



Uji t (independent & paired)

Aryan Eka Prastya Nugraha

2018

t Test for Independent Groups

The independent t test is used for testing the difference between the means of **two independent** groups. It is particularly useful when the research question requires the comparison of variables (measured at least at the ***ordinal*** level) obtained **from two independent samples**.

For example:

“Do males and females differ in performance on a standardized achievement test?”

“What is the effect of drug versus no drug on rats’ maze learning behavior?”

“Does the recidivism rate of juvenile offenders who are provided with father figures differ from those without father figures?”

C h e c k l i s t o f R e q u i r e m e n t s

In any one analysis, there must be:

- Only one independent (grouping) variable (IV) (e.g., subject's gender)
- Only two levels for that IV (e.g., male, female)
- Only one dependent variable (DV)

Example

A researcher wants to investigate whether first-year male and female students at a university differ in their memory abilities. Ten male students and 10 female students were randomly selected from the first-year enrolment roll to serve as subjects. All 20 subjects were read 30 unrelated words and were then asked to recall as many of the words as possible. The numbers of words correctly recalled by each subject were recorded.

Males	Females
s1 16	s1 24
s2 14	s2 23
s3 18	s3 26
s4 25	s4 17
s5 17	s5 18
s6 14	s6 20
s7 19	s7 23
s8 21	s8 26
s9 16	s9 24
s10 17	s10 20

210 12

210 50

20 10

20 50

Variables	Column	Code
Gender	1	1 = male, 2 = female
Words	2	Number of words correctly recalled

Testing Assumptions

Independence

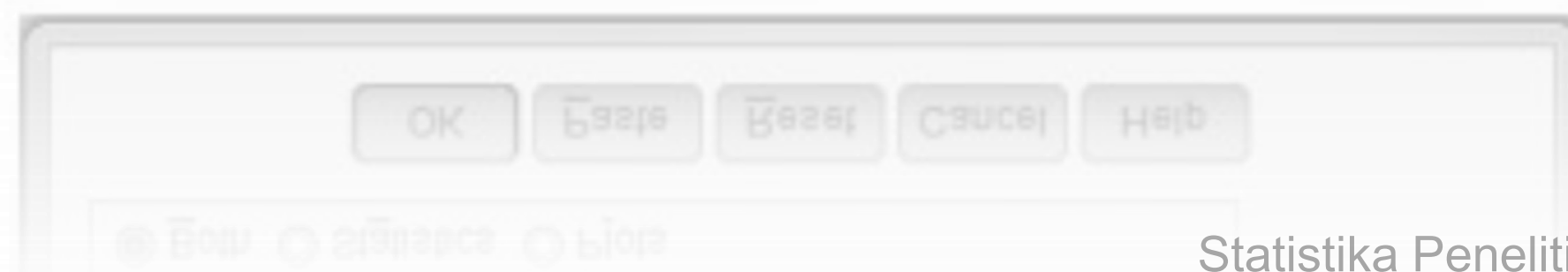
During data collection, ensure that the observations in one group are independent of the observations of the other group

N o r m a l i t y

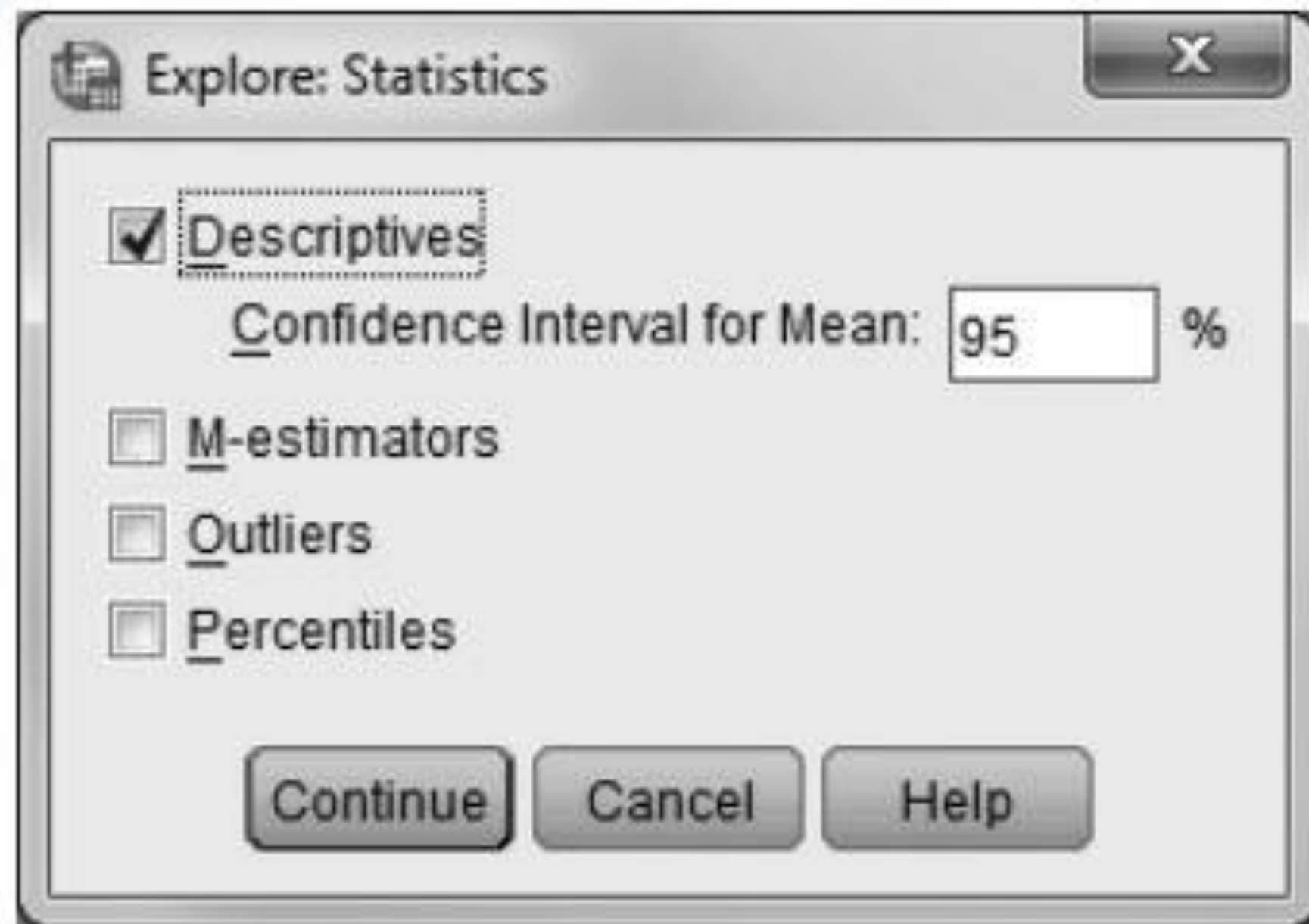
From the menu bar, click **Analyze**, then **Descriptive Statistics**, and then **Explore...**

The following **Explore** window will open

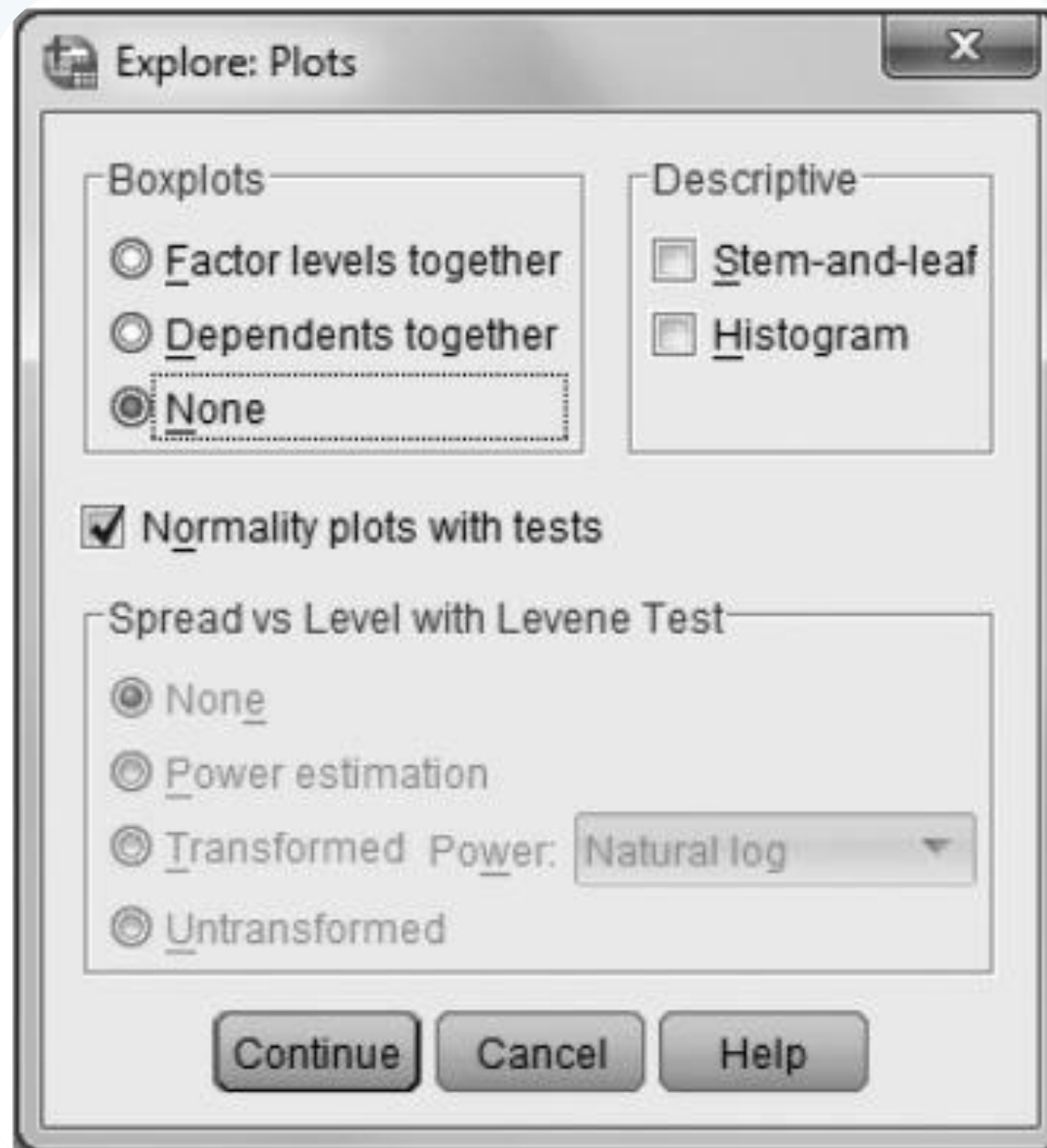




Click to open the **Explore: Statistics** window. Check the **Descriptives** field and click to return to the **Explore** window.



In the **Explore** window click to open the **Explore: Plots**



window. Check the **Normality plots with tests** field.

Click to return to the **Explore** window.



Explore Analysis (Selected) Output

Descriptives			Statistic	Std. Error
Words	Mean		19.9000	0.87027
	95% Confidence Interval for Mean	Lower Bound	18.0785	
		Upper Bound	21.7215	
	5% Trimmed Mean		19.8889	
	Median		19.5000	
	Variance		15.147	
	Std. Deviation		3.89196	
	Minimum		14.00	
	Maximum		26.00	
	Range		12.00	
	Interquartile Range		6.75	
	Skewness		0.167	0.512
	Kurtosis		-1.234	0.992

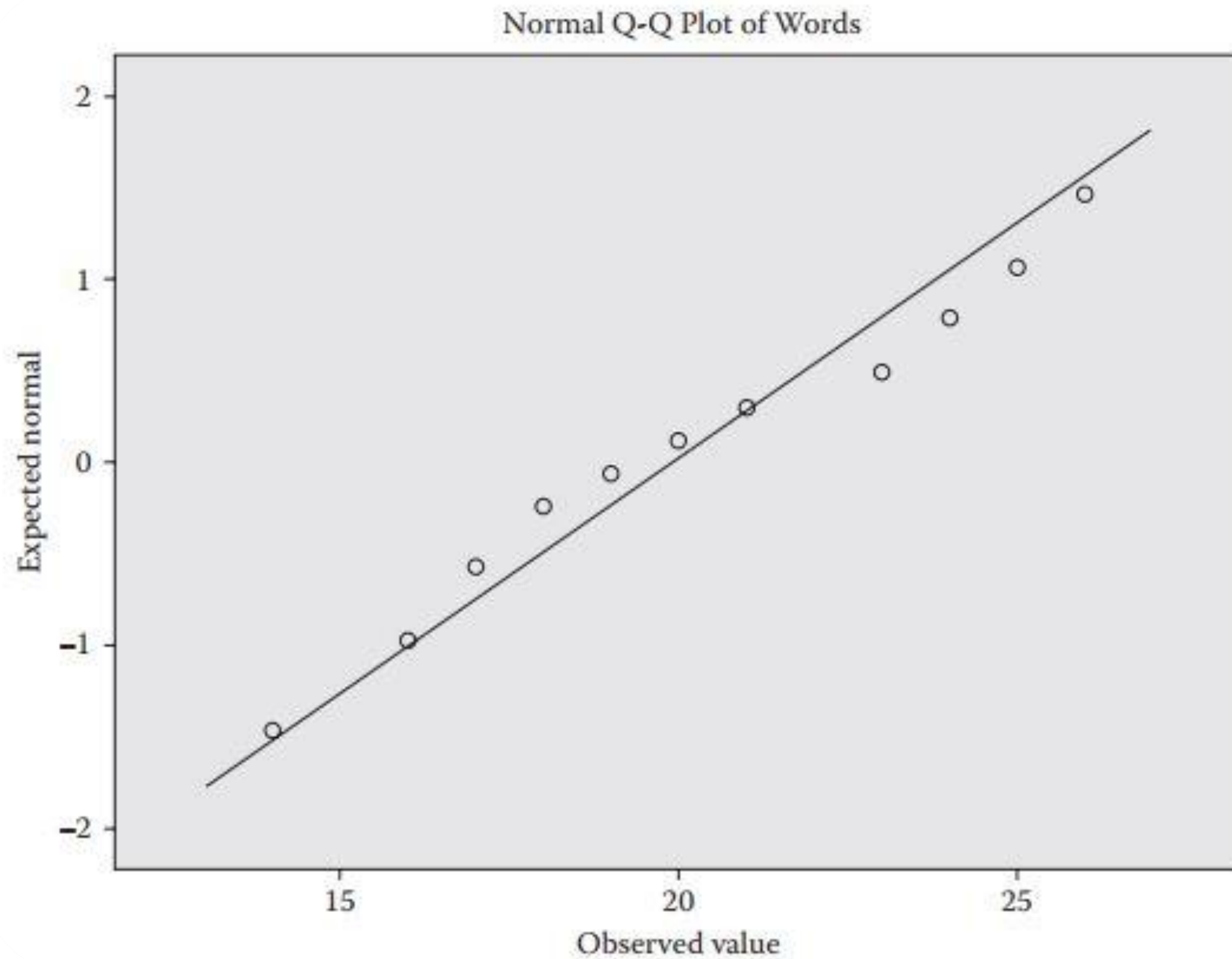
Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Words	0.137	20	0.200*	0.936	20	0.201

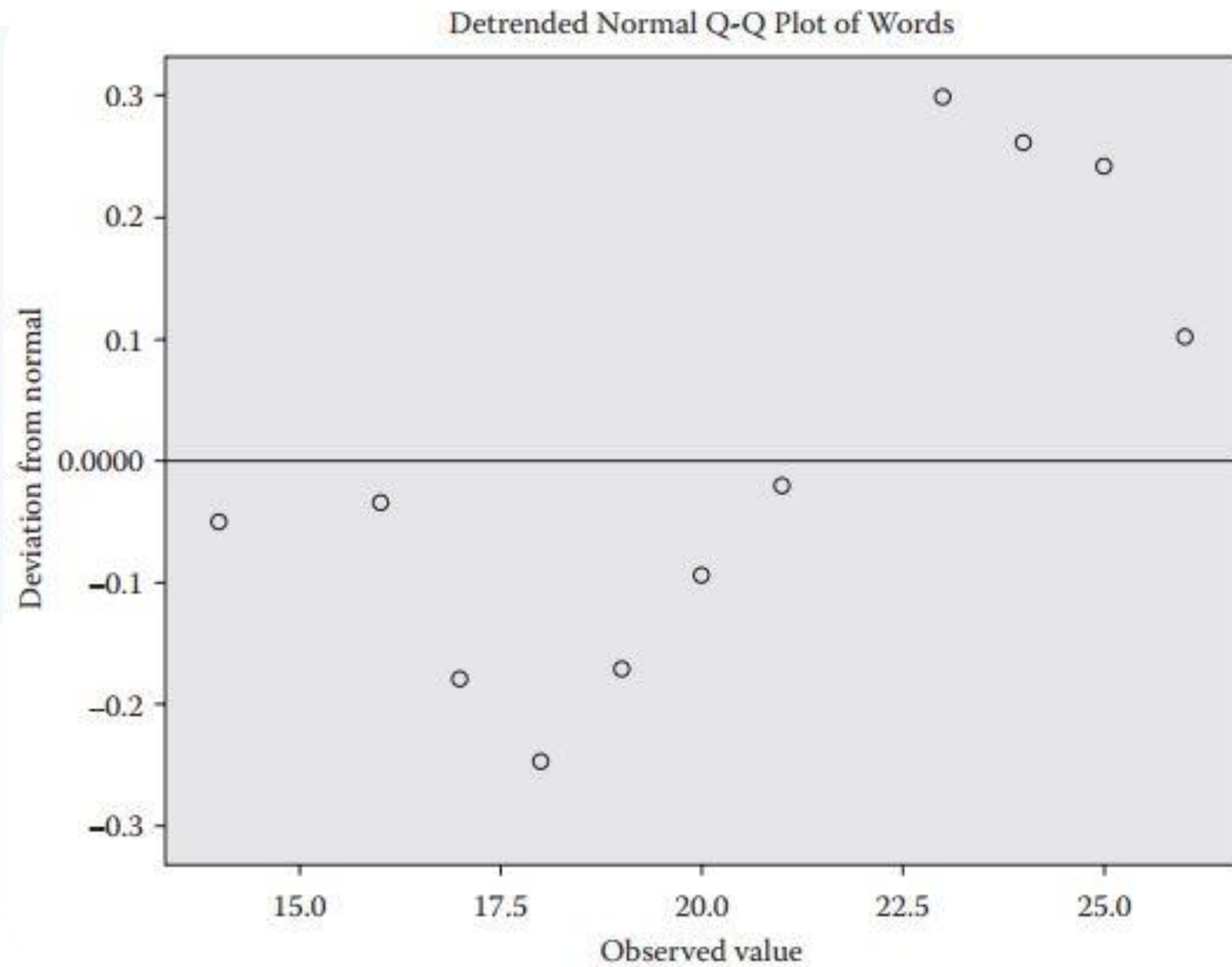
^a Lilliefors significance correction.

* This is a lower bound of the true significance.

* This is a lower bound of the true significance.

* Lilliefors significance correction





Interpretation

The Kolmogorov-Smirnov statistic and the Shapiro-Wilk statistic are tests for normality, and if their significance levels are greater than 0.05, then **normality is assumed**.

The Shapiro-Wilk statistic is calculated when the sample size is small (<50). For both the Kolmogorov-Smirnov and the Shapiro-Wilk tests, the computed significance levels are >0.05 (0.200 and 0.201, respectively).

Therefore, **normality can be assumed**.

Another diagnostic test for normality is a visual check of the **Normal Q–Q Plot** that compares the cumulative distribution of the observed values with the expected values derived from the normal distribution.

The normal distribution forms a straight diagonal line, and if a variable's distribution is normal, the **data distribution will fall more or less on the diagonal**. Inspection of the normal Q–Q plot shows very little departure from normality for the **WORDS** variable.

The **Detrended Normal Q–Q Plot** offers another visual check for normality. It shows the differences between the observed and expected values of a normal distribution, and plots the deviations of the scores from a straight line.

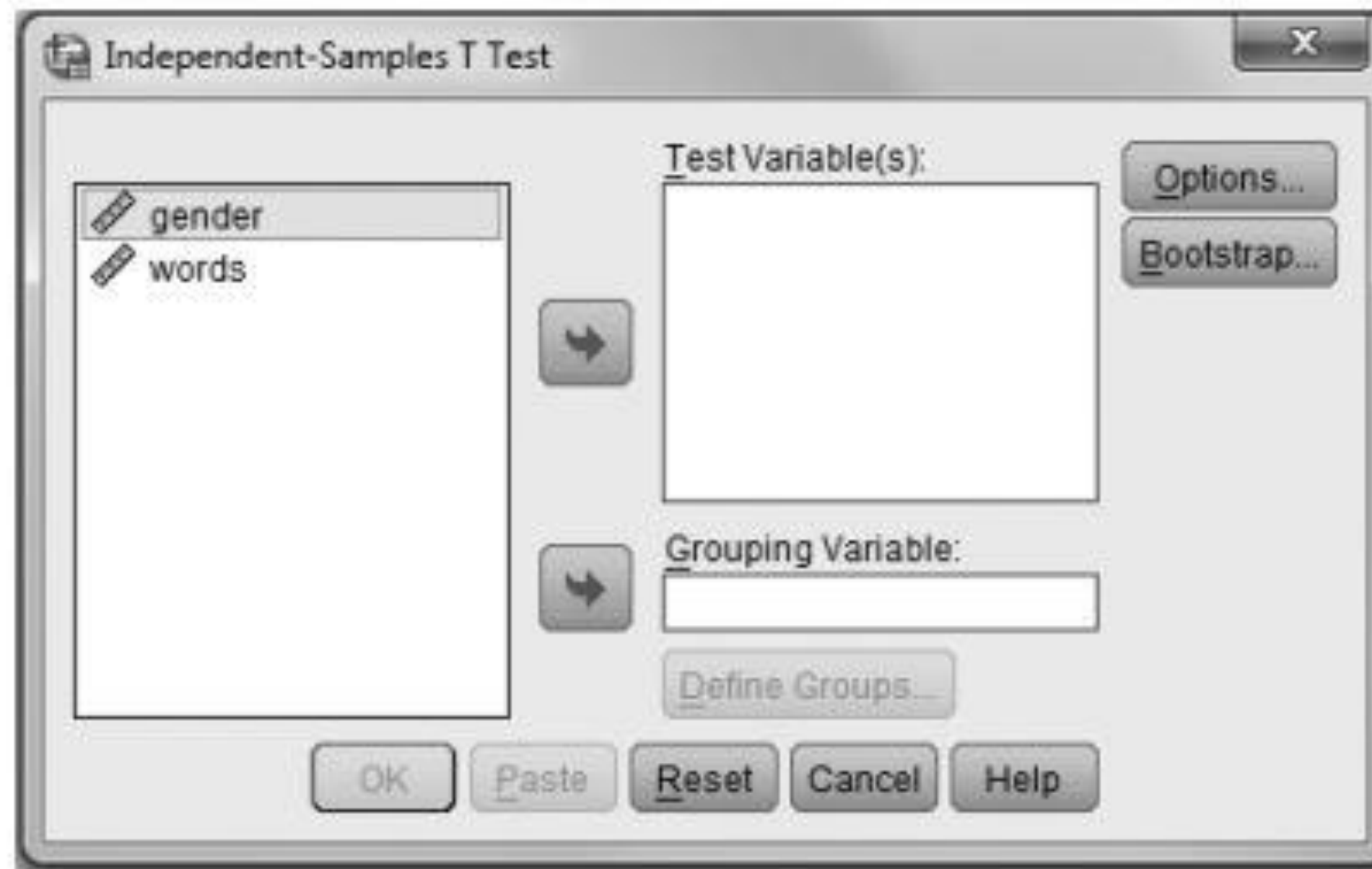
If the distribution is normal, the scores should cluster around a horizontal line through zero with no pattern. The figure shows little deviation from normality.

Homogeneity of Variance

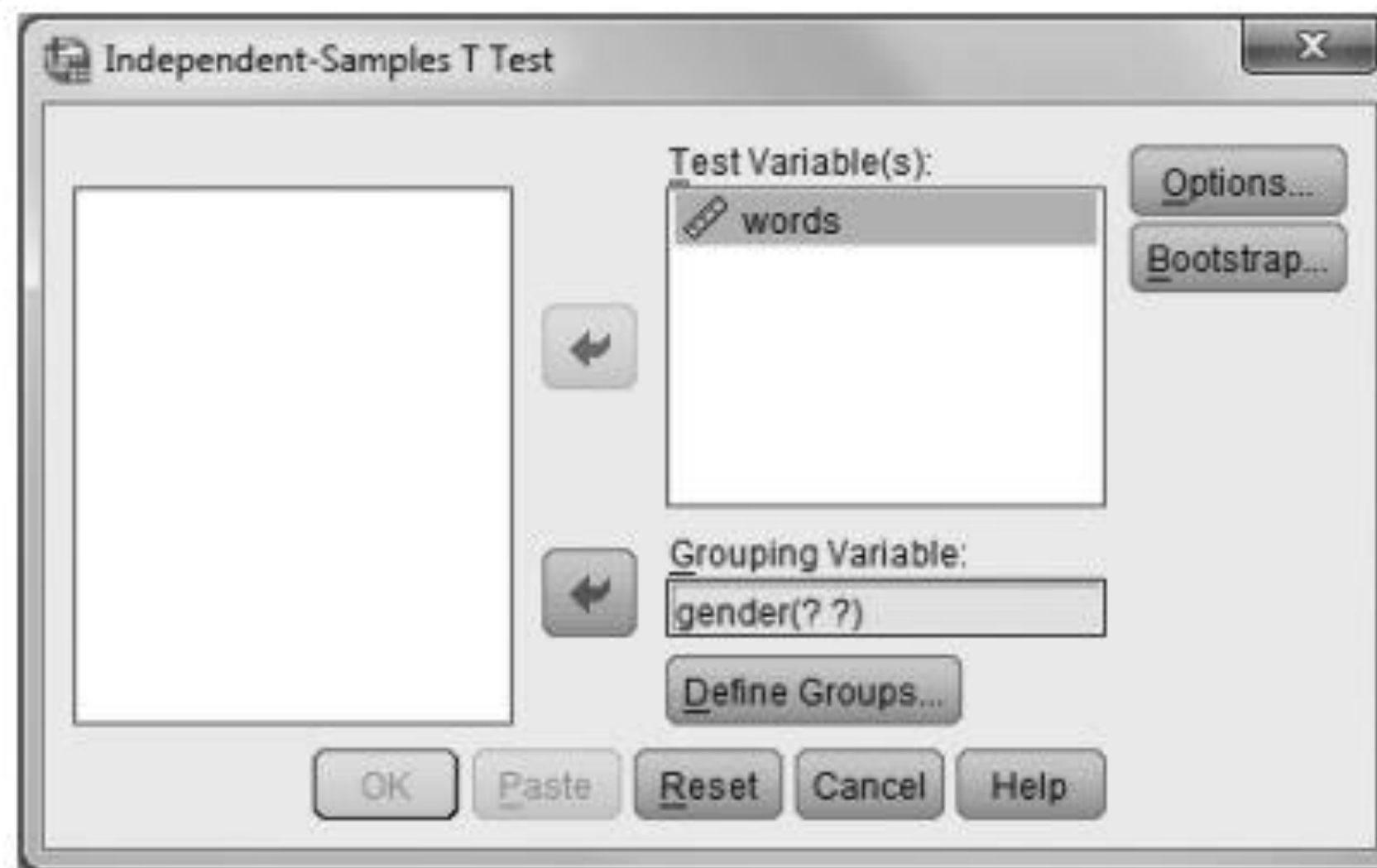
The homogeneity assumption is checked in SPSS by **Levene's test**.

Independent-Samples t Test

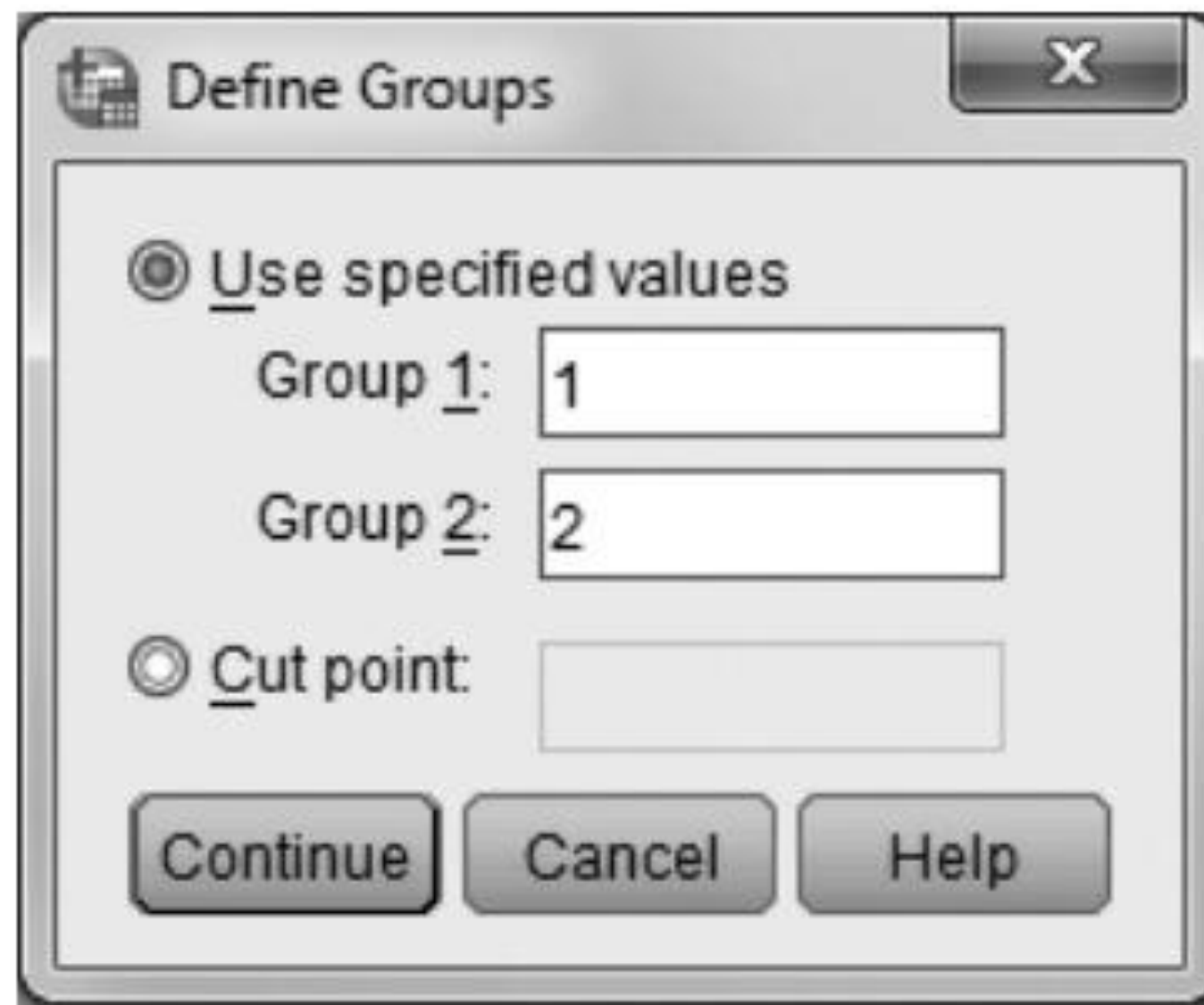
From the menu bar, click **Analyze**, then **Compare Means**, and then **Independent-Samples T Test**. The following window will open.



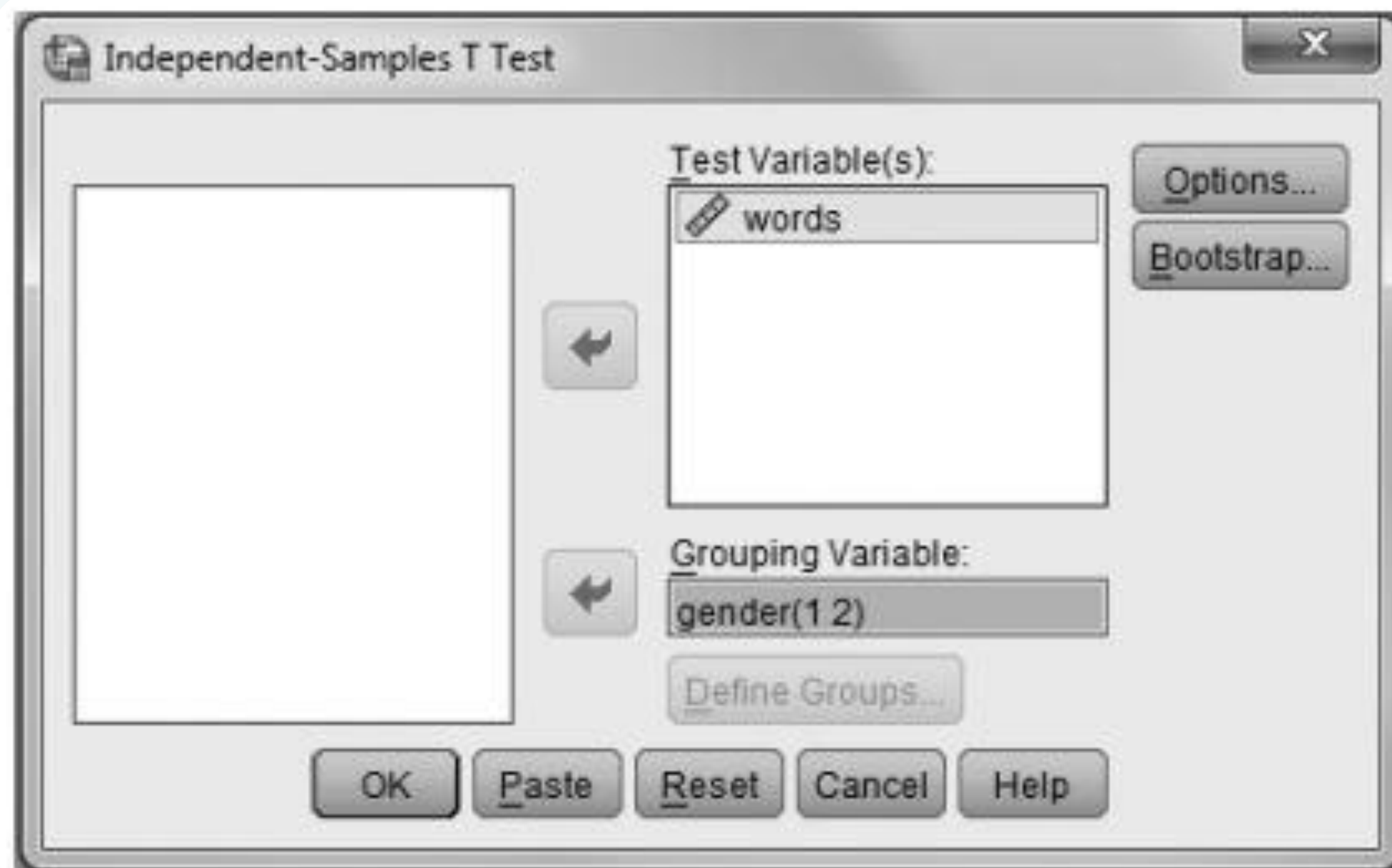
Since **GENDER** is the grouping (independent) variable, transfer it to the **Grouping Variable:** field by clicking (highlight) the variable and then clicking . As **WORDS** is the test (dependent) variable, transfer it to the **Test Variable(s):** field by clicking (highlight) the variable and then clicking



Click to define the range for the grouping variable **GENDER** (coded 1 = male, 2 = female). When the following **Define Groups** window opens, type **1** in the **Group 1:** field and **2** in the **Group 2:** field, and then click .



When the following **Independent-Samples t Test** window opens, run the t test analysis by clicking . See Table 4.2 for the results.



SPSS Output

TABLE 4.2

Independent t Test Output

Group Statistics										
		Gender	N	Mean	Std. Deviation	Std. Error Mean				
WORDS	MALE		10	17.7000	3.3390	1.0546				
	FEMALE		10	22.1000	3.1780	1.0050				
Independent Samples Test										
		Levene's Test for Equality of Variances		t test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
WORDS	Equal variances assumed	.087	.772	-3.020	18	.007	-4.4000	1.4568	-7.4606	-1.3394
	Equal variances not assumed			-3.020	17.958	.007	-4.4000	1.4568	-7.4611	-1.3389

Results and Interpretation

The assumption of **homogeneity of variance** is tested by **Levene's test for equality of variances**, which tests the hypothesis that the two population variances are equal. In this example, the Levene statistic is $F = 0.087$ and the corresponding level of significance is large (i.e., $p > 0.05$) (see Table 4.2). Thus, the assumption of homogeneity of variance has not been violated, and the **equal variances assumed** t test statistic can be used for evaluating the null hypothesis of equality of means. If the significance level of the Levene statistic is small (i.e., $p < 0.05$), the assumption that the population variances are equal is rejected and the **equal variances not assumed** t test statistic should be used.

The results from the t test analysis indicate the following:

- There is a significant difference between the male and female samples in the number of words correctly recalled, $t(df = 18) = -3.02$, $p < 0.01$. The mean values indicate that females correctly recalled significantly more words ($M = 22.10$) than males ($M = 17.70$).
- The confidence interval information shows that the null hypothesis value (i.e., zero) does not fall within this interval (Lower = -7.4606, Upper = -1.3394). Therefore, the null hypothesis of equality of means can be rejected.

Paired-Samples t Test

The paired-samples t test is used in **repeated measures** or **correlated groups** design, in which each subject is tested twice on the same variable. A common experiment of this type involves the ***before and after design***.

The test can also be used for the **matched group** design in which pairs of subjects that are matched on one or more characteristics (e.g., IQ, grades, and so forth) serve in the two conditions. As the subjects in the groups are matched and not independently assigned, this design is also referred to as a **correlated groups** design.

C h e c k l i s t o f R e q u i r e m e n t s

In any one analysis, there must be only two sets of data.

The two sets of data must be obtained from (1) the same subjects, or (2) from two matched groups of subjects.

A s s u m p t i o n

The sampling distribution of the means should be normal

Example

A researcher designed an experiment to test the effect of drug X on eating behavior. The amount of food eaten by a group of rats in a one-week period, prior to ingesting drug X, was recorded. The rats were then given drug X, and the amount of food eaten in a one-week period was again recorded. The following amounts of food in grams were eaten during the “before” and “after” conditions.

	Food Eaten	
	Before Ingesting Drug X	After Ingesting Drug X
s1	100	60
s2	180	80
s3	160	110
s4	220	140
s5	140	100
s6	250	200
s7	170	100
s8	220	180
s9	120	140
s10	210	130

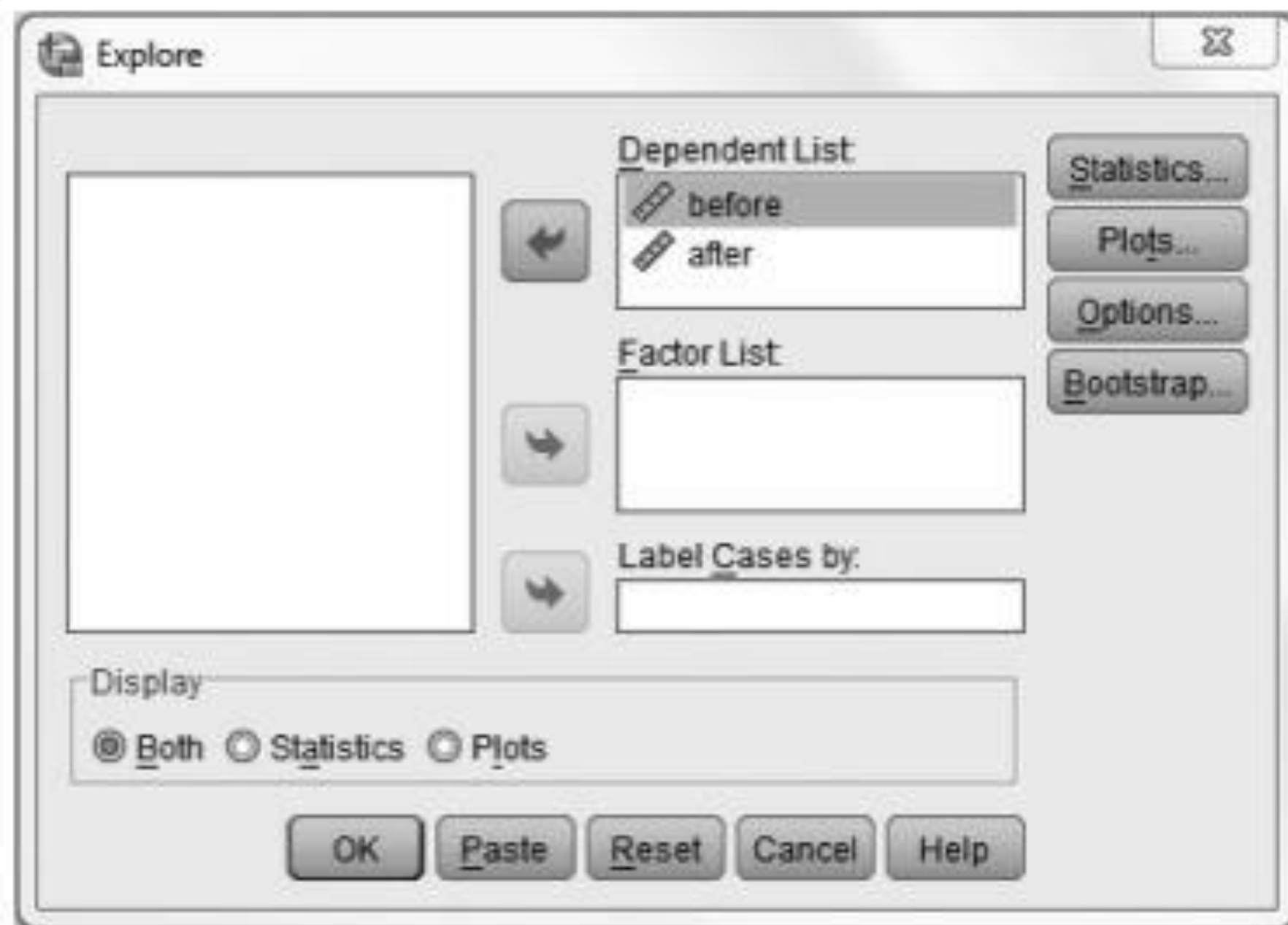
Variables	Column	Code
• BEFORE	• 1	• Food eaten in grams
• AFTER	• 2	• Food eaten in grams

Testing Assumption Normality

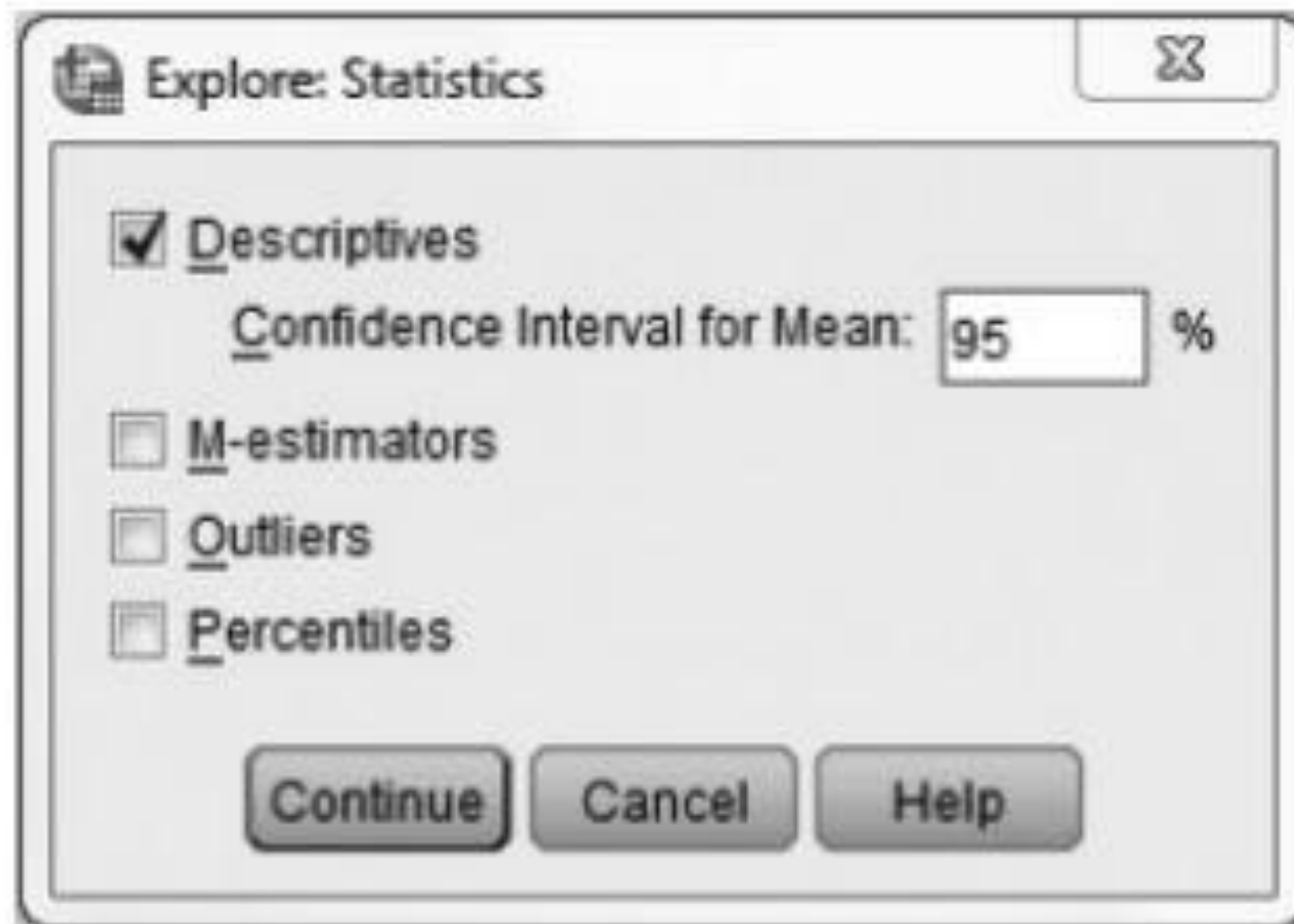
From the menu bar, click **Analyze**, then **Descriptive Statistics**, and then **Explore**.... The following **Explore** window will open.



Transfer the **BEFORE** and **AFTER** variables to the **Dependent List:** field by clicking these variables (highlight) and then clicking .

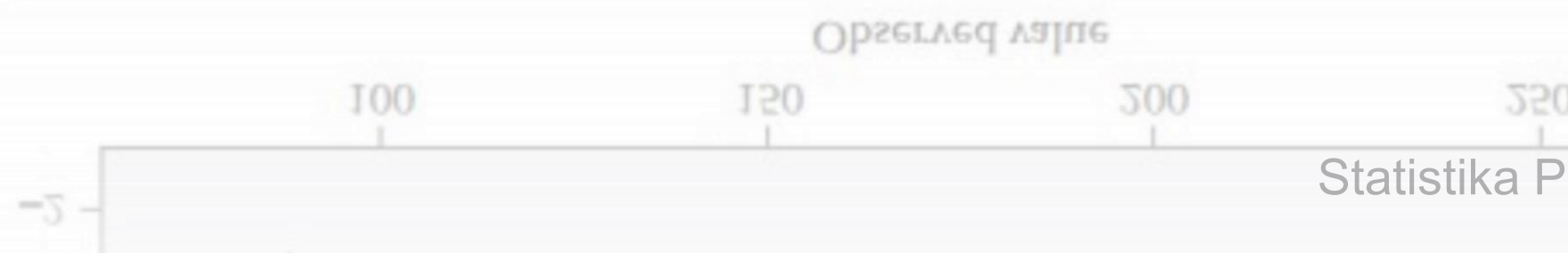
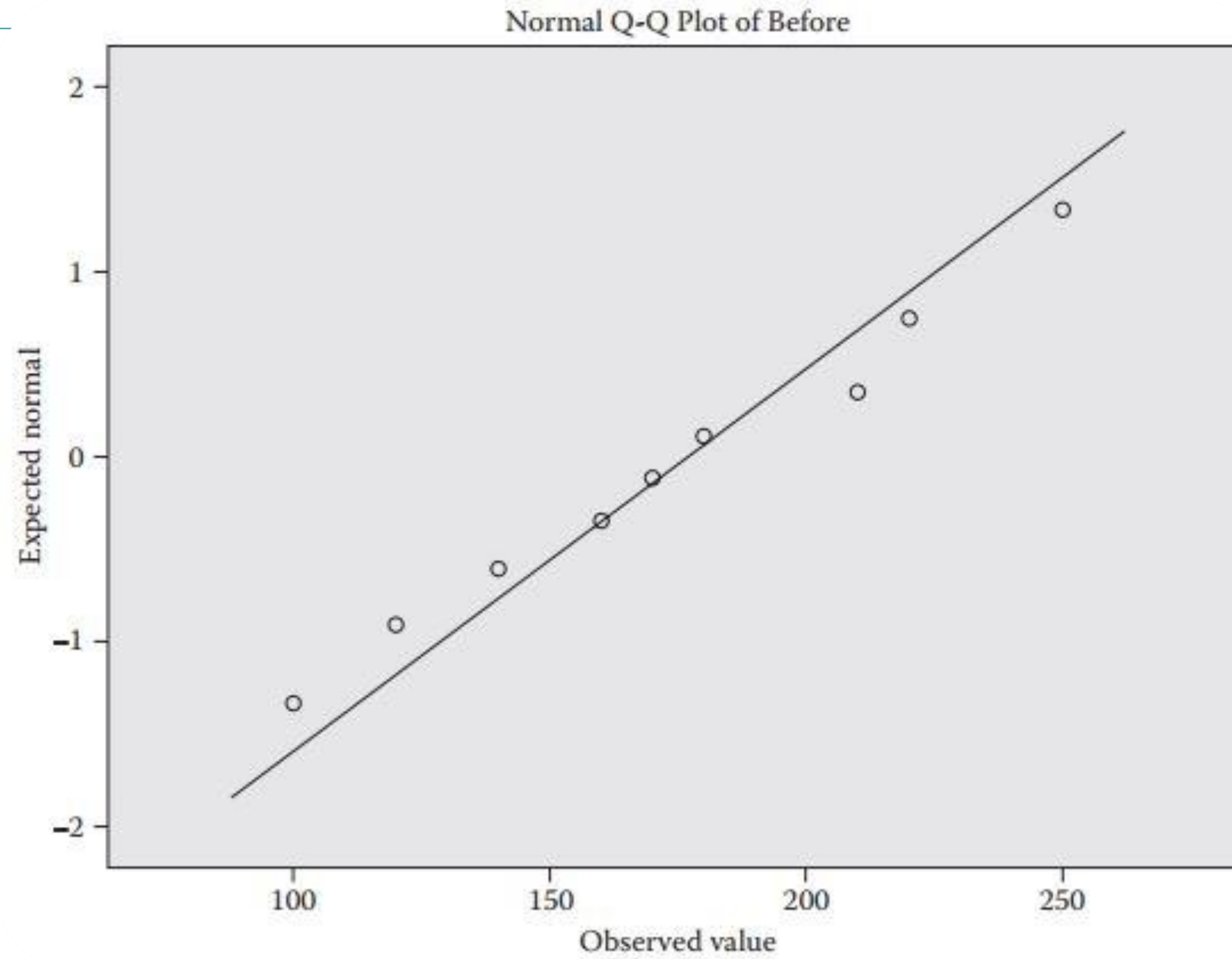


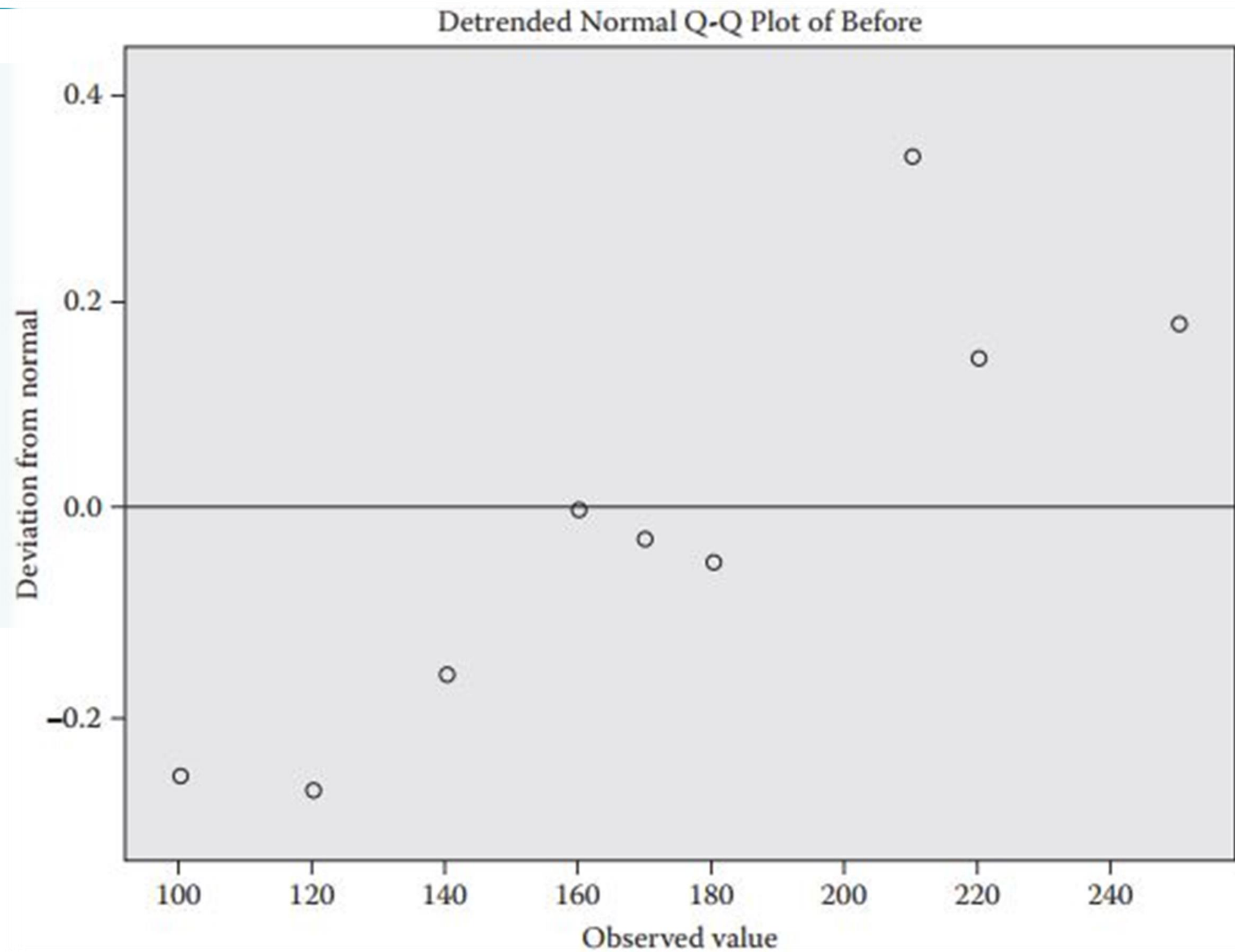
Click to open the **Explore: Statistics** window. Check the **Descriptives** field and click to return to the **Explore** window

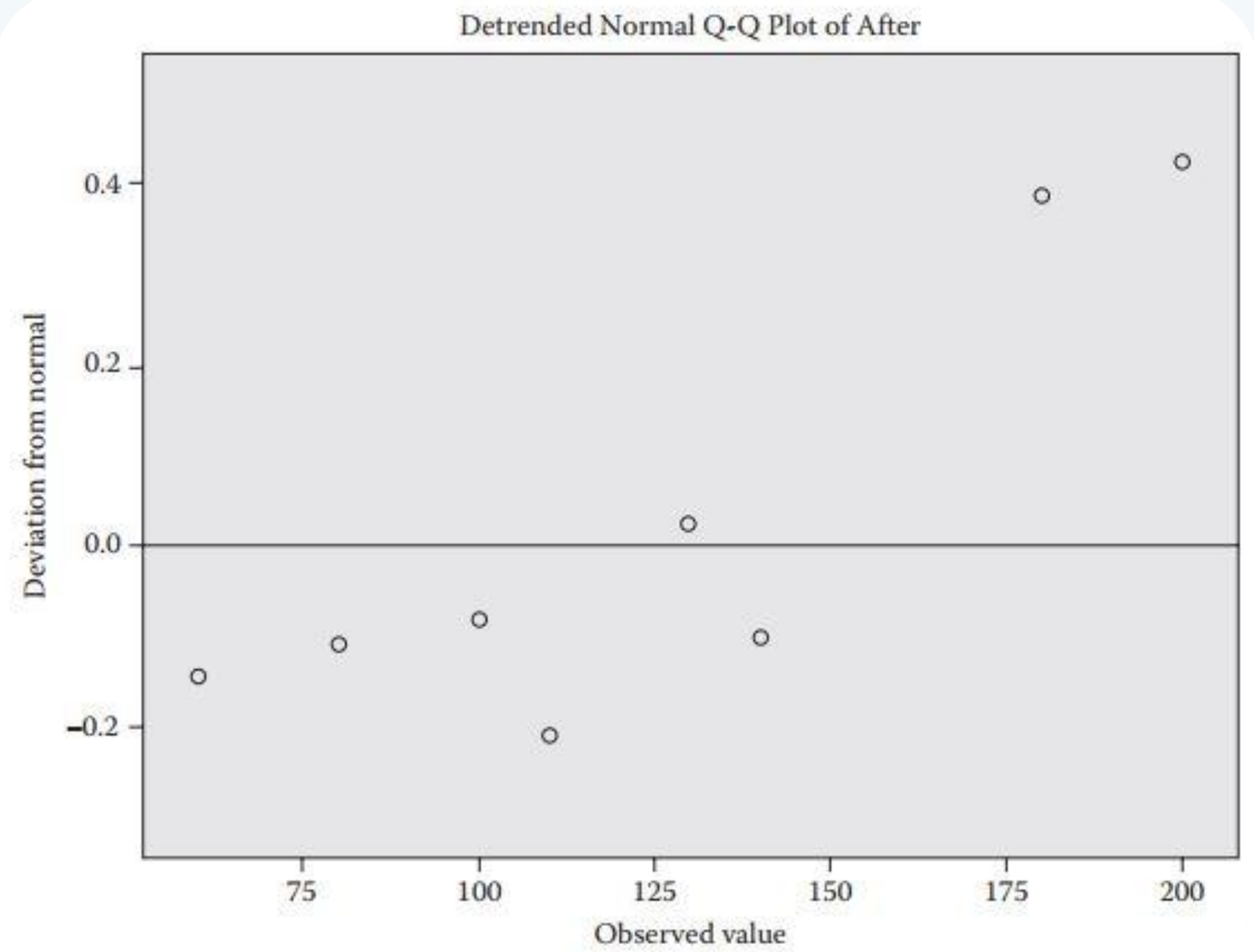
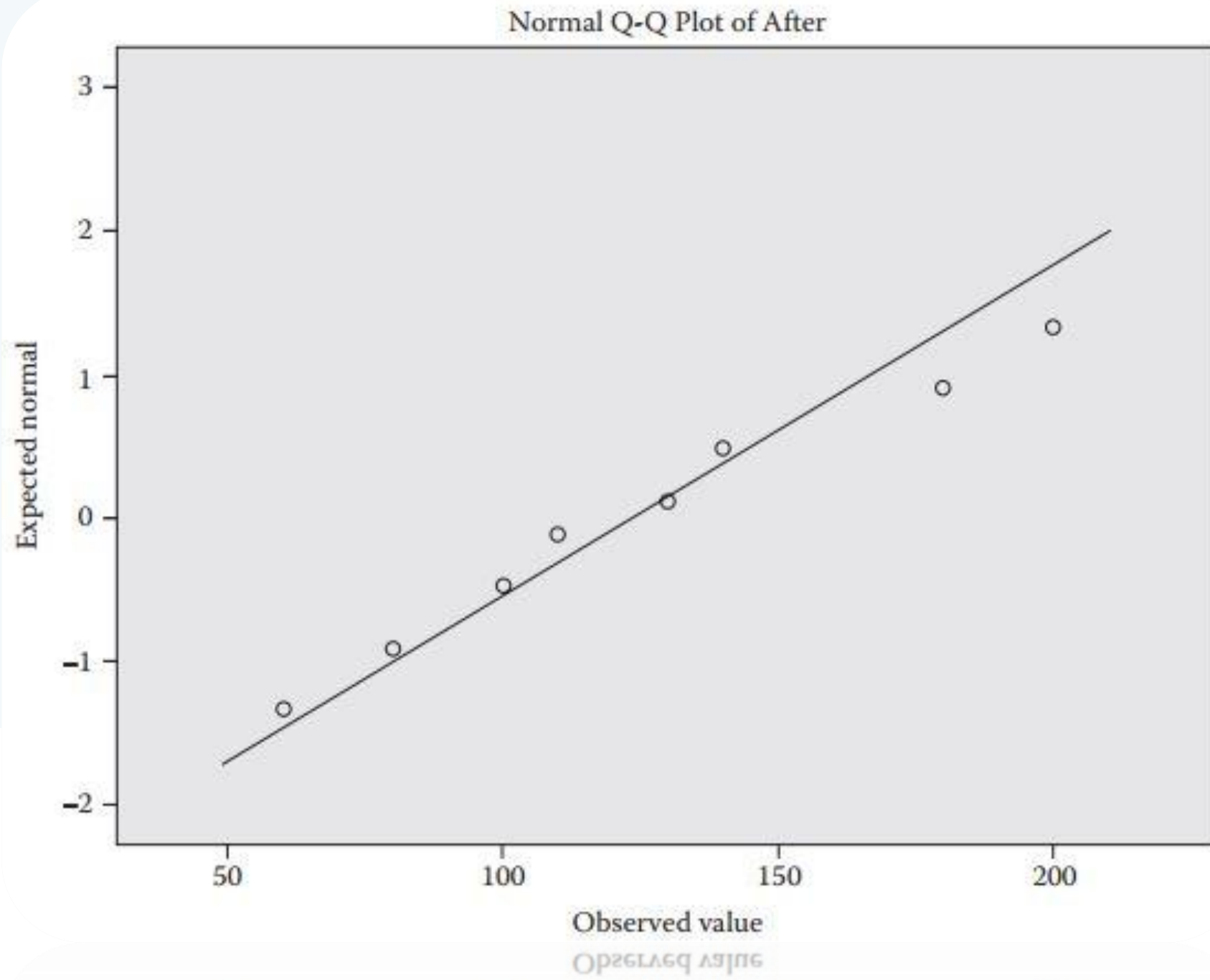


In the **Explore** window click to open the **Explore: Plots** window. Check the **Normality plots with tests** field.









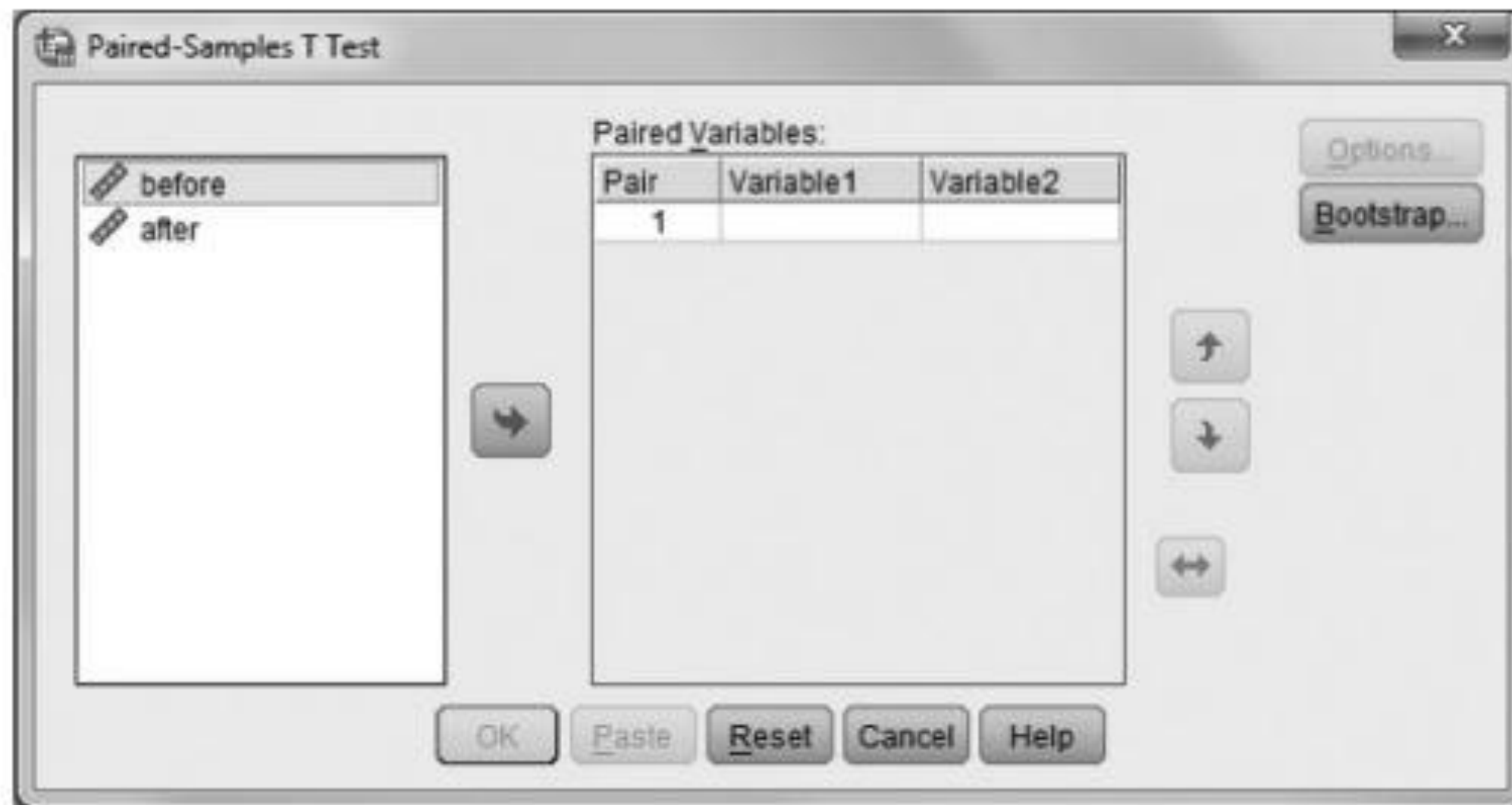
Interpretation

Another diagnostic test for normality is a visual check of the **Normal Q–Q Plot** that compares the cumulative distribution of the observed values with the expected values derived from the normal distribution. The normal distribution forms a straight diagonal line, and if a variable's distribution is normal, the data distribution will fall more or less on the diagonal. Inspection of the normal Q–Q plots shows very little departure from normality for both the **BEFORE** and **AFTER** variables.

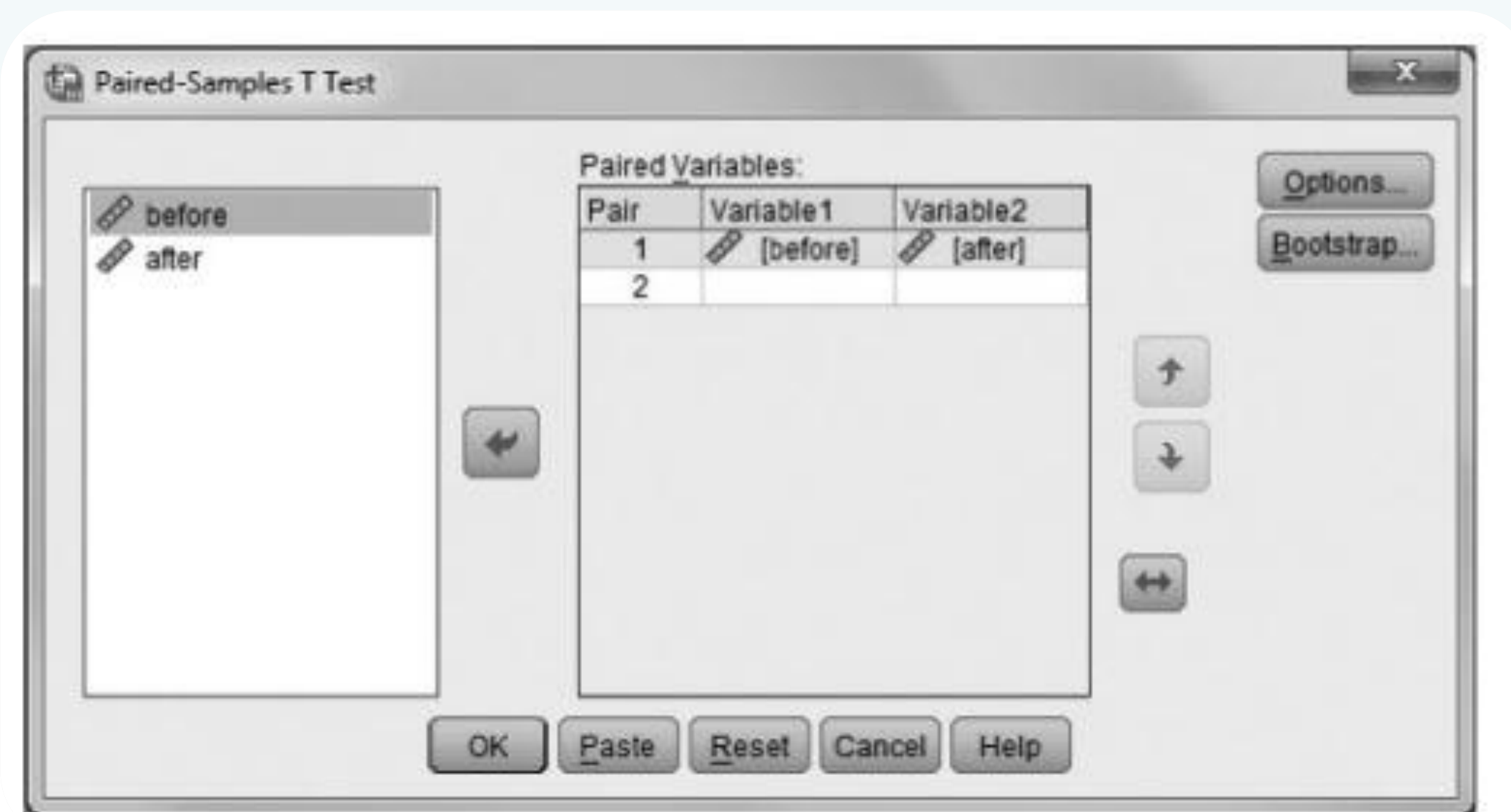
Similarly, a visual check of the **Detrended Normal Q–Q Plot**, which plots the deviations of the scores from a straight line, shows little deviation from normality for both the **BEFORE** and **AFTER** variables.

Paired-Samples t Test

From the menu bar, click **Analyze**, then **Compare Means**, and then **Paired-Samples t Test**. The following window will open



Transfer both the **BEFORE** and **AFTER** variables to the **Paired Variables:** field by clicking (highlight) these two variables, and then clicking . Click to run the *t* Test analysis. See Table for the results.



SPSS Output

Paired-Samples *t* Test Output

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Before	177.0000	10	48.31609	15.27889
	After	124.0000	10	43.25634	13.67886

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	Before and After	10	0.745	0.013

Pair 1	Before and After	10	0.745	0.013
		N	Correlation	Sig.

Paired Samples Test

		Paired Differences			95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	before - after	53.00000	33.01515	10.44031	29.38239	76.61761	5.076	9	.001


Pair 1	before - after	53.00000	33.01515	10.44031	29.38239	76.61761	5.076	9	.001
--------	----------------	----------	----------	----------	----------	----------	-------	---	------

Results and Interpretation

The result from the analysis indicates that there is a significant difference in the amount of food eaten before and after drug X was ingested, $t(df = 9) = 5.08$, $p < .01$ (see **Paired Samples Test** table). The mean values indicate that significantly less food was consumed after ingestion of drug X ($M = 124.00$) than before ($M = 177.00$).

REFLEKSI

1. Informasi penting hari ini
2. Manfaat penting dari informasi penting hari ini
3. Tindak lanjut yang dapat saudara lakukan

The background features teal-colored geometric shapes in the corners, resembling folded paper or abstract triangles. The main text is centered in a clean, sans-serif font.

THANK YOU!

ANY QUESTIONS?