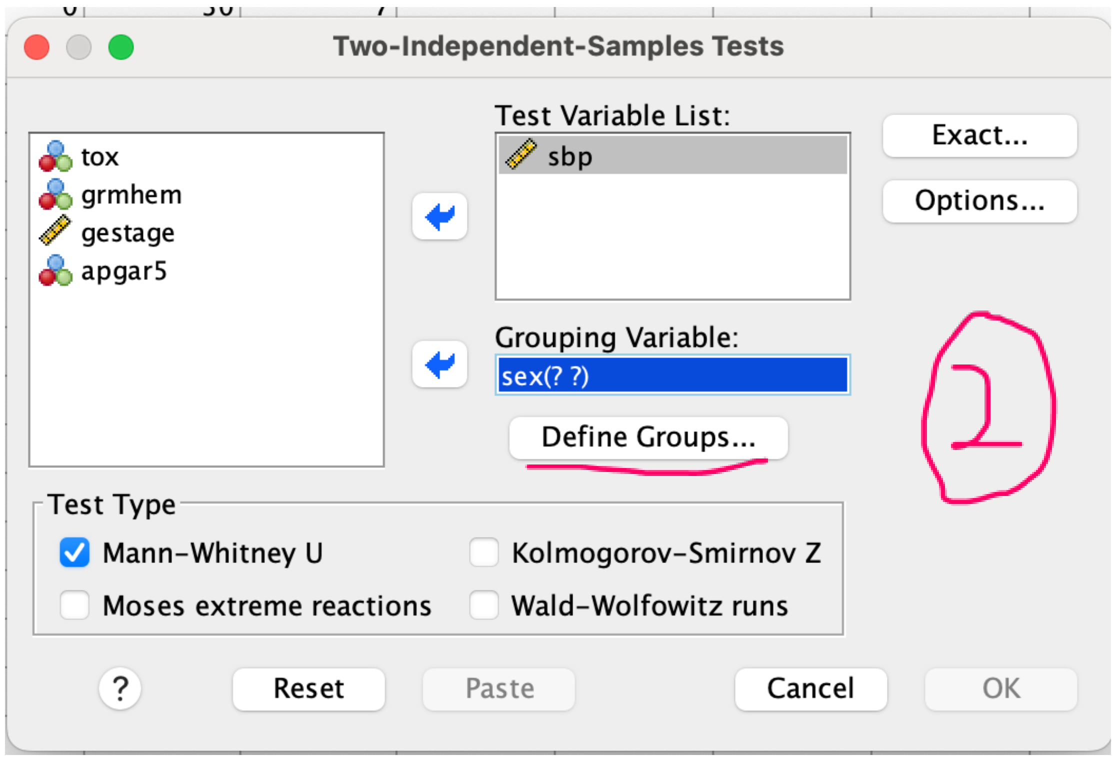
Hypothesis testing 1-2

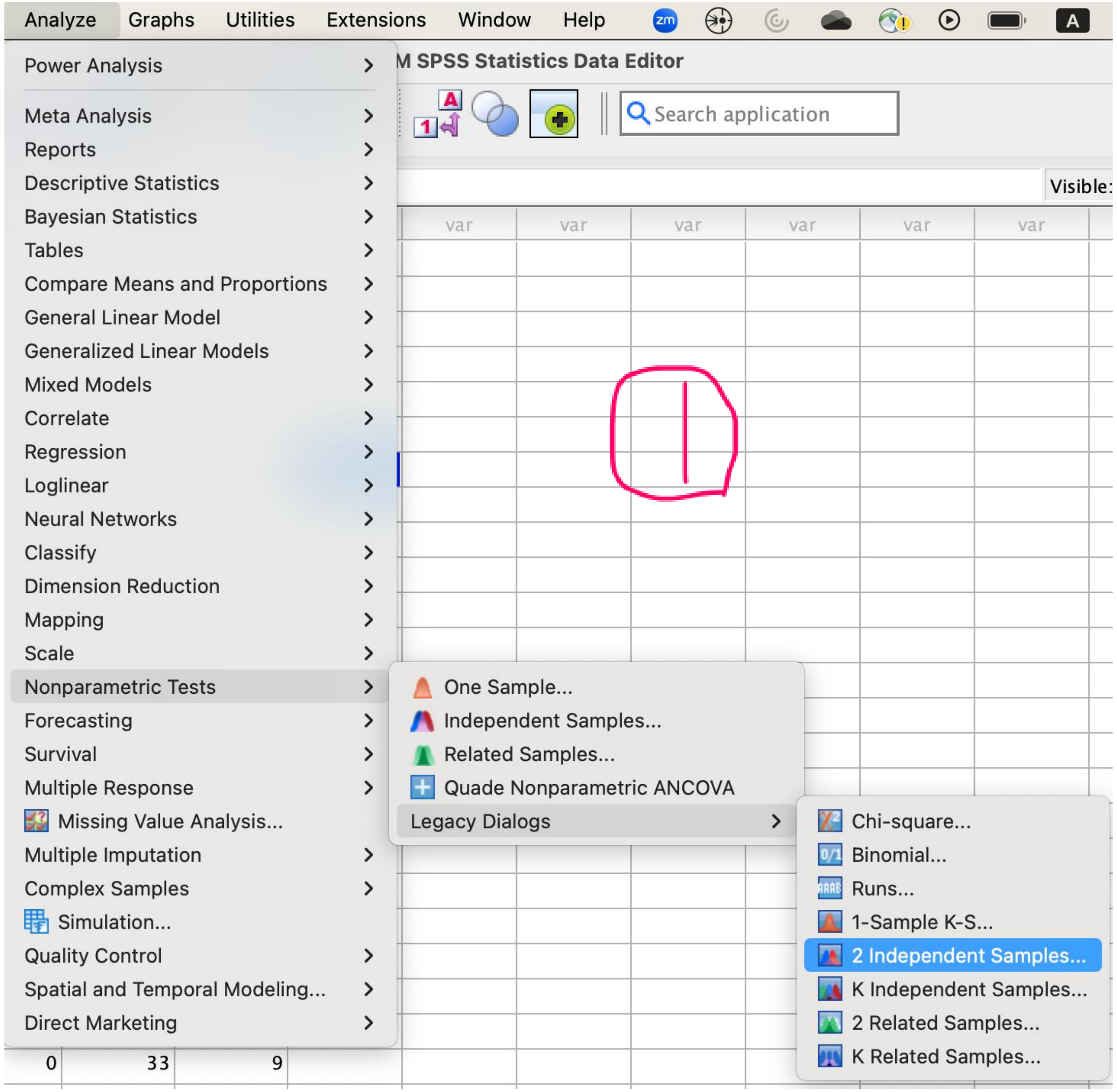
Mann Whitney U-test, paired t-test

Mann-Whitney U test

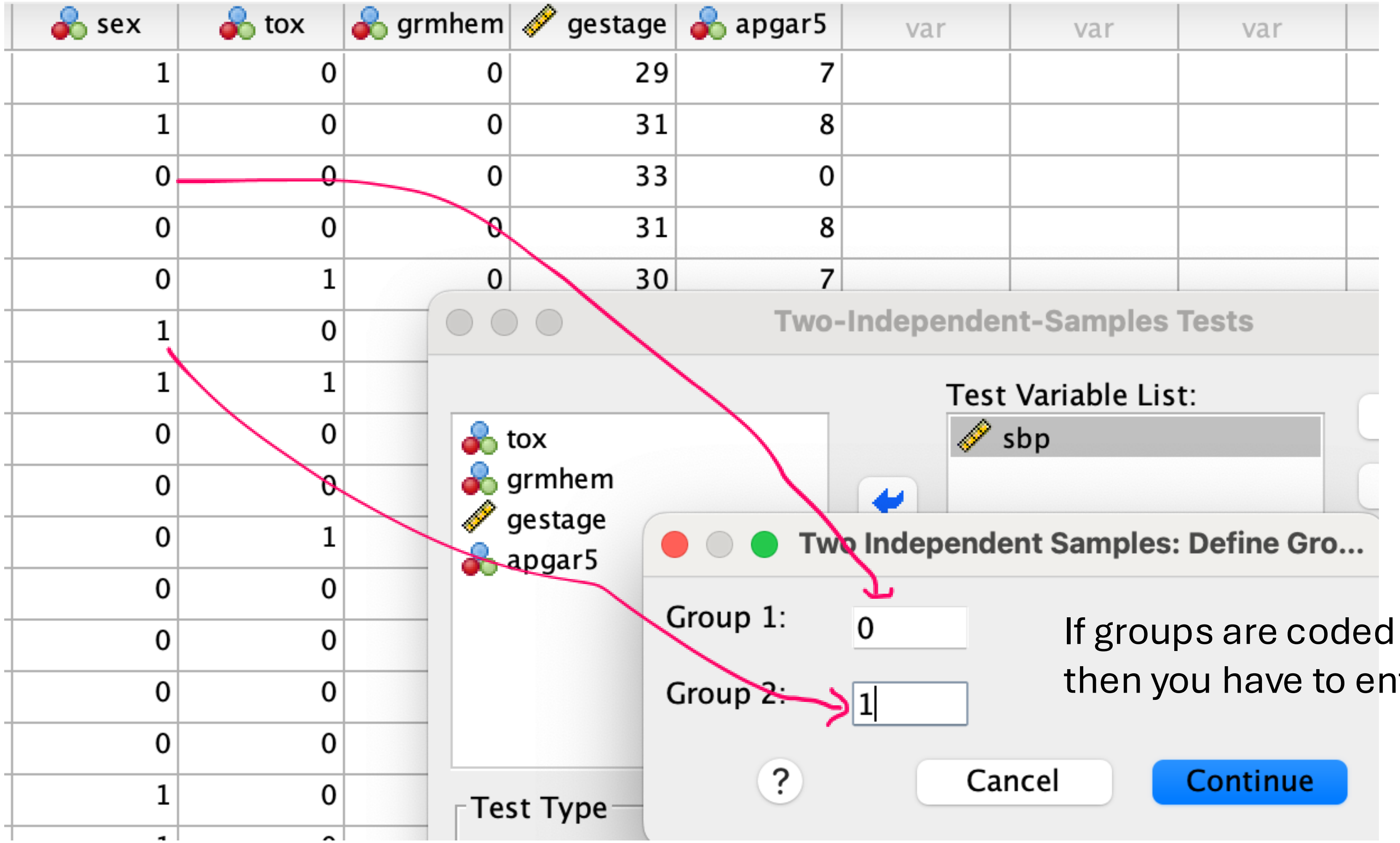
- Also known as the **Wilcoxon rank-sum test**
- A non-parametric test used to compare two independent groups when the data is ordinal or continuous.
- Let's again check if systolic blood pressure (sbp) level differs between boys and girls (sex).

Mann-Whitney U test





Mann-Whitney U test



If groups are coded differently (ex. 1 vs. 2), then you have to enter 1 and 2, respectively.

Compare with independent samples t-test

NPar Tests

Mann-Whitney Test

Ranks

	sex	N	Mean Rank	Sum of Ranks
sbp	0	56	50.06	2803.50
	1	44	51.06	2246.50
	Total	100		

Test Statistics[a]

	sbp
Mann-Whitney U	1207.500
Wilcoxon W	2803.500
Z	-.170
Asymp. Sig. (2-tailed)	.865

a. Grouping Variable: sex

P > 0.05… what's the null hypothesis?

T-Test

Group Statistics

	sex	N	Mean	Std. Deviation	Std. Error Mean
sbp	0	56	46.46	11.145	1.489
	1	44	47.86	11.806	1.780

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					
						Significance			
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference
sbp	Equal variances assumed	.079	.779	-.607	98	.273	.545	-1.399	2.305
	Equal variances not assumed			-.603	89.858	.274	.548	-1.399	2.321

Reporting results

Example statement of results [edit]

In reporting the results of a Mann–Whitney *U* test, it is important to state:[12]

- A measure of the central tendencies of the two groups (means or medians; since the Mann–Whitney *U* test is an ordinal test, medians are usually recommended)
- The value of *U* (perhaps with some measure of effect size, such as common language effect size or rank-biserial correlation).
- The sample sizes
- The significance level.

In practice some of this information may already have been supplied and common sense should be used in deciding whether to repeat it. A typical report might run,

> "Median latencies in groups E and C were 153 and 247 ms; the distributions in the two groups differed significantly (Mann–Whitney $U = 10.5$, $n_1 = n_2 = 8$, $P < 0.05$ two-tailed)."

Reporting results

- Please write a sentence reporting the results of the Mann-Whitney U test demonstrated in previous slides.

Paired t-test

- This is essentially the same as one-sample t-test which is testing the null hypothesis that the population mean *difference* is zero.

- We will use sleep data for this task (sleep.csv).
  - Compares reaction times before and after sleep deprivation for 10 subjects. Reaction time measured before and after sleep deprivation in milliseconds (ms).

Load the dataset

	extra	group	ID
1	.7	1	1
2	-1.6	1	2
3	-.2	1	3
4	-1.2	1	4
5	-.1	1	5
6	3.4	1	6
7	3.7	1	7
8	.8	1	8
9	.0	1	9
10	2.0	1	10
11	1.9	2	1
12	.8	2	2
13	1.1	2	3
14	.1	2	4
15	-.1	2	5
16	4.4	2	6
17	5.5	2	7
18	1.6	2	8
19	4.6	2	9
20	3.4	2	10

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	extra	Numeric	4	1		None	None	8	Right	Scale	Input
2	group	Numeric	1	0		None	None	8	Right	Nominal	Input
3	ID	Numeric	2	0		None	None	8	Right	Nominal	Input

Explore the data

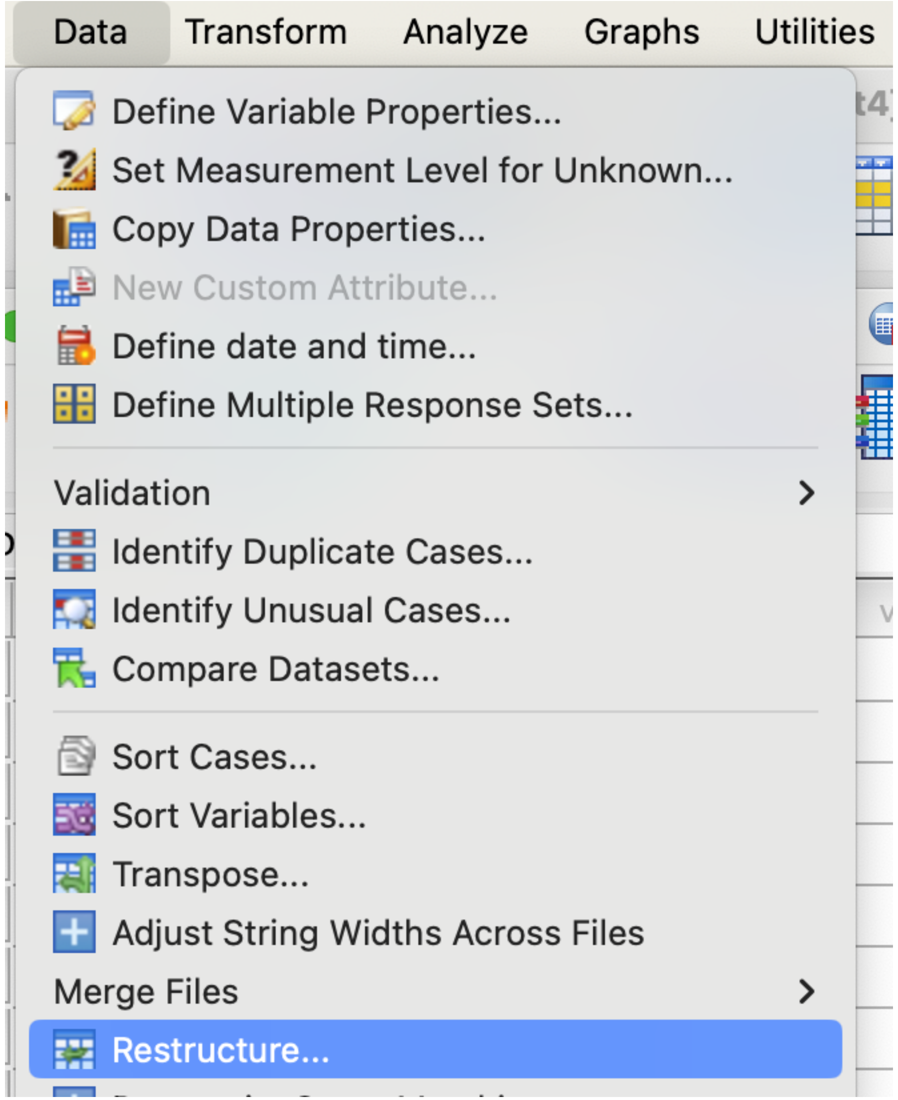
- 1. What are the sample means and standard deviations of the reaction time?

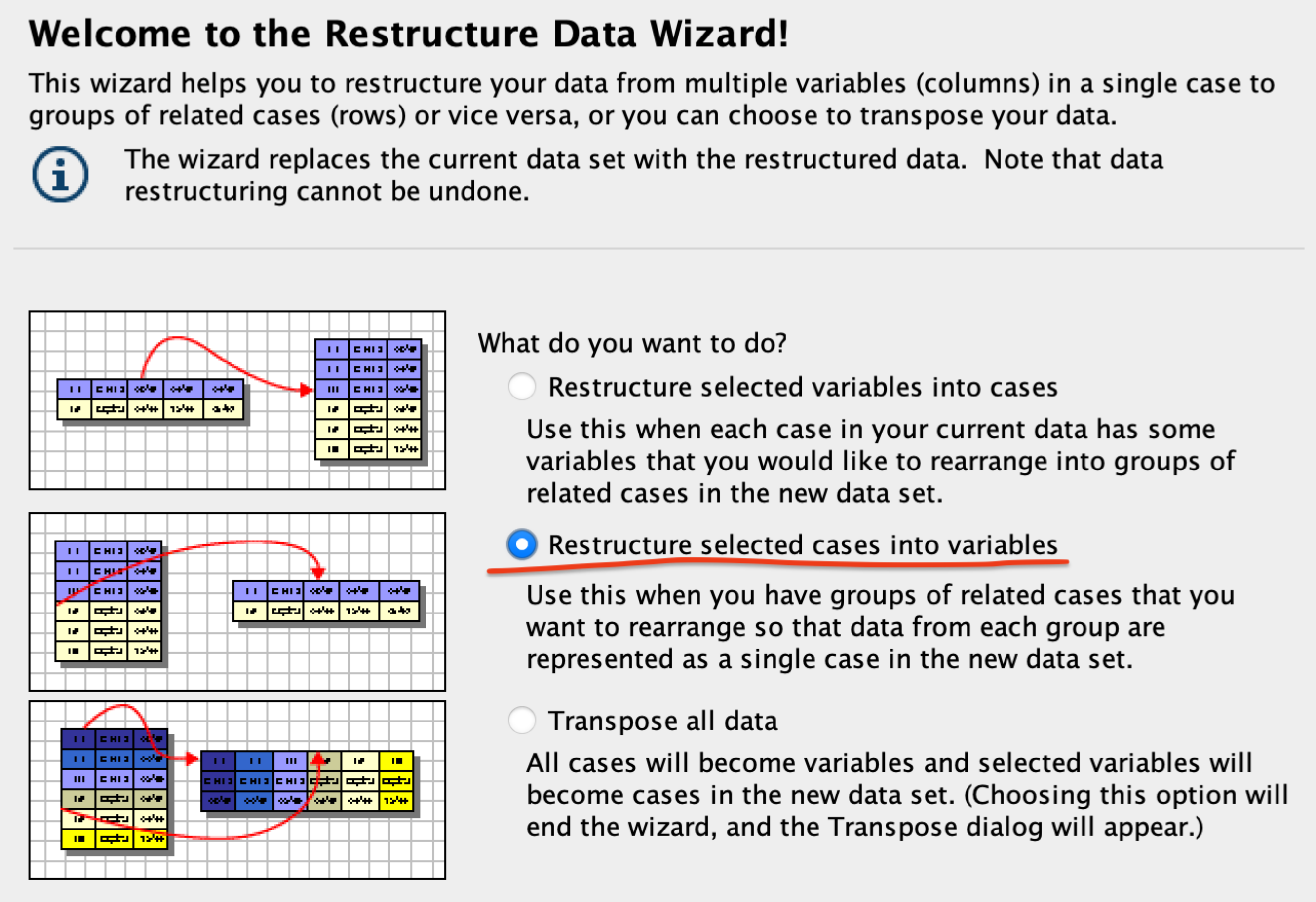
	Group 1	Group 2
Sample mean		
Sample standard deviation		

Explore the data

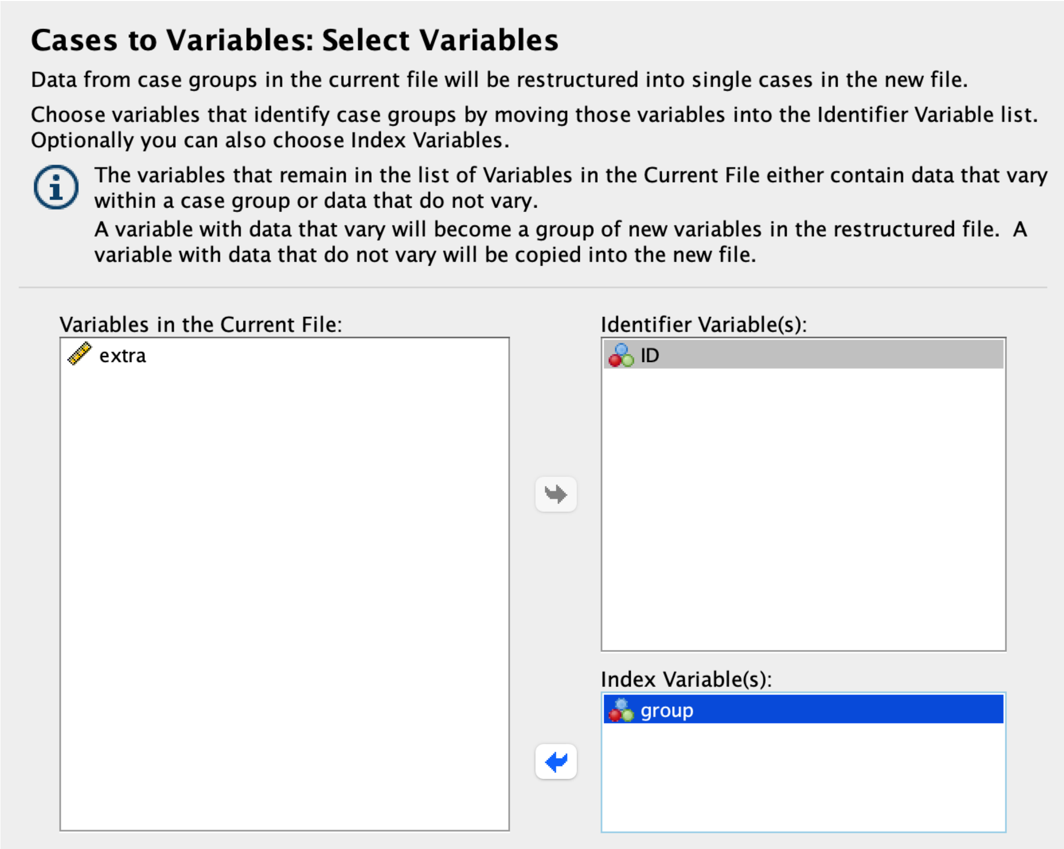
- 2. Can you check if the samples can be assumed to follow normal distributions? What are your supporting materials? Use plots (ex. histogram, boxplot, Q-Q plot) or test results (ex. Shapiro-Wilk, Kolmogorov-Smirnov) to support your claim.

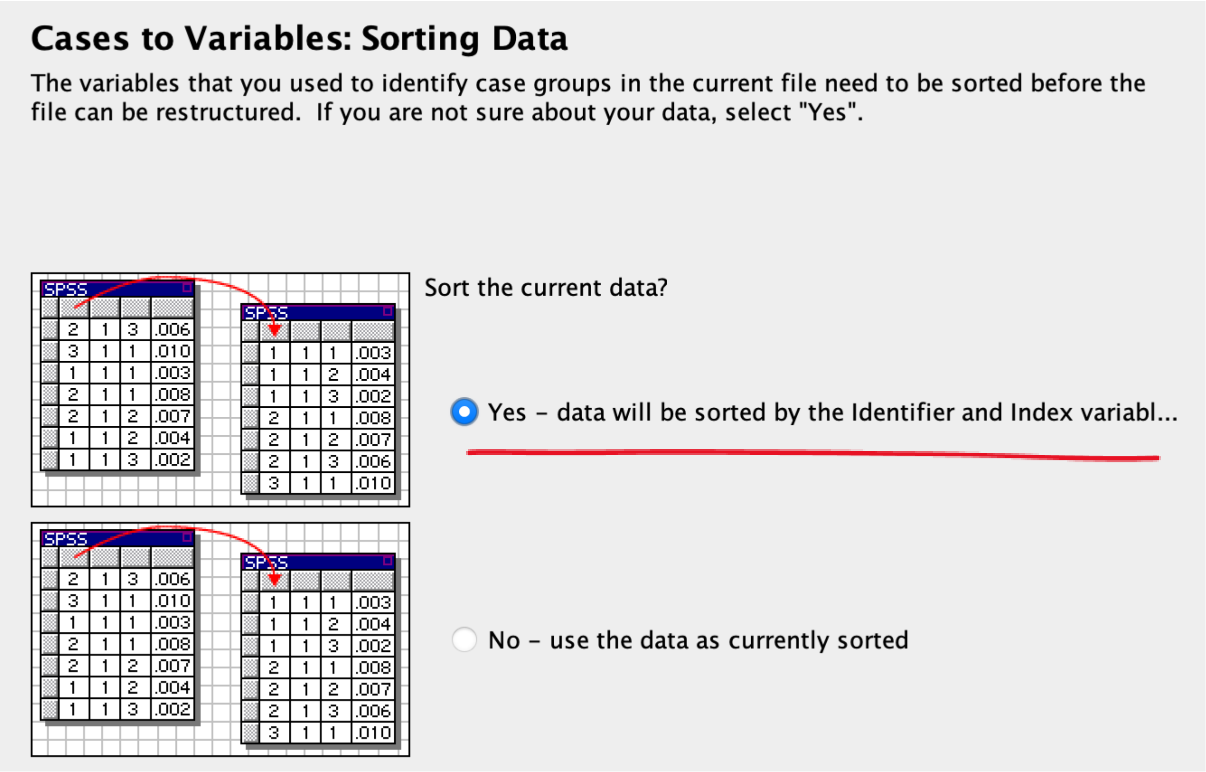
Restructure your data



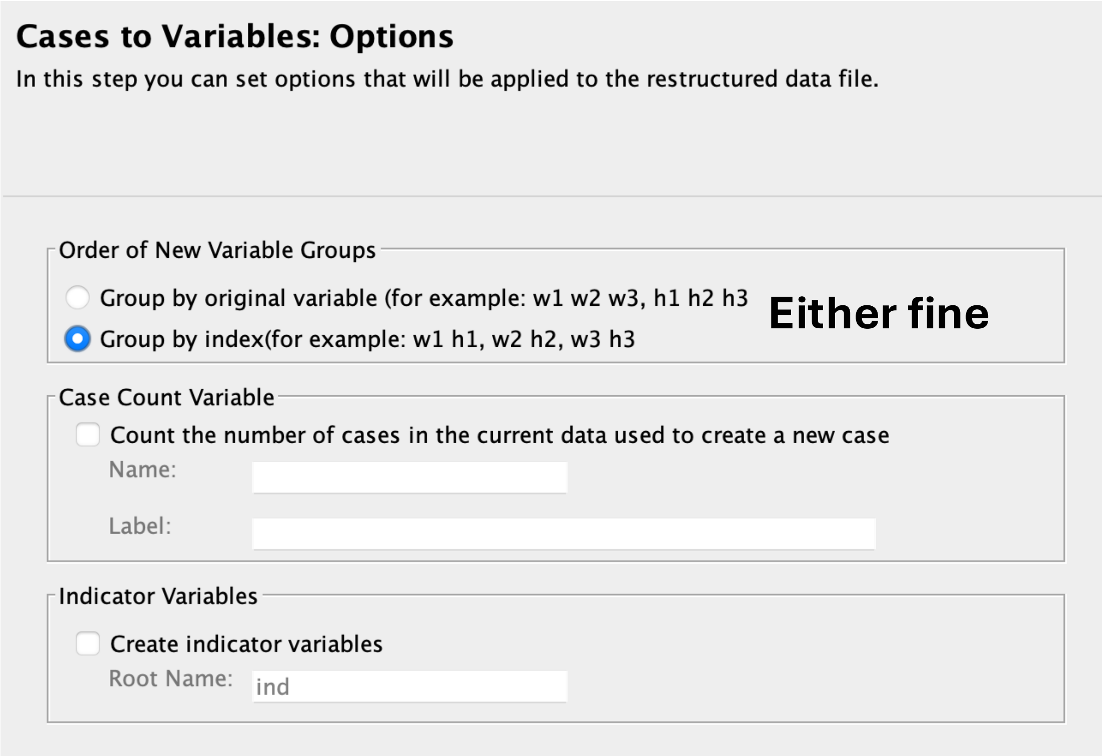


Restructure your data





Restructure your data

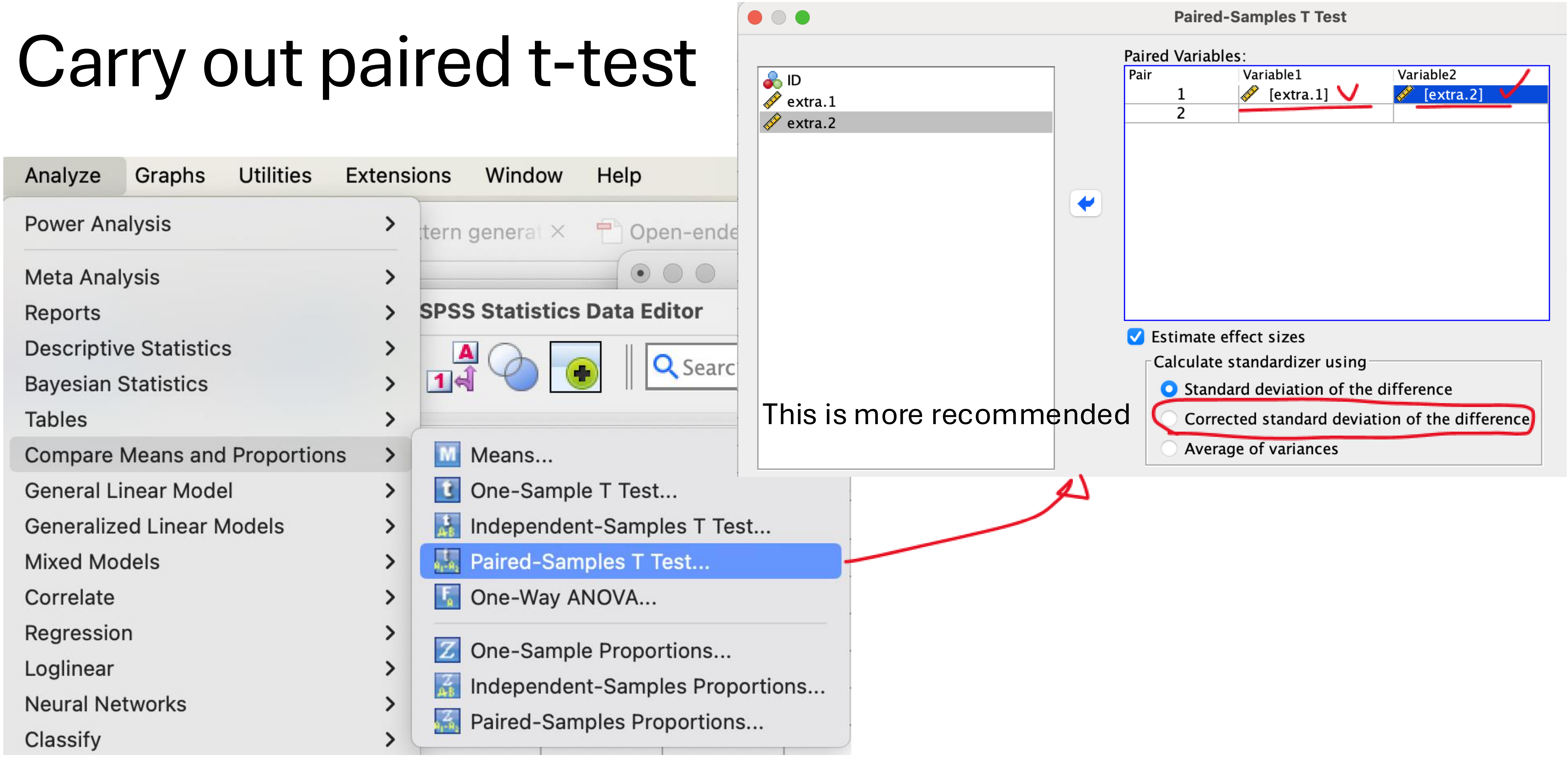


Either fine

Final output

	ID	extra.1	extra.2
2	2	-1.6	.8
3	3	-.2	1.1
4	4	-1.2	.1
5	5	-.1	-.1
6	6	3.4	4.4
7	7	3.7	5.5
8	8	.8	1.6
9	9	.0	4.6
10	10	2.0	3.4

Carry out paired t-test



Understand your results

T-Test

[DataSet7] /Users/joh/Downloads/Untitled4.sav

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	extra.1	.750	10	1.7890	.5657
	extra.2	2.330	10	2.0022	.6332

Are they the same as what you reported in **slide 4**?

Paired Samples Correlations

		N	Correlation	Significance One-Sided p	Significance Two-Sided p
Pair 1	extra.1 & extra.2	10	.795	.003	.006

Pearson's r

I don't know why SPSS spits One-Sided p. Check the Two-Sided p.

Paired Samples Test

		Paired Differences Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Significance One-Sided p	Two-Sided p
Pair 1	extra.1 – extra.2	-1.5800	1.2300	.3890	-2.4599	-.7001	-4.062	9	.001	.003

This is what you report w.r.t. t-test

Paired Samples Effect Sizes

			Standardizer[a]	Point Estimate	95% Confidence Interval Lower	Upper
Pair 1	extra.1 – extra.2	Cohen's d	1.9217	-.822	-1.456	-.188
		Hedges' correction	2.1028	-.751	-1.331	-.172

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation of the mean difference adjusted by the correlation between measures.
Hedges' correction uses the sample standard deviation of the mean difference adjusted by the correlation between measures, plus a correction factor.

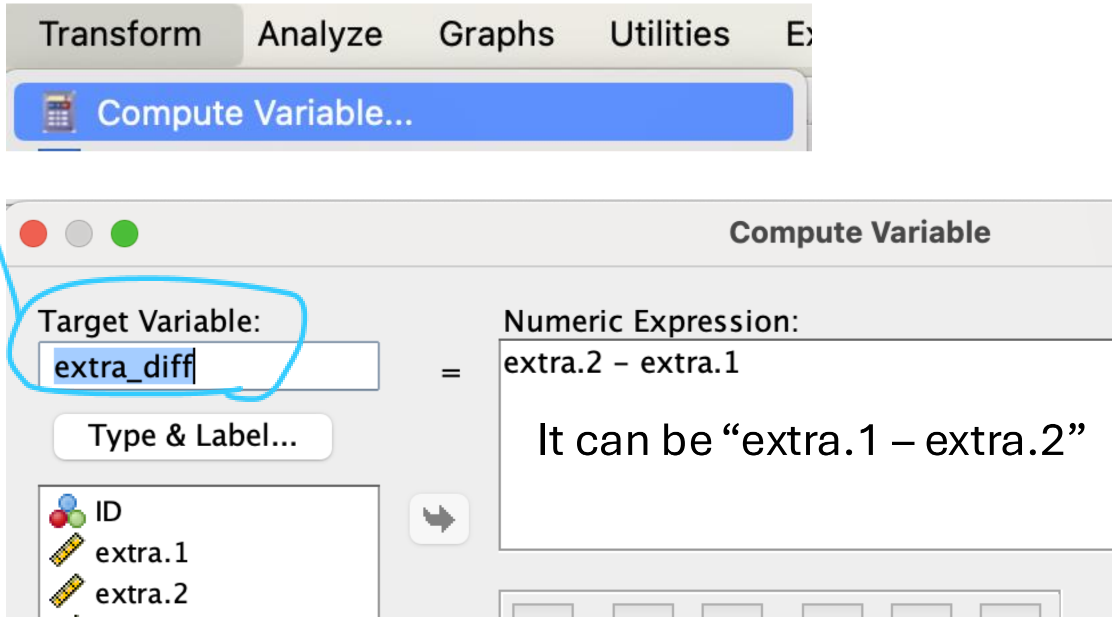
Again, better report positive values (ex. point estimate: 0.822, 95% CI: 0.188 ~ 1.456)

			Standardizer[a]	Point Estimate	95% Confidence Interval Lower	Upper
Pair 1	extra.2 – extra.1	Cohen's d	1.9217	.822	.188	1.456
		Hedges' correction	2.1028	.751	.172	1.331

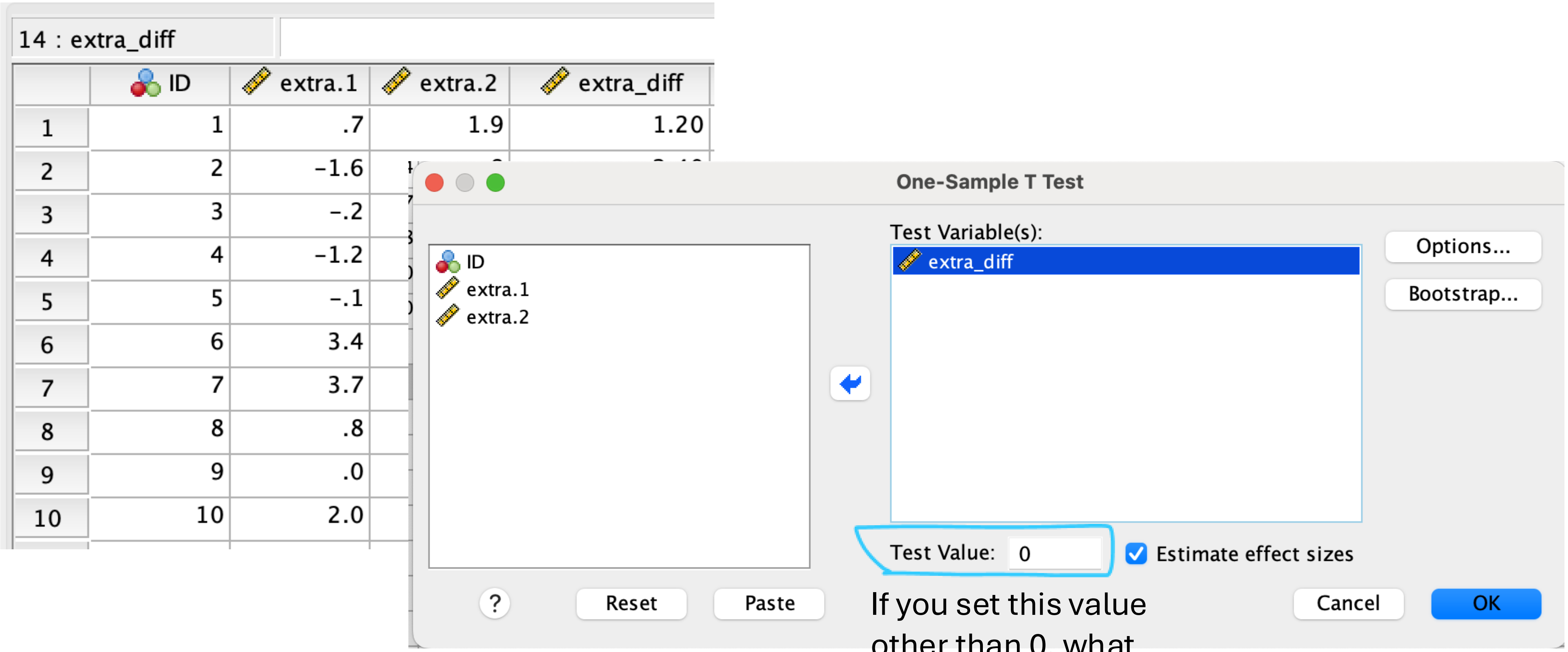
Replicate results using one sample t-test?

14 : extra_diff

	ID	extra.1	extra.2	extra_diff
1	1	.7	1.9	1.20
2	2	-1.6	.8	2.40
3	3	-.2	1.1	1.30
4	4	-1.2	.1	1.30
5	5	-.1	-.1	.00
6	6	3.4	4.4	1.00
7	7	3.7	5.5	1.80
8	8	.8	1.6	.80
9	9	.0	4.6	4.60
10	10	2.0	3.4	1.40



Replicate results using one sample t-test?



If you set this value other than 0, what does that mean?

Replicate results using one sample t-test?

Paired Samples Test

		Paired Differences							Significance	
					95% Confidence Interval of the Difference					
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	One-Sided p	Two-Sided p
Pair 1	extra.2 - extra.1	1.5800	1.2300	.3890	.7001	2.4599	4.062	9	.001	.003

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
extra_diff	10	1.5800	1.23000	.38896

One-Sample Test

	Test Value = 0						
			Significance			95% Confidence Interval of the Difference	
	t	df	One-Sided p	Two-Sided p	Mean Difference	Lower	Upper
extra_diff	4.062	9	.001	.003	1.58000	.7001	2.4599

Why are the two different?

Can you answer?

One-Sample Effect Sizes

		Standardizer[a]	Point Estimate	95% Confidence Interval Lower	Upper
extra_diff	Cohen's d	1.23000	1.285	.415	2.118
	Hedges' correction	1.34591	1.174	.379	1.936

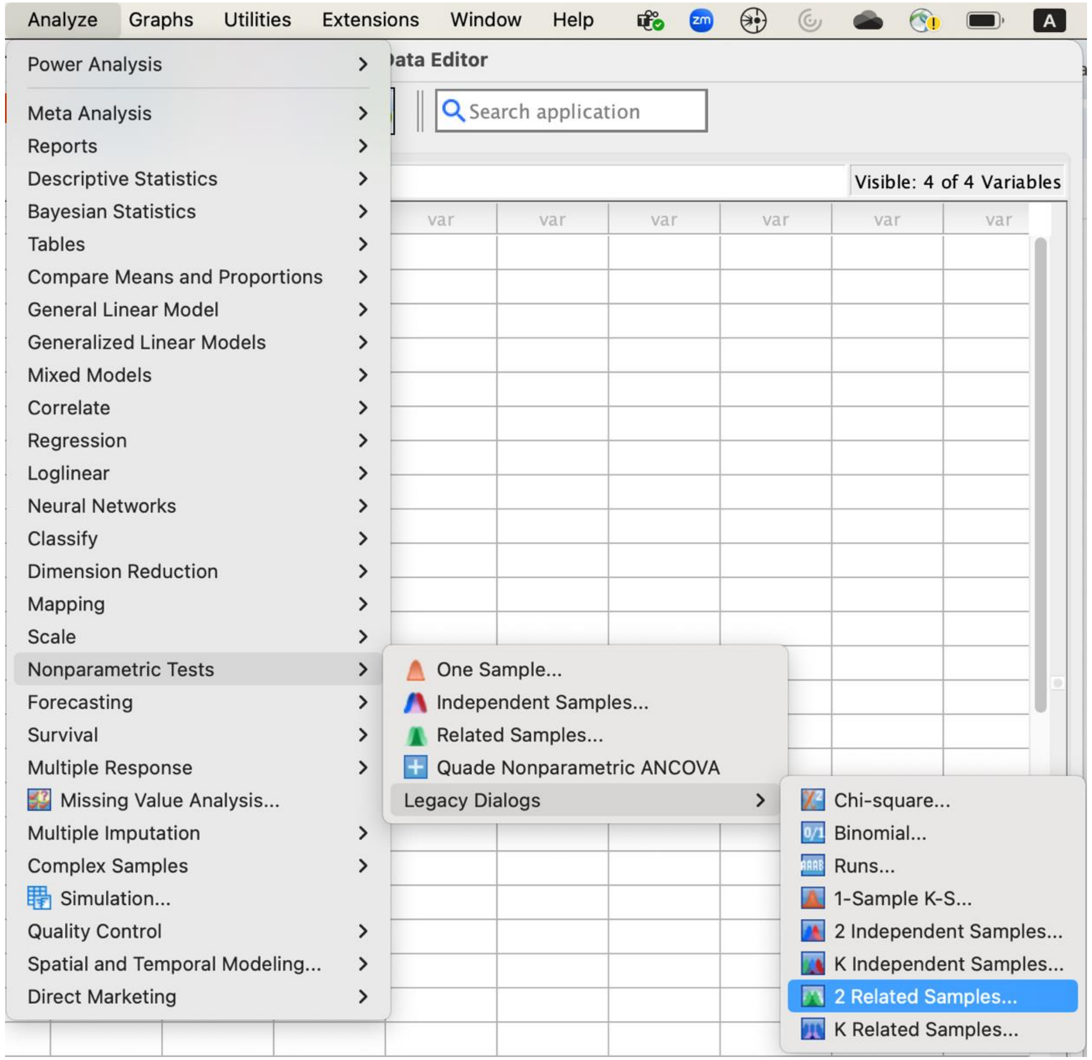
a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation.
Hedges' correction uses the sample standard deviation, plus a correction factor.

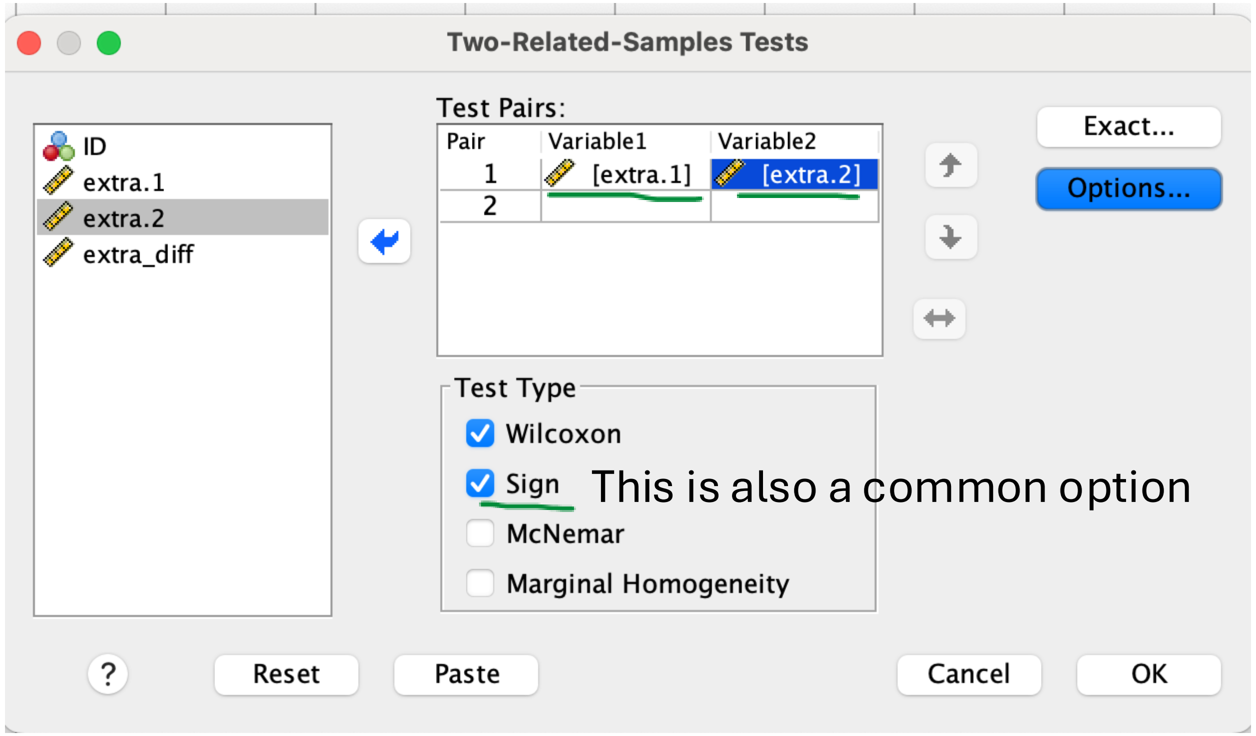
Paired Samples Effect Sizes

			Standardizer[a]	Point Estimate	95% Confidence Interval Lower	Upper
Pair 1	extra.2 - extra.1	Cohen's d	1.9217	.822	.188	1.456
		Hedges' correction	2.1028	.751	.172	1.331

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation of the mean difference adjusted by the correlation between measures.
Hedges' correction uses the sample standard deviation of the mean difference adjusted by the correlation between measures, plus a correction factor.

Non-parametric: Wilcoxon Signed-Rank Test





This is also a common option

Reporting results

NPar Tests

[DataSet9]

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
extra.2 – extra.1	Negative Ranks	0[a]	.00	.00
	Positive Ranks	9[b]	5.00	45.00
	Ties	1[c]		
	Total	10		

a. extra.2 < extra.1

b. extra.2 > extra.1

c. extra.2 = extra.1

Test Statistics[a]

	extra.2 – extra.1
Z	-2.668[b]
Asymp. Sig. (2-tailed)	.008

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

You can report results in a similar fashion to how you reported results for Mann-Whitney U test.

Compare the medians of the two samples, report Statistic (Z) and its significance, and each sample size.

Covered all relevant 2-sample comparisons

Source: https://p-library.com/o/stats/