Example 1: One Way ANOVA in SPSS

A consumer group wants to compare a new brand of wax (Brand-X) to two leading brands (Sureglow and Microsheen) in terms of Effectiveness of wax. Following data is collected for this purpose:

Brand	Effectiveness	Brand	Effectiveness	Brand	Effectiveness
Sureglow	93	Mirrorsheen	90	Brand_X	105
Sureglow	96	Mirrorsheen	97	Brand_X	91
Sureglow	87	Mirrorsheen	91	Brand_X	95
Sureglow	91	Mirrorsheen	94	Brand_X	107
Sureglow	88	Mirrorsheen	100	Brand_X	90
Sureglow	85	Mirrorsheen	95	Brand_X	96
Sureglow	88	Mirrorsheen	88	Brand_X	92
Sureglow	91	Mirrorsheen	92	Brand_X	94
Sureglow	82	Mirrorsheen	94	Brand_X	84
Sureglow	91	Mirrorsheen	89	Brand_X	86
Sureglow	86	Mirrorsheen	96	Brand_X	82
Sureglow	93	Mirrorsheen	91	Brand_X	91
Sureglow	91	Mirrorsheen	97	Brand_X	106
Sureglow	87	Mirrorsheen	92	Brand_X	90
Sureglow	88	Mirrorsheen	92	Brand_X	91
				Brand_X	92
				Brand_X	91
				Brand_X	106
				Brand_X	98
				Brand_X	97
				Brand_X	80
				Brand_X	97
				Brand_X	91
				Brand_X	99
				Brand_X	86

To test the null hypothesis of equal mean effectiveness for the three brands of wax, the data is first converted to Group Format which will have 2 columns, Brand and Effectiveness. Note that the Brand variable in One-Way ANOVA procedure in SPSS must be *numeric* and therefore Sureglow is coded as 1, Microsheen as 2, and Brand-X as 3 (see data file WaxEffectiveness1Way.xlsx).

To run the One-Way ANOVA procedure in SPSS, open the data file WaxEffectiveness1Way.xlsx in SPSS, and then click the following sequence:

Analyze/Compare Means/One-WAY ANOVA (see Figure 1)

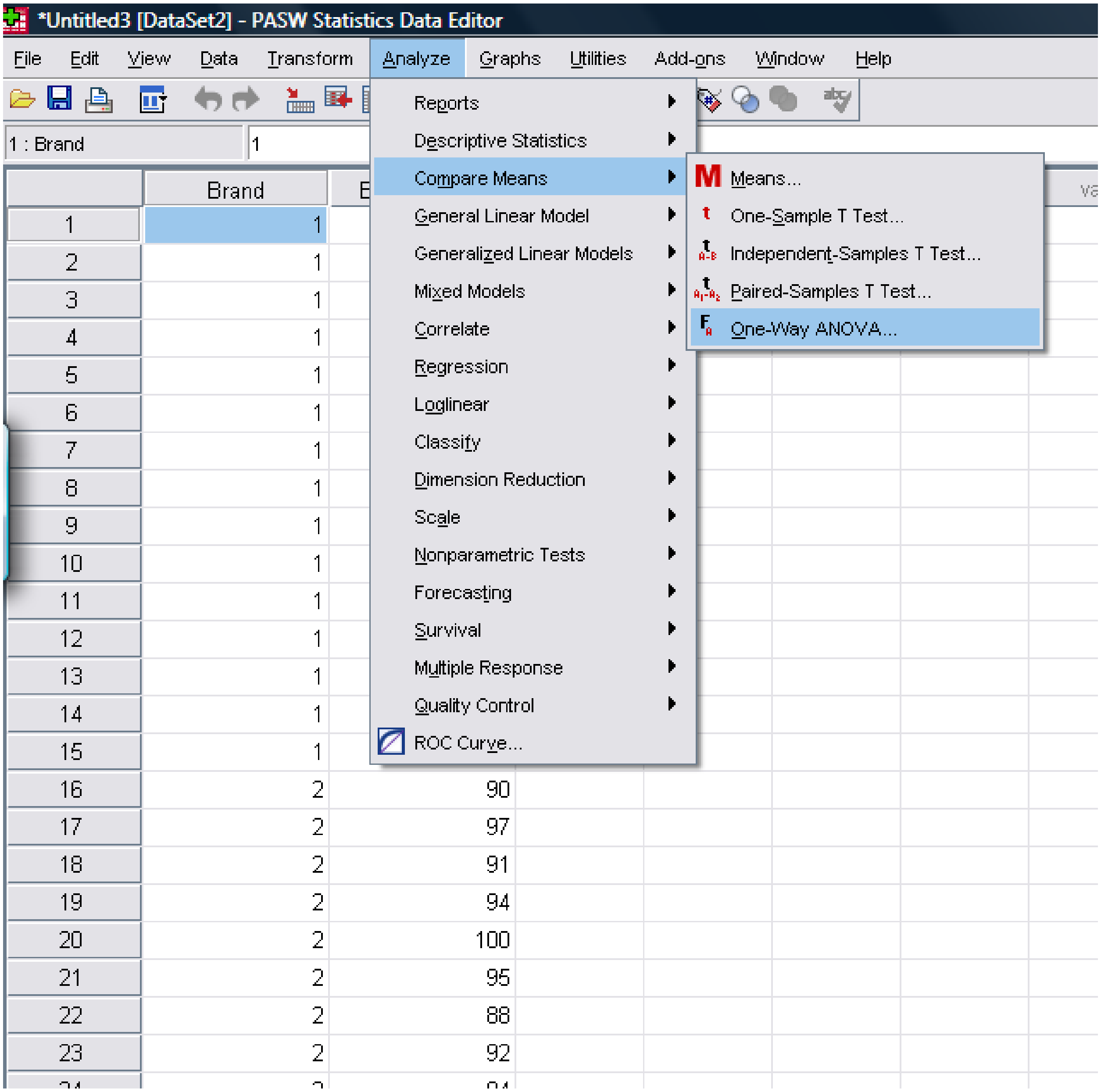


Figure 1: Analyze/Compare Means/One-WAY ANOVA

This will open the window shown in Figure 2. Select Effectiveness in the Dependent List, and Brand as the Factor (see Figure 2a), click on Options then check Descriptives and Test Homogeneity of Variance boxes (Figure 2b), then click OK. The output is shown below.

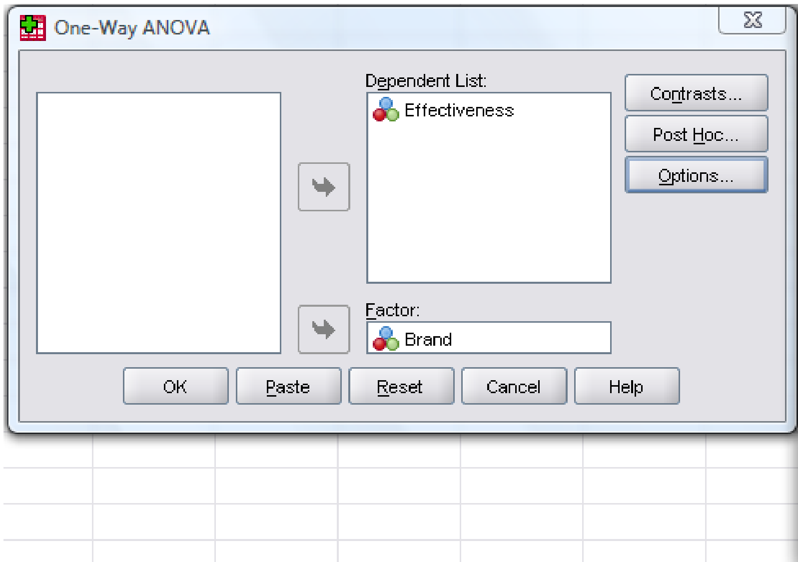


Figure 2a

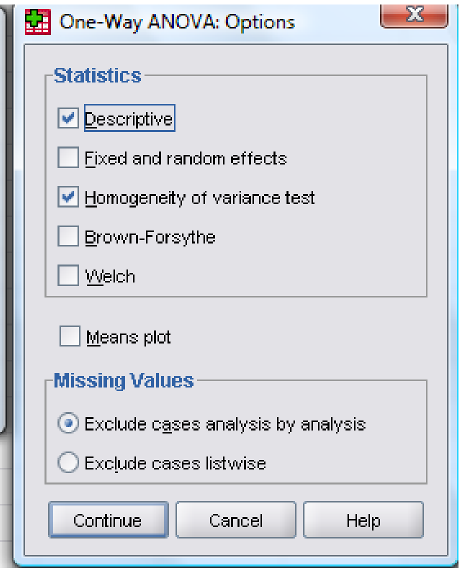


Figure 2b

Oneway

[DataSet2]

Descriptives

Effectiveness

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	15	89.13	3.603	.930	87.14	91.13	82	96
2	15	93.20	3.342	.863	91.35	95.05	88	100
3	25	93.48	7.326	1.465	90.46	96.50	80	107
Total	55	92.22	5.811	.784	90.65	93.79	80	107

Test of Homogeneity of Variances

Effectiveness

Levene Statistic	df1	df2	Sig.
5.309	2	52	.008

Since P-value for Levene's Test for equal variances hypothesis is .008, equality of variances is rejected, ANOVA results are not valid. (Some recommend a data transformation in such a situation.)

ANOVA

Effectiveness

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	197.008	2	98.504	3.149	.051
Within Groups	1626.373	52	31.276		
Total	1823.382	54			

Since P-value for equal MEANS hypothesis is .051, means can be considered equal.

Another limitation of the One-Way ANOVA procedure in SPSS is that it does not have an option for storing residuals (which are needed so that the assumption of normality of residuals can be tested). For this reason, it is better to run General Linear Model procedure in SPSS by clicking on the sequence:

Analyze/ General Linear Model/Univariate (Figure 3)

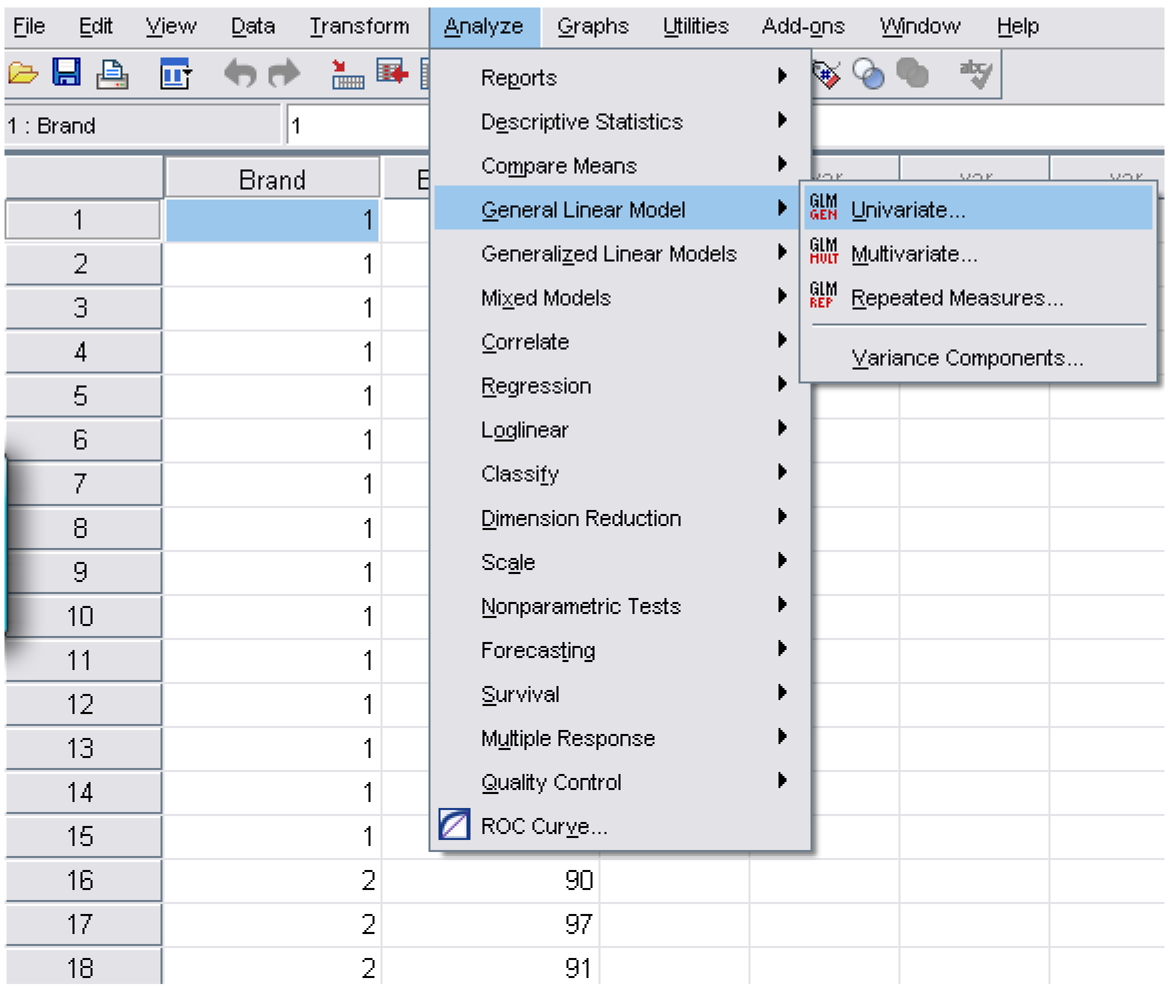
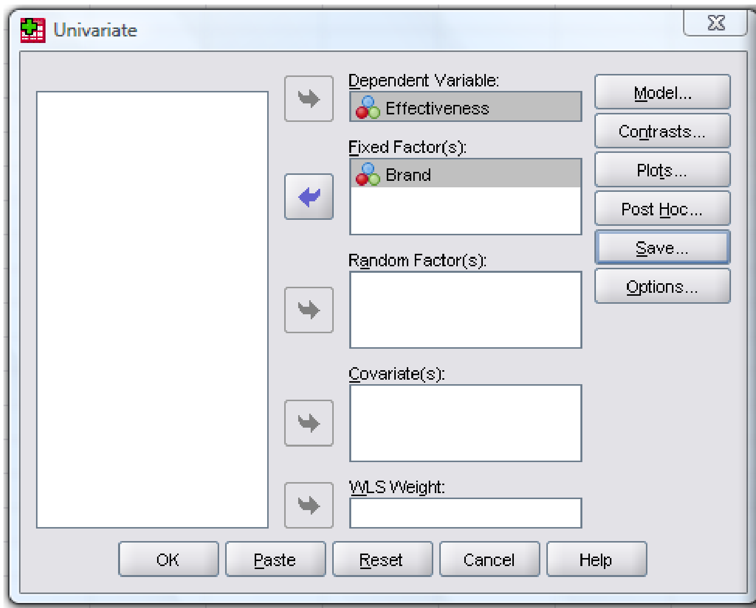


Figure 3: Analyze/ General Linear Model/Univariate

This opens the window shown in Figure 4; select Effectiveness as the Dependent variable, Brand as the Fixed Factor (assuming that the consumer group in Example 1 is only interested in comparing these three brands) – next click on Save then check Unstandardized Residuals (see Figure 4b), and click on Continue then OK. SPSS will save the residuals in the open worksheet as column RES_1.



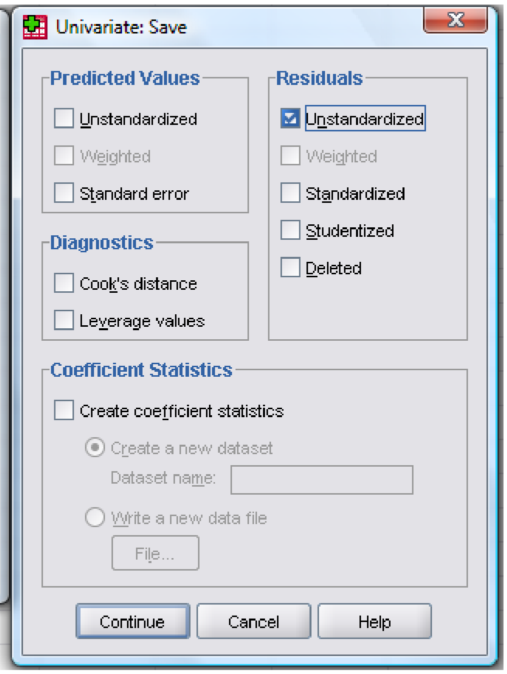
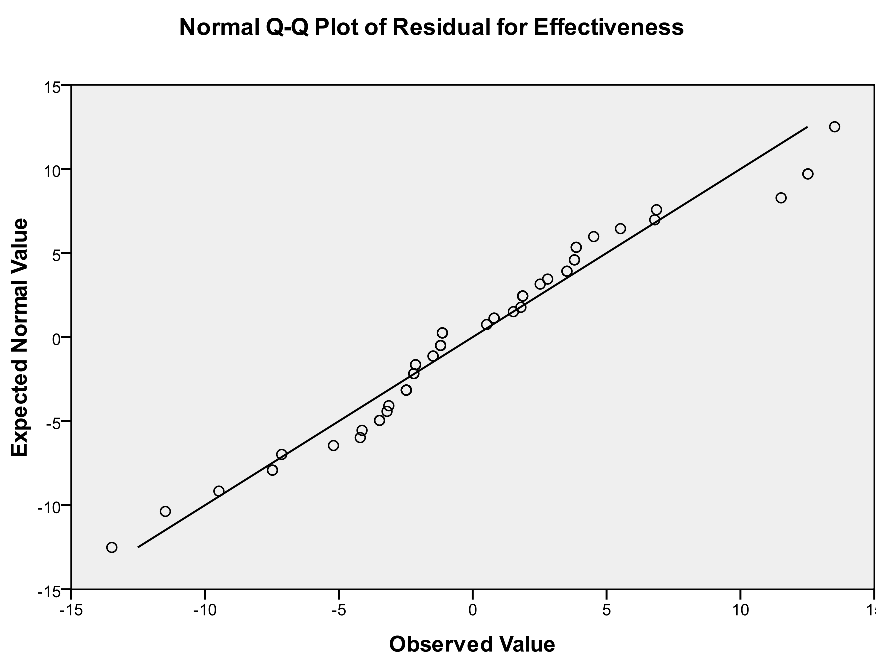


Figure 4a

Figure 4b

Click on

Analyze/Descriptive Statistics/Q-Q Plot and select Residuals to obtain the Q-Q Plot



Since the Q-Q Plot for Residuals shows that the data falls along the Y=X line, the normality of residuals is verified.

The output from General Linear Model is a bit difficult to read – you only need to look at the rows corresponding to Brand, Error, and Total.

Univariate Analysis of Variance

Between-Subjects Factors

		N
Brand	1	15
	2	15
	3	25

Tests of Between-Subjects Effects

Dependent Variable:Effectiveness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	197.008[a]	2	98.504	3.149	.051
Intercept	438882.663	1	438882.663	14032.386	.000
Brand	197.008	2	98.504	3.149	.051
Error	1626.373	52	31.276		
Total	469554.000	55			
Corrected Total	1823.382	54			

a. R Squared = .108 (Adjusted R Squared = .074)

Do not reject the null hypothesis of equal means since P = .051 > .05

Estimated Marginal Means

Brand

Dependent Variable:Effectiveness

Brand	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	89.133	1.444	86.236	92.031
2	93.200	1.444	90.302	96.098
3	93.480	1.119	91.236	95.724

Example 2: Two Way ANOVA in SPSS

Following table shows drying time of concrete obtained from a set of 12 experiments conducted at 3 levels of CONCRETE amounts, and 2 levels of WATER amounts.

CONCRETE(CUPS)	WATER(CUPS)	TIME(MINUTES)
1.5	0.25	23
1.5	0.25	21
1.5	0.5	153
1.5	0.5	161
1.75	0.25	25
1.75	0.25	27
1.75	0.5	159
1.75	0.5	171
2	0.25	29
2	0.25	31
2	0.5	183
2	0.5	187

Test if the factors CONCRETE and WATER have an effect on mean drying time.

To run the 2-Way ANOVA in SPSS, you first have to create a data file in the following format (see file Concrete2Way.xlsx):

CONCRETE	WATER	TIME
1	1	23
1	1	21
1	2	153
1	2	161
2	1	25
2	1	27
2	2	159
2	2	171
3	1	29
3	1	31
3	2	183
3	2	187

Open the data file Concrete2Way.xlsx in SPSS, and click on the following sequence:

Analyze/General Linear Model/Univariate (Figure 5a)
Then click on Save/Unstandardized Residuals (Figure 5b)
and click on Continue then OK to obtain the SPSS output shown below Figure 5.

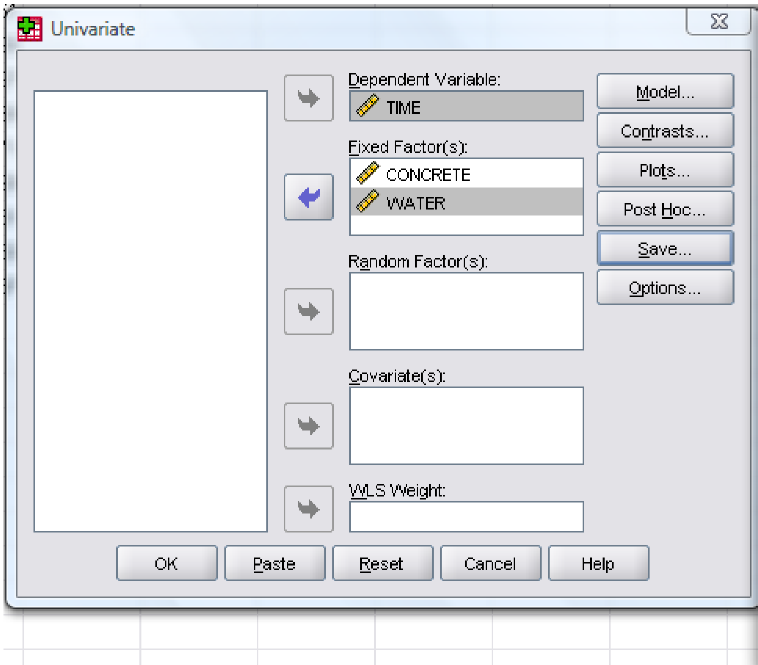


Figure 5a

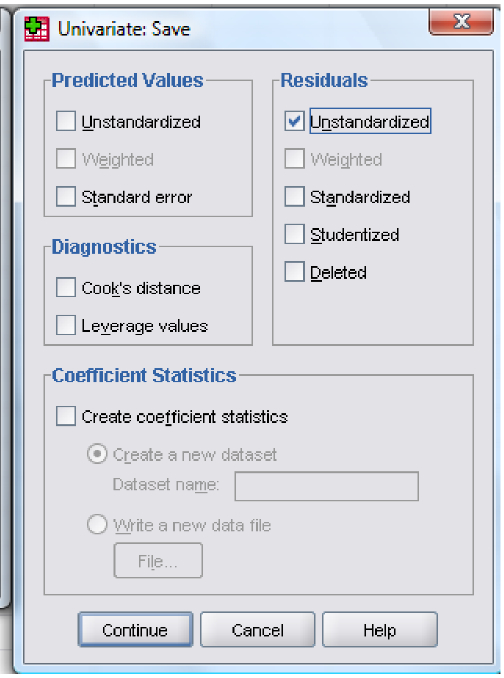


Figure 5b

Univariate Analysis of Variance

[DataSet2]

Between-Subjects Factors

		N
CONCRETE	1	4
	2	4
	3	4
WATER	1	6
	2	6

Tests of Between-Subjects Effects

Dependent Variable:TIME

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	62243.000[a]	5	12448.600	632.980	.000
Intercept	114075.000	1	114075.000	5800.424	.000
CONCRETE	672.000	2	336.000	17.085	.003
WATER	61347.000	1	61347.000	3119.339	.000
CONCRETE * WATER	224.000	2	112.000	5.695	.041
Error	118.000	6	19.667		
Total	176436.000	12			
Corrected Total	62361.000	11			

a. R Squared = .998 (Adjusted R Squared = .997)

CONCRETE significant
WATER significant
INTERACTION significant