and One Within Subjects Treatments

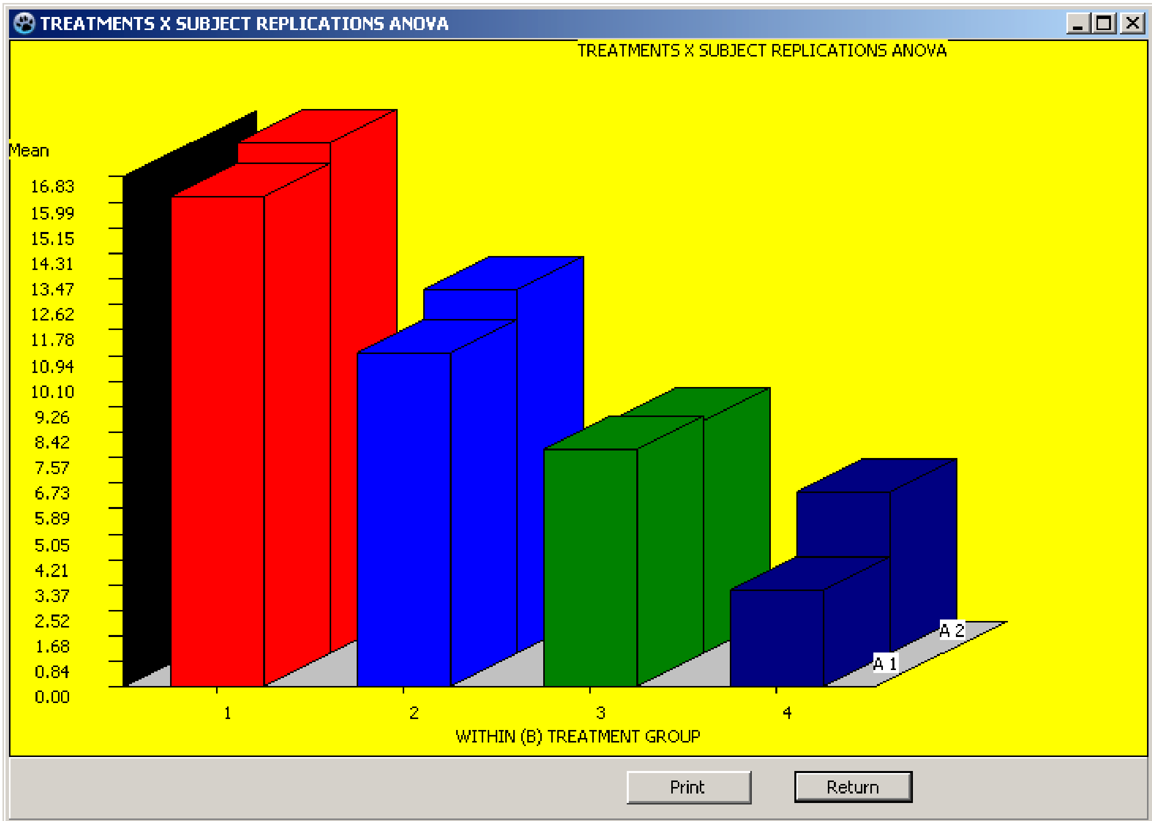
Source	df	SS	MS	F	Prob.
Between	11	181.000			
Groups (A)	1	10.083	10.083	0.590	0.4602
Subjects w.g.	10	170.917	17.092		
Within Subjects	36	1077.000			
B Treatments	3	991.500	330.500	128.627	0.0000
A X B inter.	3	8.417	2.806	1.092	0.3677
B X S w.g.	30	77.083	2.569		
TOTAL	47	1258.000			

Means

TRT. A	B 1	B 2	B 3	B 4	TOTAL
1	16.167	11.000	7.833	3.167	9.542
2	16.833	12.000	7.667	5.333	10.458
TOTAL	16.500	11.500	7.750	4.250	10.000

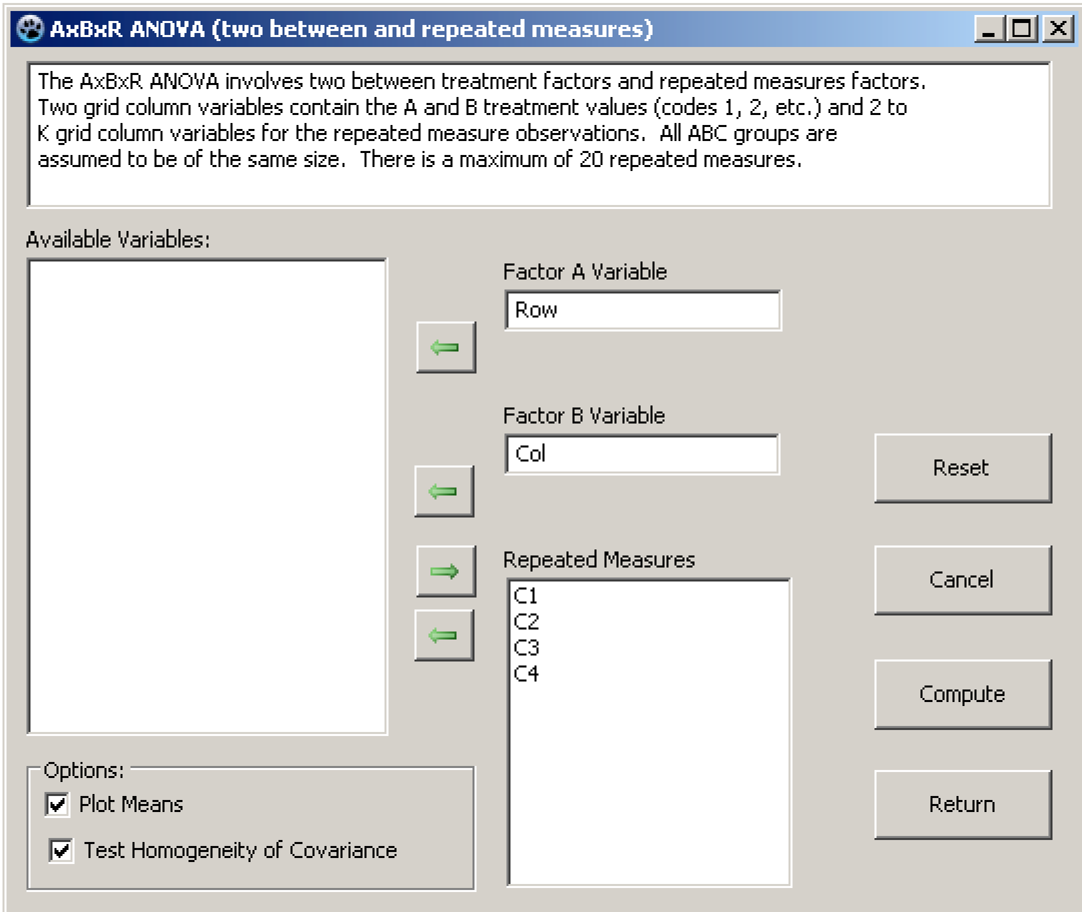
Standard Deviations

TRT.	B 1	B 2	B 3	B 4	TOTAL
A					
1	2.714	2.098	2.714	1.835	5.316
2	1.329	2.828	2.338	3.445	5.099
TOTAL	2.067	2.431	2.417	2.864	5.174



The A x B x R Analysis of Variance

Like the previous “mixed” design ANOVA that had repeated measures for different levels of treatment for one independent variable, we can also combine a two-way ANOVA with repeated measures. We will demonstrate using the same data file as in the previous analysis, namely the ABRDATA.LAZ file.



When you click the Compute button you obtain:

SOURCE	DF	SS	MS	F	PROB.
Between Subjects	11	181.000			
A Effects	1	10.083	10.083	0.978	0.352
B Effects	1	8.333	8.333	0.808	0.395
AB Effects	1	80.083	80.083	7.766	0.024
Error Between	8	82.500	10.313		
Within Subjects	36	1077.000			
C Replications	3	991.500	330.500	152.051	0.000
AC Effects	3	8.417	2.806	1.291	0.300
BC Effects	3	12.167	4.056	1.866	0.162
ABC Effects	3	12.750	4.250	1.955	0.148
Error Within	24	52.167	2.174		
Total	47	1258.000			

ABR Means Table with 3 cases.

Variables

	C1	C2	C3	C4
A1 B1	17.000	12.000	8.667	4.000

A1 B2	15.333	10.000	7.000	2.333
A2 B1	16.667	10.000	6.000	2.333
A2 B2	17.000	14.000	9.333	8.333

AB Means Table with 12 cases.
Variables

	B 1	B 2
A1	10.417	8.667
A2	8.750	12.167

AC Means Table with 6 cases.
Variables

	C 0	C 1	C 2	C 3
A0	16.167	11.000	7.833	3.167
A1	16.833	12.000	7.667	5.333

BC Means Table with 6 cases.
Variables

	C 1	C 2	C 3	C 4
B1	16.833	11.000	7.333	3.167
B2	16.167	12.000	8.167	5.333

Variance-Covariance AMatrix for A1 B1 with 12 cases.
Variables

	C1	C2	C3	C4
C1	7.000	9.500	8.667	5.583
C2	4.000	10.000	10.083	6.667
C3	5.000	11.000	12.333	7.167
C4	4.000	11.000	10.667	8.167

Variance-Covariance AMatrix for A1 B2 with 12 cases.
Variables

	C1	C2	C3	C4
C1	9.333	8.750	4.333	2.125
C2	4.000	9.000	9.042	5.333
C3	0.000	9.500	13.167	7.583
C4	-0.667	7.500	9.333	6.417

Variance-Covariance AMatrix for A2 B1 with 12 cases.
Variables

	C1	C2	C3	C4
C1	1.333	2.375	0.167	-0.271
C2	-2.000	8.500	6.521	3.667
C3	-2.000	6.750	10.583	6.792
C4	-1.333	4.750	7.667	5.542

Variance-Covariance AMatrix for A2 B2 with 12 cases.
Variables

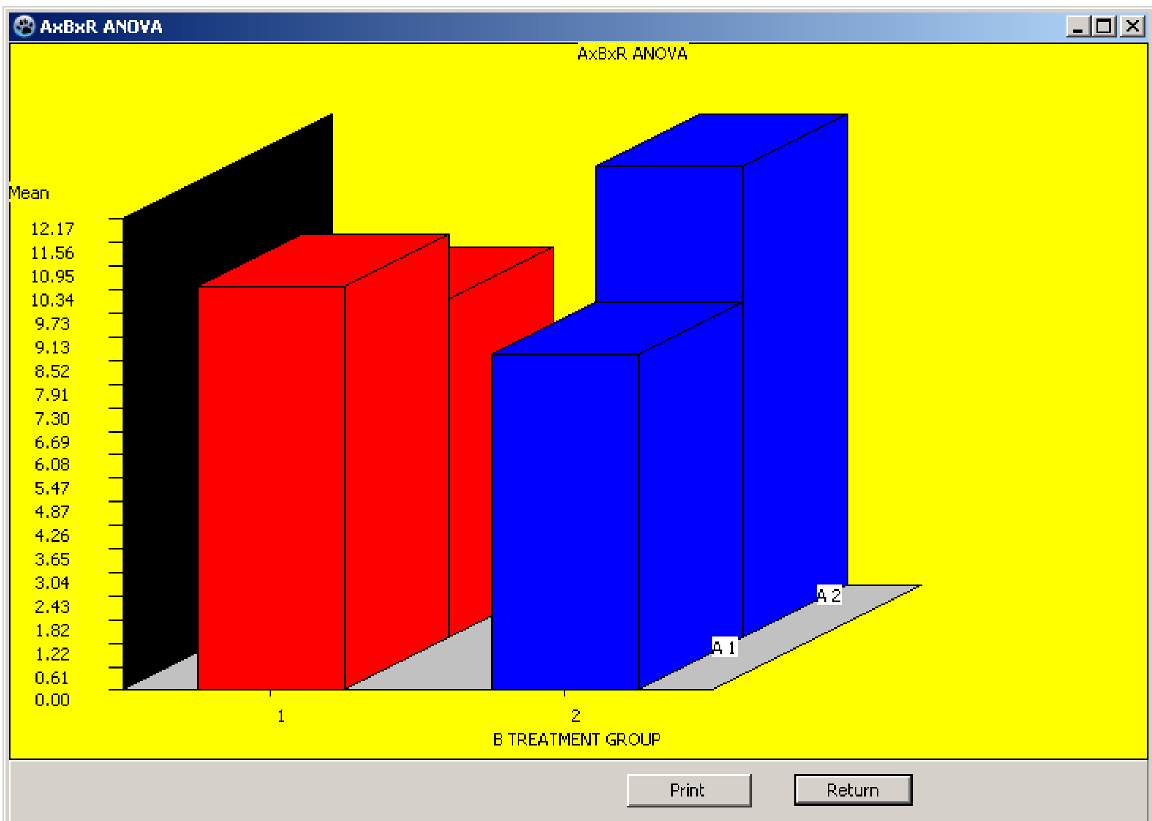
	C1	C2	C3	C4
C1	3.000	4.188	1.083	-0.635
C2	3.000	8.250	5.260	1.833
C3	1.000	5.375	6.625	3.729
C4	-0.500	2.375	4.167	3.104

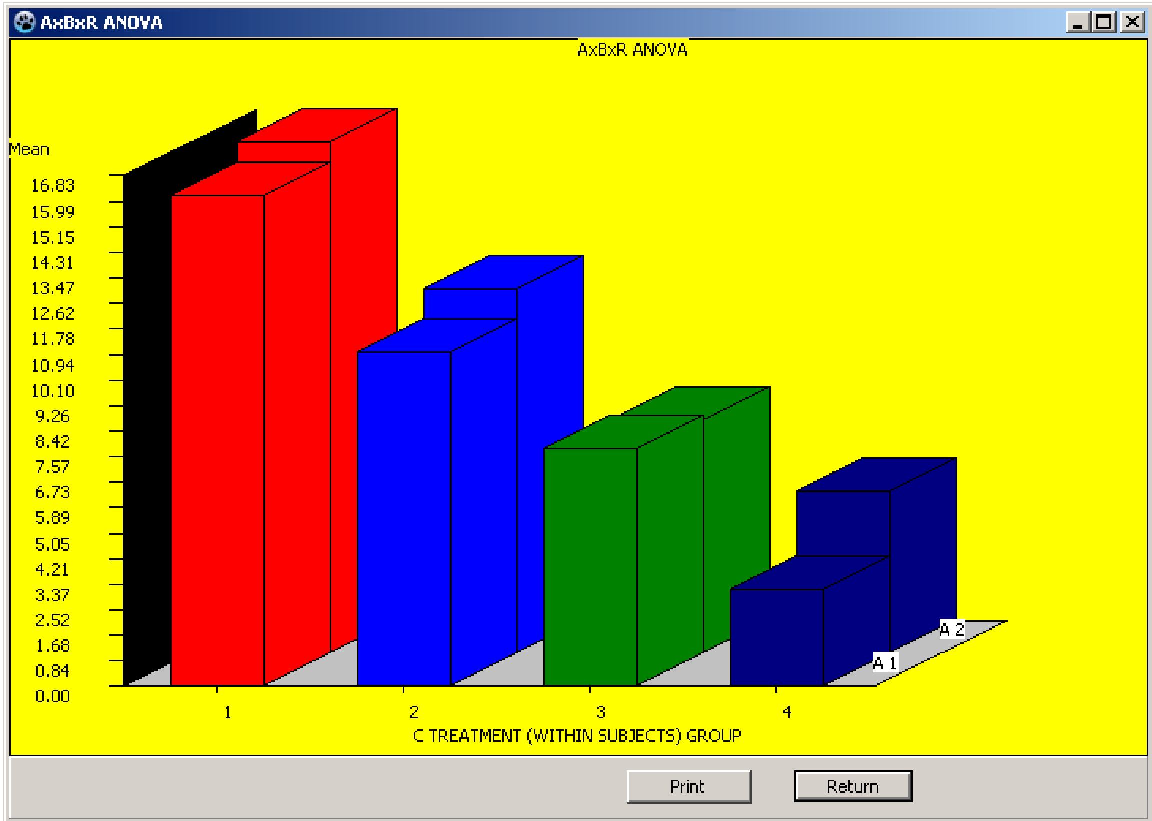
Pooled Variance-Covariance AMatrix with 12 cases.
Variables

	C1	C2	C3	C4
C1	5.167	6.203	3.563	1.701
C2	2.250	8.938	7.727	4.375
C3	1.000	8.156	10.677	6.318
C4	0.375	6.406	7.958	5.807

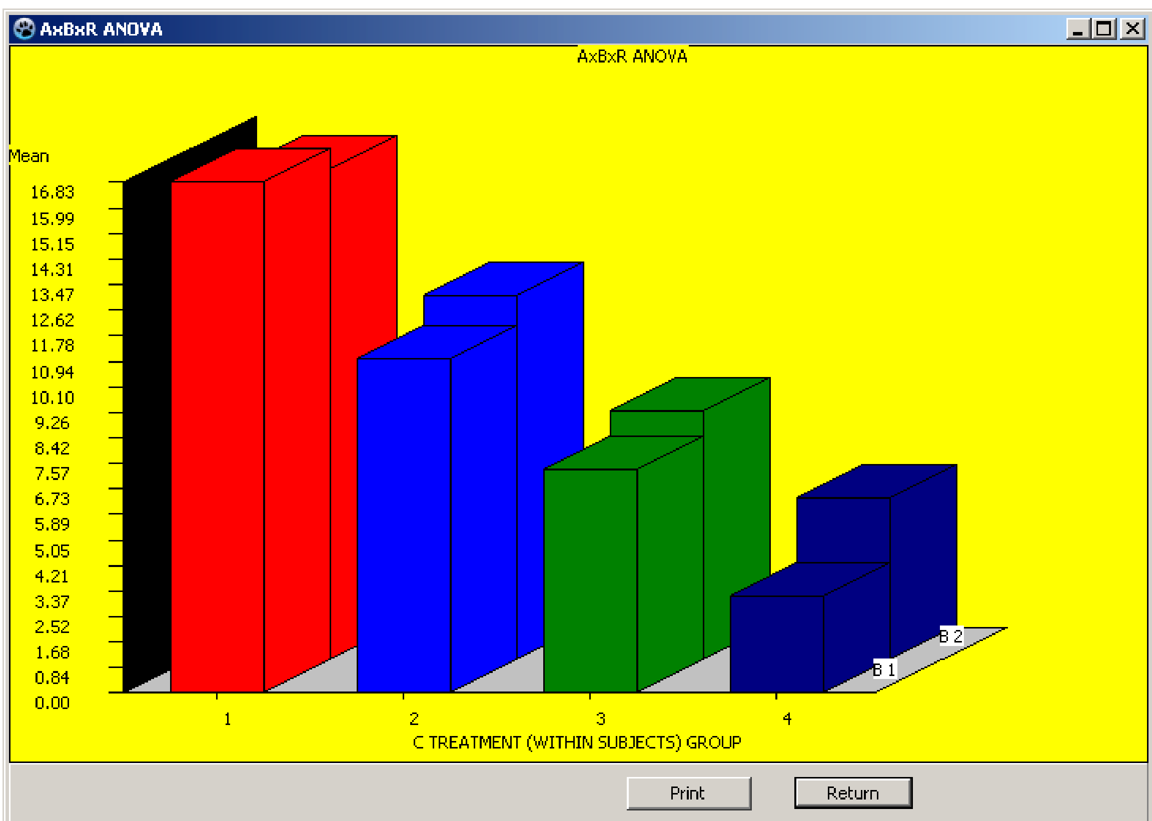
Test that sample covariances are from same population:
Chi-Squared := 11.222 with 30 degrees of freedom.
Probability of > Chi-Squared := 0.999

Test that variance-covariances AMatrix has equal variances and equal covariances:
Chi-Squared := 8.589 with 8 degrees of freedom.
Probability of > Chi-Squared := 0.378





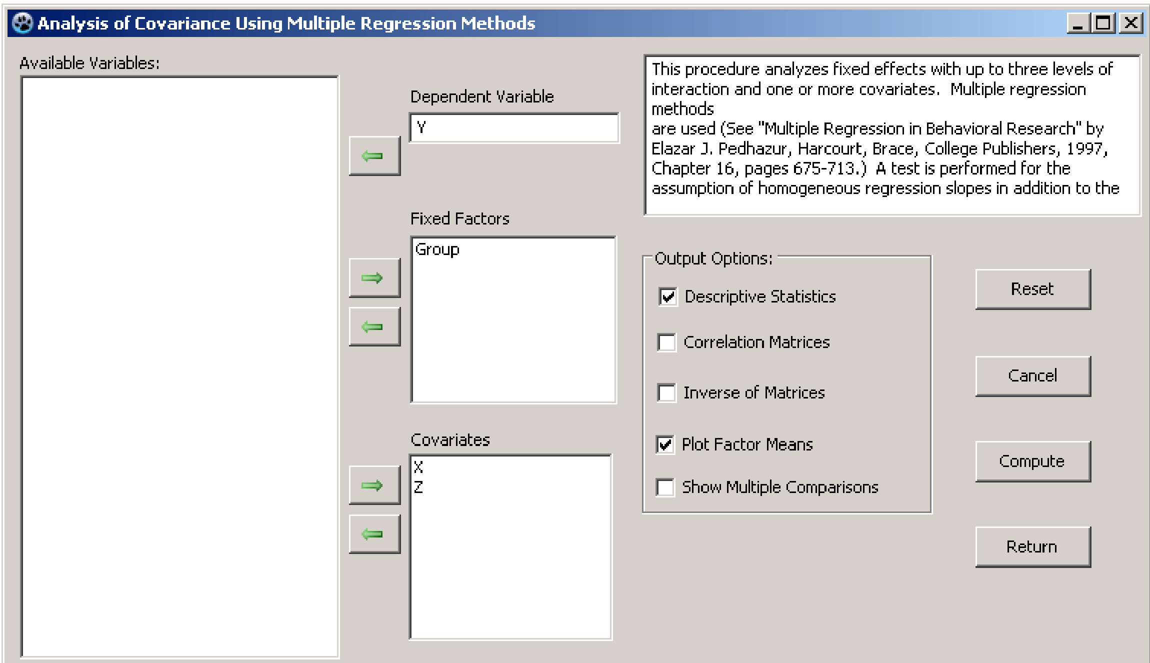
AxBxR ANOVA
AxBxR ANOVA
Mean
16.83
15.99
15.15
14.31
13.47
12.62
11.78
10.94
10.10
9.26
8.42
7.57
6.73
5.89
5.05
4.21
3.37
2.52
1.68
0.84
0.00
A 2
A 1
1
2
3
4
C TREATMENT (WITHIN SUBJECTS) GROUP
Print
Return



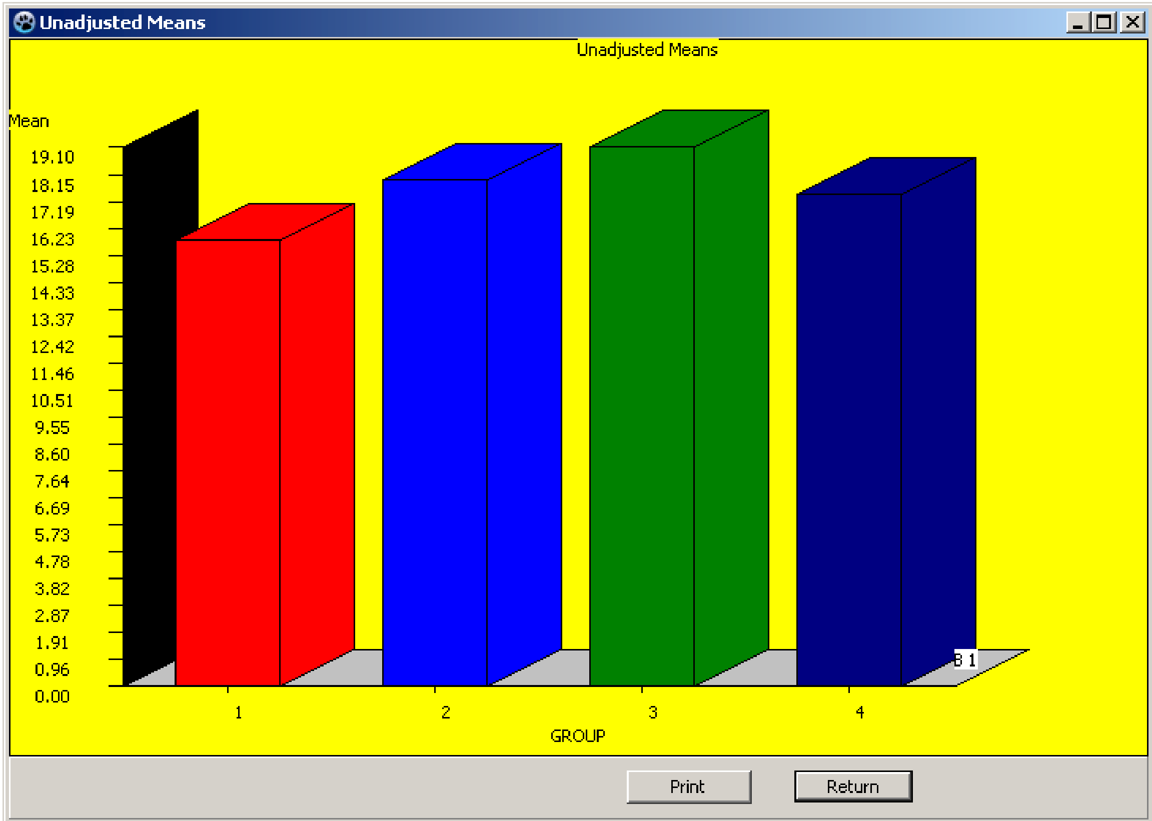
AxBxR ANOVA
AxBxR ANOVA
Mean
16.83
15.99
15.15
14.31
13.47
12.62
11.78
10.94
10.10
9.26
8.42
7.57
6.73
5.89
5.05
4.21
3.37
2.52
1.68
0.84
0.00
B 2
B 1
1
2
3
4
C TREATMENT (WITHIN SUBJECTS) GROUP
Print
Return

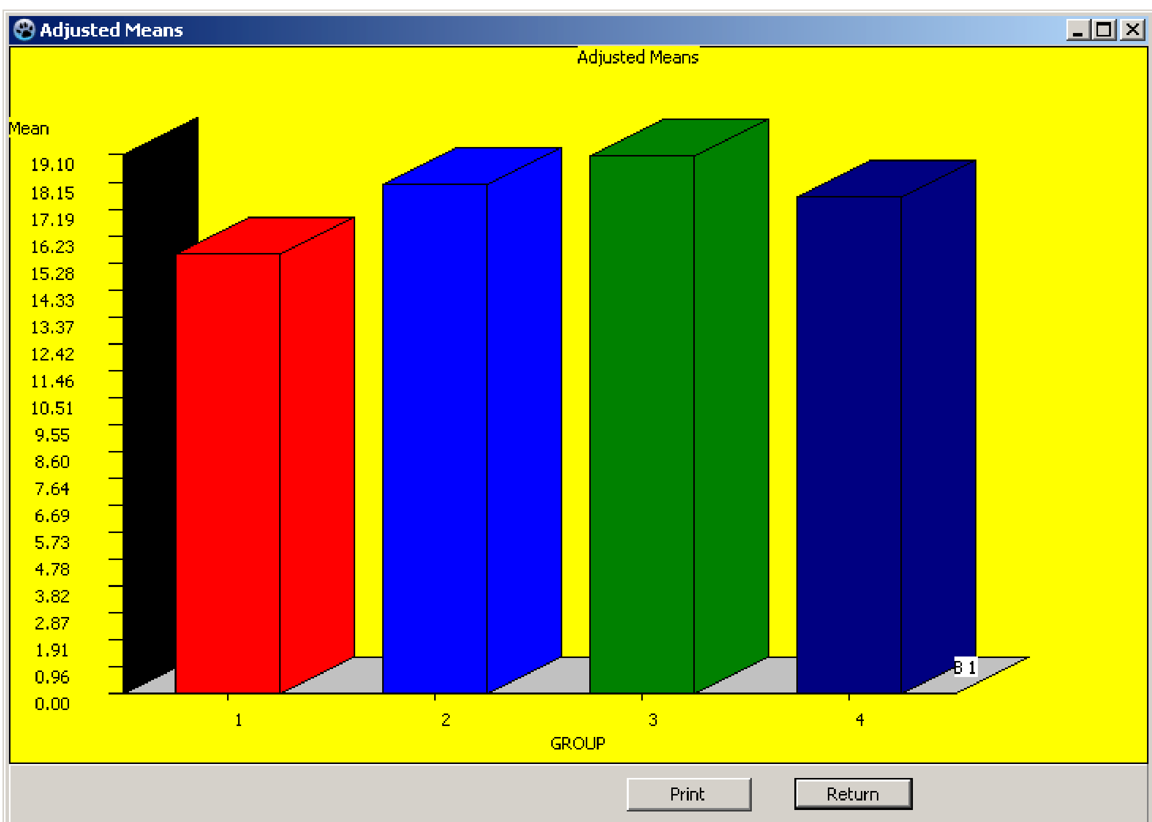
Analysis of Covariance by Multiple Regression

All of the analysis of variance designs may be considered as different problems in multiple regression. The model of each ANOVA is actually a multiple regression model. In some cases, it is easier to specify the analysis as a multiple regression equation to do the analysis than to "partition" variance into separate components as is done for many of the more simple designs. This procedure demonstrates the use of multiple regression to obtain an analysis of covariance. We will use the file labeled ANCOVA.LAZ. When you choose this analysis option, you see the form below:



Clicking the compute button yields the results displayed next. Examine your grid data following the output results. You will see that additional variables have been created that reflect the contributions of each level of each treatment variable using effect coding.


Unadjusted Means
Unadjusted Means
Mean
19.10
18.15
17.19
16.23
15.28
14.33
13.37
12.42
11.46
10.51
9.55
8.60
7.64
6.69
5.73
4.78
3.82
2.87
1.91
0.96
0.00
B 1
1
2
3
4
GROUP
Print
Return


Adjusted Means
Adjusted Means
Mean
19.10
18.15
17.19
16.23
15.28
14.33
13.37
12.42
11.46
10.51
9.55
8.60
7.64
6.69
5.73
4.78
3.82
2.87
1.91
0.96
0.00
B 1
1
2
3
4
GROUP
Print
Return

ANALYSIS OF COVARIANCE USING MULTIPLE REGRESSION

File Analyzed: C:\lazarus\Projects\LazStats\ANCOVA.LAZ

Model for Testing Assumption of Zero Interactions with Covariates

MEANS with 40 valid cases.

Variables	X	Z	A1	A2	A3
	7.125	14.675	0.000	0.000	0.000

Variables	XxA1	XxA2	XxA3	ZxA1	ZxA2
	0.125	0.025	0.075	-0.400	-0.125

Variables	ZxA3	Y
	-0.200	17.550

VARIANCES with 40 valid cases.

Variables	X	Z	A1	A2	A3
	4.163	13.866	0.513	0.513	0.513

Variables	XxA1	XxA2	XxA3	ZxA1	ZxA2
	28.010	27.102	27.712	116.759	125.035

Variables	ZxA3	Y
	124.113	8.254

STD. DEV.S with 40 valid cases.

Variables	X	Z	A1	A2	A3
	2.040	3.724	0.716	0.716	0.716

Variables	XxA1	XxA2	XxA3	ZxA1	ZxA2
	5.292	5.206	5.264	10.806	11.182

Variables	ZxA3	Y
	11.141	2.873

Analysis of Variance for the Model to Test Regression Homogeneity

SOURCE	Deg.F.	SS	MS	F	Prob>F
Explained	11	228.08	20.73	6.188	0.0000
Error	28	93.82	3.35		
Total	39	321.90			

R Squared = 0.709

Model for Analysis of Covariance

MEANS with 40 valid cases.

Variables	X	Z	A1	A2	A3
	7.125	14.675	0.000	0.000	0.000

Variables	Y
	17.550

VARIANCES with 40 valid cases.

Variables	X	Z	A1	A2	A3
	4.163	13.866	0.513	0.513	0.513

Variables	Y
	8.254

STD. DEV.S with 40 valid cases.

Variables	X	Z	A1	A2	A3
	2.040	3.724	0.716	0.716	0.716

Variables	Y
	2.873

Test for Homogeneity of Group Regression Coefficients
Change in R2 = 0.0192. F = 0.308 Prob.> F = 0.9275 with d.f. 6 and 28

R Squared = 0.689

Analysis of Variance for the ANCOVA Model

SOURCE	Deg.F.	SS	MS	F	Prob>F
Explained	5	221.89	44.38	15.087	0.0000
Error	34	100.01	2.94		
Total	39	321.90			

Unadjusted Group Means for Group Variables Group
Means with 40 valid cases.

Variables			
15.800	17.900	19.100	17.400

Intercepts for Each Group Regression Equation for Variable: Group
Inercepts with 40 valid cases.

Variables	Group 1	Group 2	Group 3	Group 4
	8.076	10.505	11.528	10.076

Adjusted Group Means for Group Variables Group
Means with 40 valid cases.

Variables	Group 1	Group 2	Group 3	Group 4
	15.580	18.008	19.032	17.579

Test for Each Source of Variance - Type III SS

SOURCE	Deg.F.	SS	MS	F	Prob>F
Cov0	1	78.70	78.70	26.754	0.0000
Cov1	1	0.66	0.66	0.225	0.6379
A	3	60.98	20.33	6.911	0.0009
ERROR	34	100.01	2.94		