T-Test for independent samples

Empirical Research Methods I

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Independent Samples T- Test Structure

- When to use
- Assumptions
- Alpha error inflation
- In SPSS

T-test

Used to:

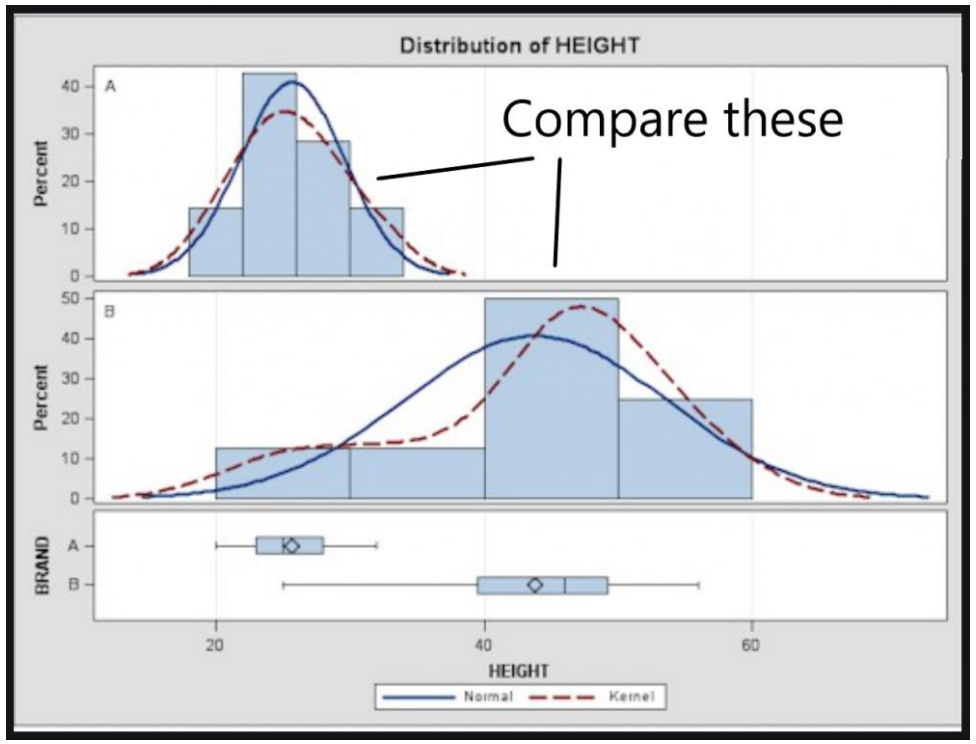
1. Determine if the **means** are statistically different
2. That's all
3. It has one job to do

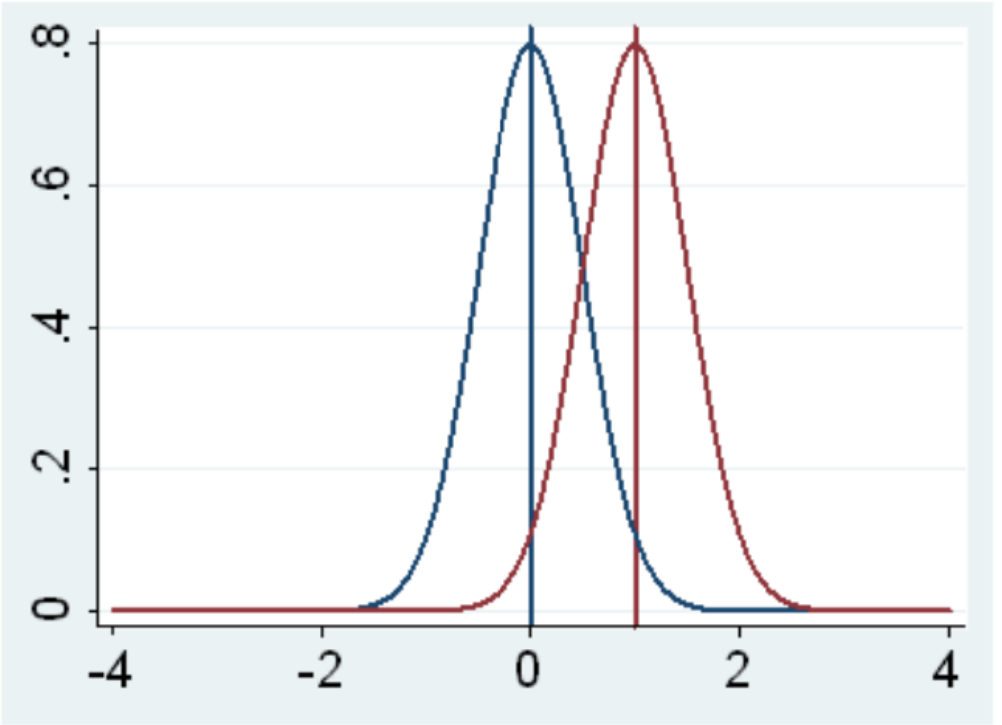
Pairwise Comparison

- Comparing the **means** ; not groups , not variables, not individuals, just "**2 means**"

Statistically Different Means:

Which graphs show statistically different means?





Statistically Different Means:

Which graphs show statistically different means?

https://learningapps.org/display?v=pdpetxbwa20

Click to check answers:

Just by looking at the graphs, it is not possible to know whether the means are statistically different.

You need to perform a test, most likely a t-test.

T-Test types

ONE SAMPLE T-TEST

To draw a comparison between a mean obtained from an experiment/study with an existing population or hypothetical mean

Do males score higher than the average of 70 on a test if their exam time is switched to 8 a.m.?

PAIRED T TEST (DEPENDENT SAMPLES)

To compare related observations, which are means and come from the same group from an experiment/study/collected data

Do test scores differ significantly if the test is taken at 8 a.m. or noon?

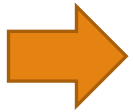
Wait! There is one more.

T-Test types

INDEPENDENT SAMPLE T-TEST

- An **inferential statistical test** that determines whether there is a statistically significant difference between the means in two unrelated groups

- Suitable for verifying a difference in hypothesis between two independent samples

- Used as 

  ✓ Statistical differences between the means of two groups
  ✓ Statistical differences between the means of two interventions
  ✓ Statistical differences between the means of two change scores

What are the "inferential statistics"?
Quiz time

T-Test for independent samples

ALSO KNOWN AS:

- Independent t Test
- Independent Measures t Test
- Independent Two-sample t Test
- Student t Test
- Two-Sample t Test
- Uncorrelated Scores t Test
- Unpaired t Test
- Unrelated t Test

THE VARIABLES IN THIS TEST ARE KNOWN AS:

- Dependent variable, or test variable
- Independent variable, or grouping variable

Assumptions

- **Independence**

Two independent, categorical groups that represent the independent variable

- ✓ Cases that have values for both the dependent and independent variables
- ✓ Independent samples/groups (i.e., independence of observations)

- **Dependence**

The dependent variables should be measured in a continuous scale (interval or ratio)

- **Outliers**

There should not be any outliers within our data

Assumptions

- **Normality**

The dependent variable should be approximately normally distributed and measured on a continuous scale

✓ Non-normal population distributions reduce the power of the test

✓ Among moderate or large samples, a violation of normality may still yield accurate *p* values

- **Variance**

The variances of the dependent variable are equal in the population

✓When this assumption is violated and the sample sizes for each group differ, the *p* value is not trustworthy

T-Test for independent samples forms

What if our data doesn't meet the assumptions for the t-test?

The standard *Student's t-test*

- assumes that the variance of the two groups are equal

The *Welch's t-test*

- we do not assume that the variance is the same in the two groups ⇨ fractional degrees of freedom
- meet the normality assumption

T-Test for independent samples- Hypotheses (RECAP)

The null hypothesis (H_0) and alternative hypothesis (H_1) of the Independent Samples *t* Test can be expressed in following ways:

Quiz time

H_0: $\mu_1 = \mu_2$

("the two population/sample means are equal")

H_1: $\mu_1 \neq \mu_2$

("the two population/sample means are not equal")

Where H_0 and H_1 are Null Hypothesis and Alternative Hypothesis respectively,

and μ_1 and μ_2 are respective means of two groups.

Alpha Error and Beta Error (Recap)

Quiz time

Alpha Error:
Type I Error = Rejection of true Null Hypothesis

Beta Error:
Type II Error = Acceptance of False Null Hypothesis

Alpha Inflation

Also known as Familywise Error Rate (FEW or FWER) or cumulative Type I error.

Definition

Probability of making at least one alpha error (Type 1 error) in a series of tests.

How can it happen?

When too many tests are conducted

Why is it bad?

Chances of incorrectly rejecting the null hypothesis is high.

The estimated Alpha Inflation

$\leq 1 - (1 - \alpha_{IT})^c$

where:

- α_{IT} = alpha level for an individual test (e.g., .05),
- c = Number of comparisons.

For example, an alpha level of 5% and a series of 20 tests,

the alpha inflation is:

Alpha Inflation = ≤ 1 – (1 – .05)^20 = 0.64

This means the probability of Type I error (Incorrectly rejecting the null hypothesis) is about 64% which is

very high.

Independent T-Test in SPSS

Research Question:

Are soles made from rubber and from leather equally wear-resistant?

Quiz time

H_0: $\mu_1 = \mu_2$

(" The wear amount for both materials are equal")

H_1: $\mu_1 \neq \mu_2$

(" The wear amount for both materials are not equal")

Where H_0 and H_1 are Null Hypothesis and Alternative Hypothesis respectively,

and μ_1 and μ_2 are the wear-amount means for rubber and leather, respectively.

Is H1 a directional or a non-directional hypothesis?

Non-directional

How would you rephrase H1 for it to be a directional hypothesis?

H1: The wear amount for leather is more than the wear amount for rubber.

This test is trying to measure whether it is better to buy shoes with rubber soles or leather soles

.

	A	B
1	Wear Amount	Sole Material Type
2	13.2	Rubber
3	8.2	Rubber
4	10.9	Rubber
5	14.3	Rubber
6	10.7	Rubber
7	6.6	Rubber
8	9.5	Rubber
9	10.8	Rubber
10	8.8	Rubber
11	13.3	Rubber
12	14	Leather
13	8.8	Leather
14	11.2	Leather
15	14.2	Leather
16	11.8	Leather
17	6.4	Leather
18	9.8	Leather
19	11.3	Leather
20	9.3	Leather
21	13.6	Leather

DATASET IN EXCEL

WearAmount	SoleMaterialType
13.2	Rubber
8.2	Rubber
10.9	Rubber
14.3	Rubber
10.7	Rubber
6.6	Rubber
9.5	Rubber
10.8	Rubber
8.8	Rubber
13.3	Rubber
14.0	Leather
8.8	Leather
11.2	Leather
14.2	Leather
11.8	Leather
6.4	Leather
9.8	Leather
11.3	Leather
9.3	Leather
13.6	Leather

IMPORTING INTO SPSS

DATA EDITOR VIEW

Testing Assumptions

- Dependent Variable wear is measured on a continuous scale

  Amount of wear (Ratio)

- Independent Variable should consist of Two Categorical, Independent Groups

  Sole Material (Rubber, Leather)

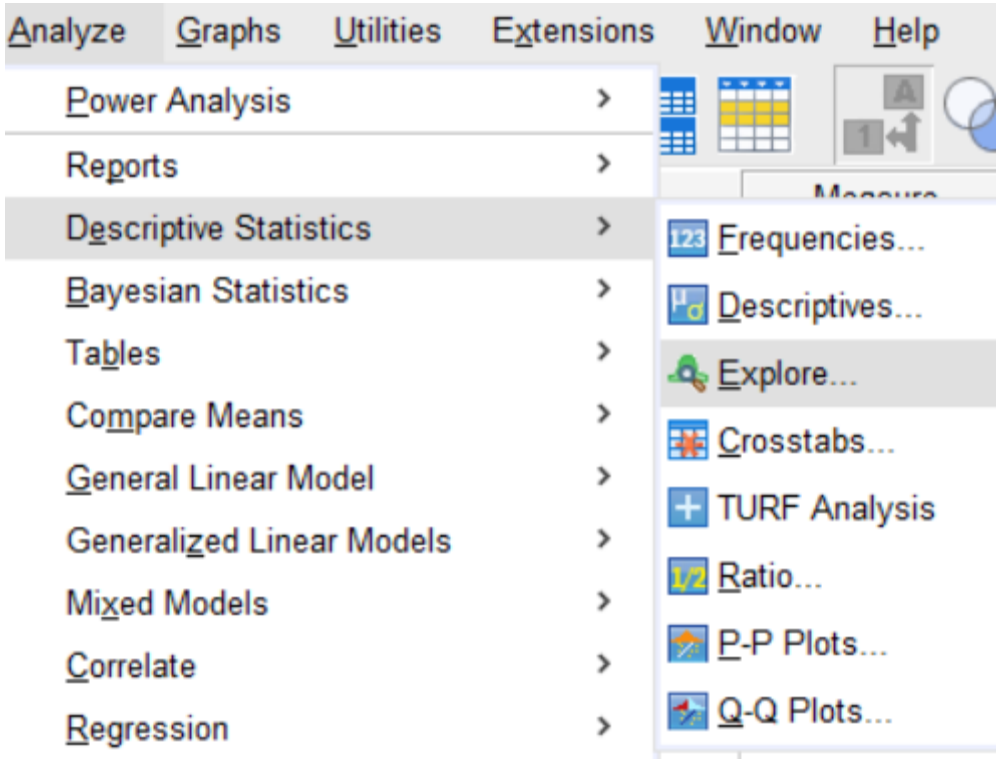
- Independence of observation (Random Sampling)

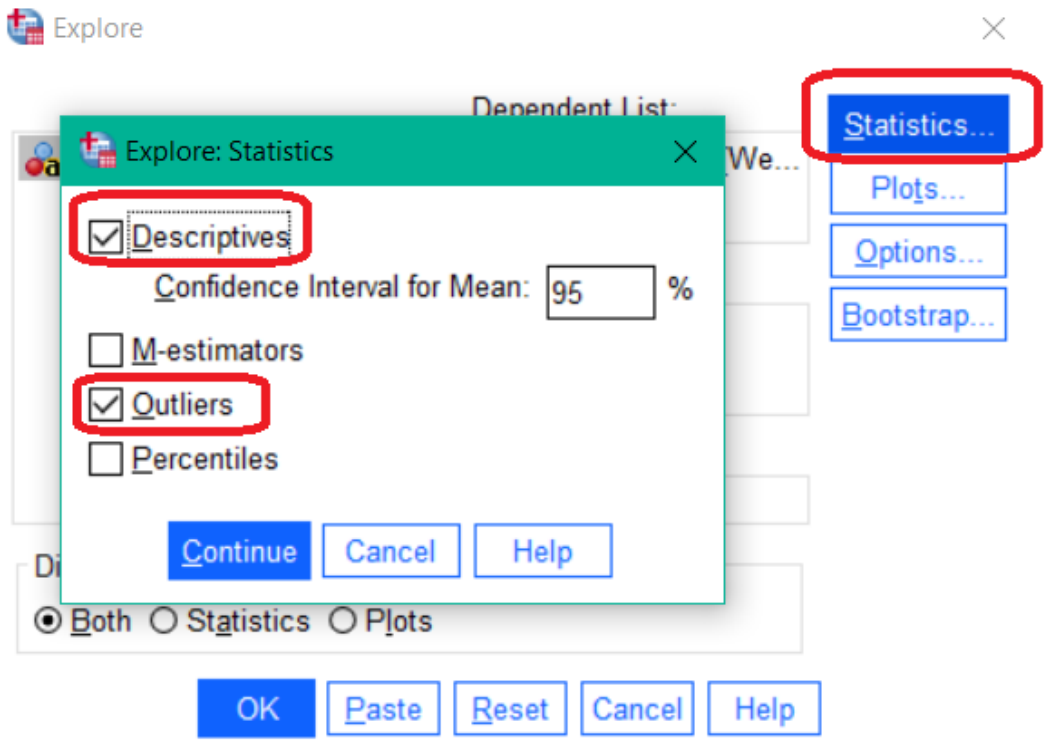
  Measuring the wear amount of 10 random leather soles and 10 random rubber soles.

Testing Assumptions

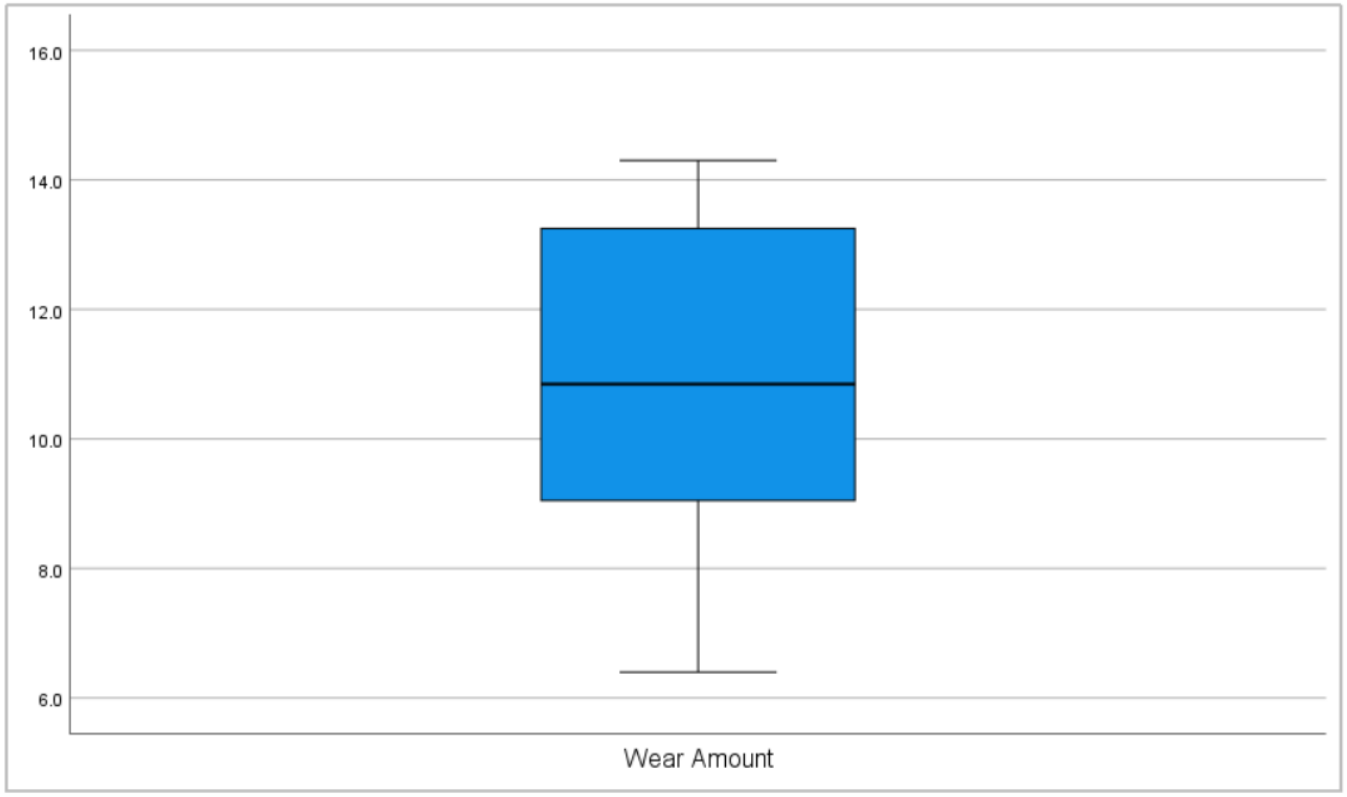
- No Significant Outliers (Testing in SPSS)
- Dependent Variable normally distributed (Testing in SPSS)
- Homogeneity of Variances (Testing in SPSS)

Testing for Outliers



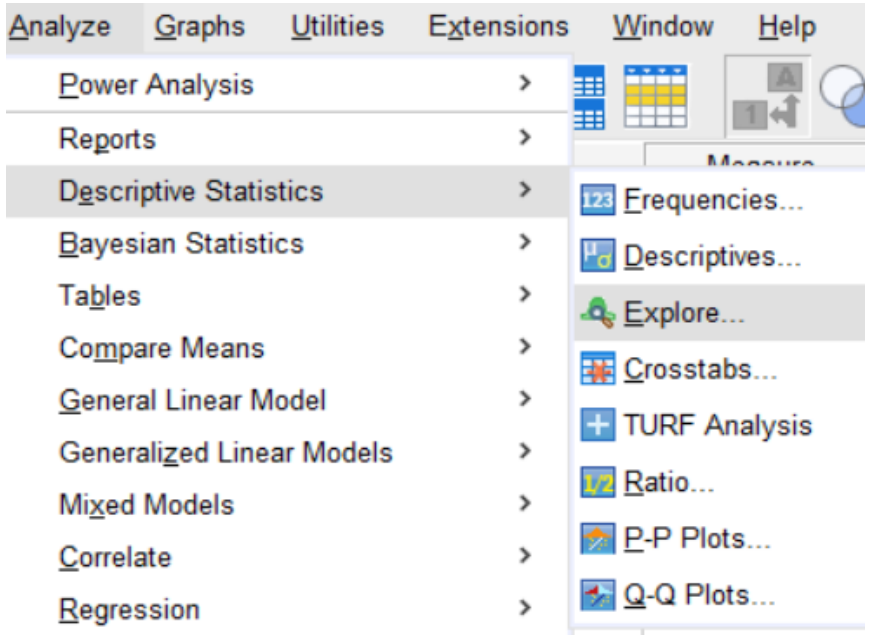


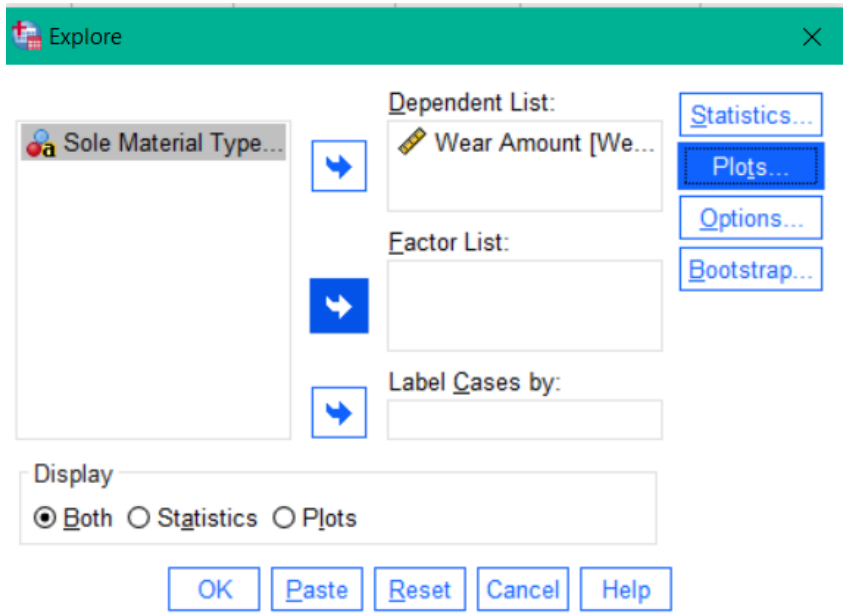
Testing for Outliers

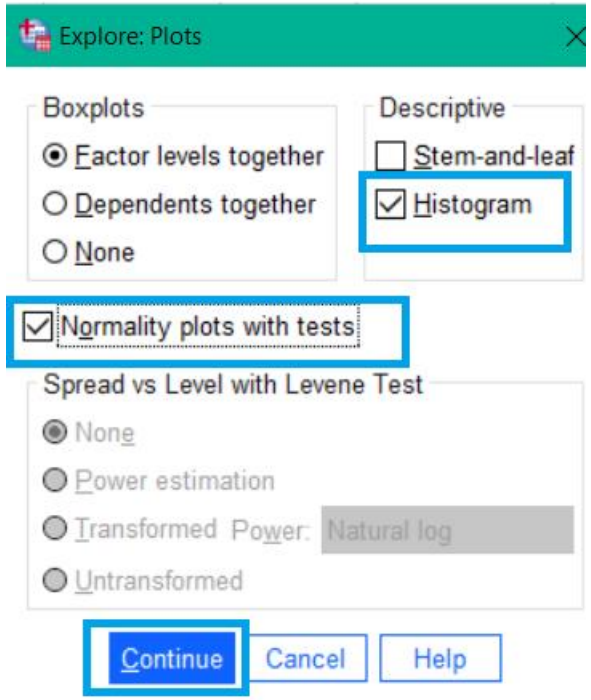


Boxplot shows no presence of outliers

Dependent Variable Normal Distribution Test







Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Wear Amount	.135	20	.200*	.949	20	.353

*. This is a lower bound of the true significance.

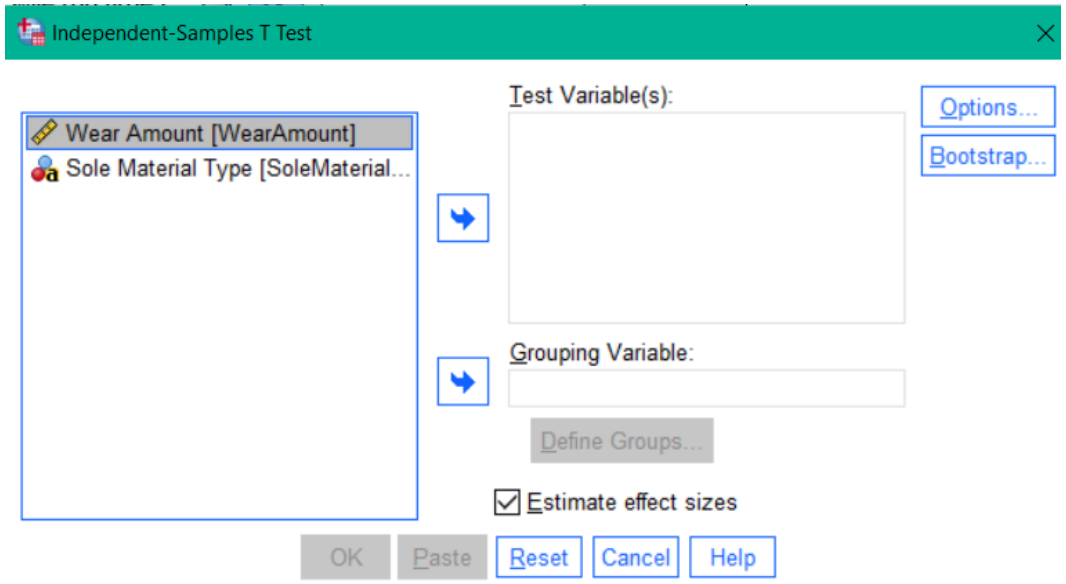
a. Lilliefors Significance Correction

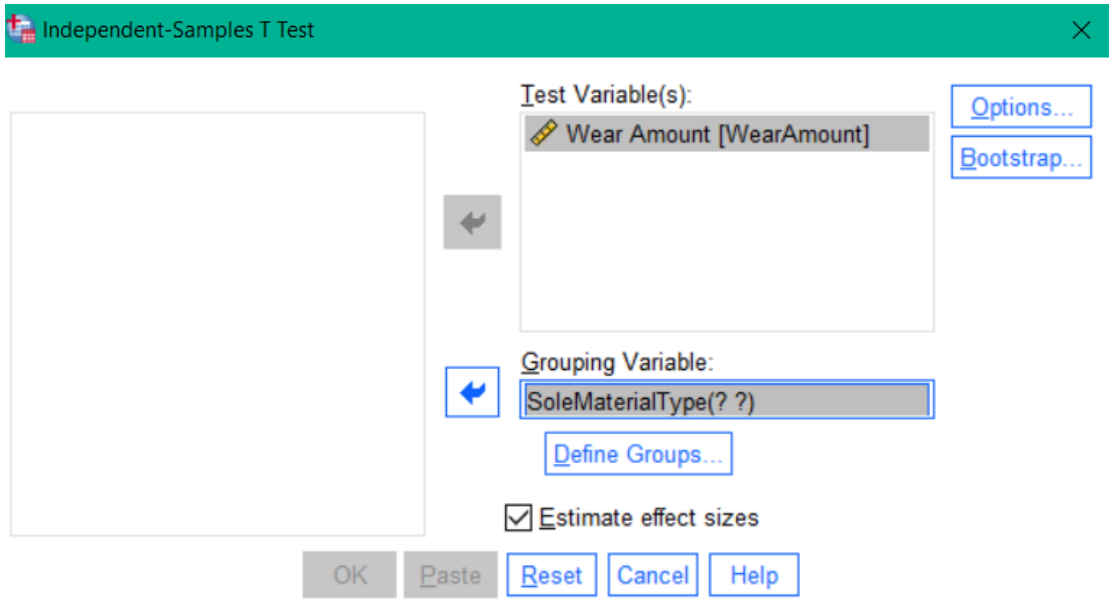
Both Kolmogorov-Smirnov and Shapiro-Wilk test of Normalty show that Sig value is greater than alpha-value =0.05.

Therefore, it is safe to say that our data is normally distributed

SPSS

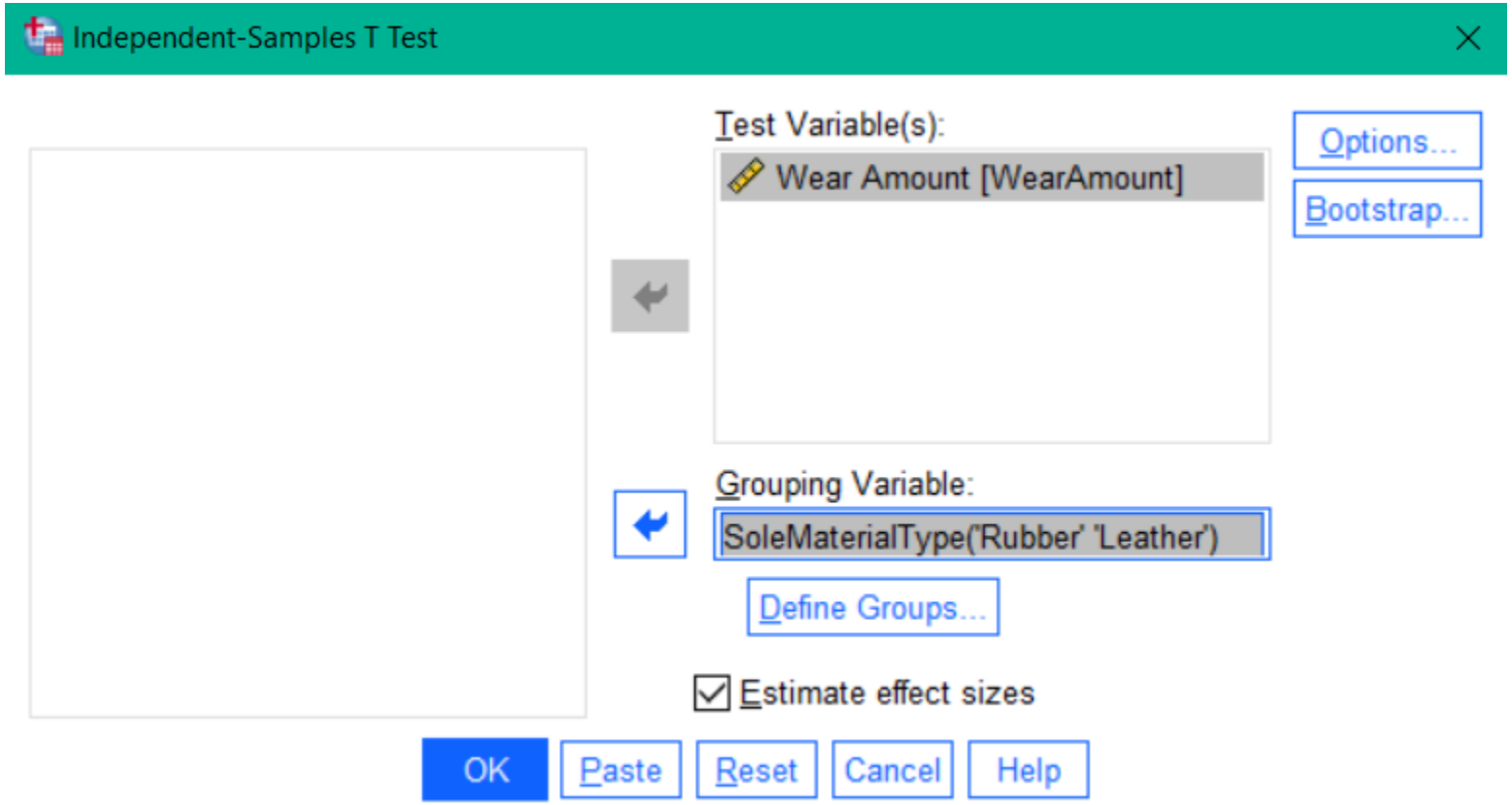
To run an Independent Samples *t* Test in SPSS, click **Analyze > Compare Means > Independent-Samples T Test**.





SPSS

Define Groups



SPSS (Output)

T-Test

Group Statistics

	Sole Material Type	N	Mean	Std. Deviation	Std. Error Mean
Wear Amount	Rubber	10	10.630	2.4513	.7752
	Leather	10	11.040	2.5185	.7964

SPSS (Output)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Wear Amount	Equal variances assumed	.019	.892	-.369	18	.716	-.4100	1.1114	-2.7449	1.9249
	Equal variances not assumed			-.369	17.987	.717	-.4100	1.1114	-2.7450	1.9250

Sig. is the p-value corresponding to this test statistic. Since p-value (0.892) is greater than alpha (0.05), we use the Equal Variances Assumed row for t-test (One of the assumptions fulfilled)

Sig. (2-tailed) is the p-value corresponding to the given test statistic and degrees of freedom. Since this p-value is greater than alpha, we accept the null hypothesis; i.e., the wear amount for rubber and leather are equal.

It does not really matter. Just buy the best looking one.

Review Game

Link: https://www.educandy.com/site/resource.php?activity-code=6605f

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