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Non-Parametric Tests

Learning Centre

Content

Non-parametric Tests?

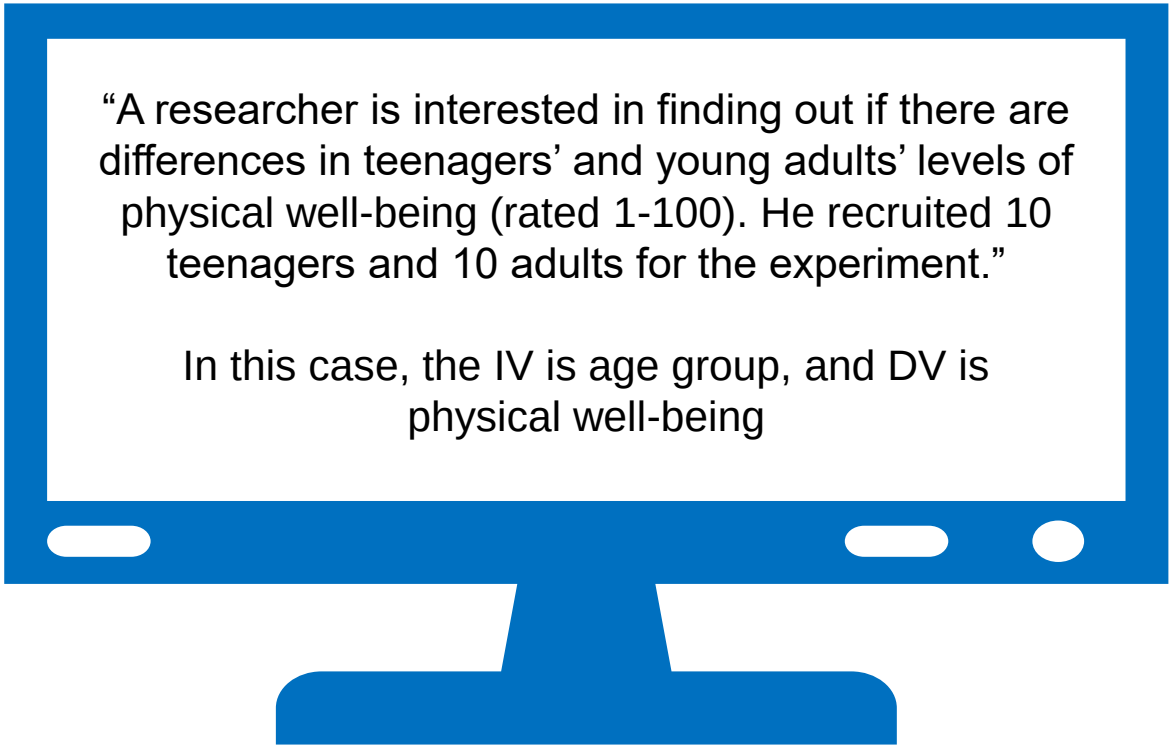
- While most common statistical analyses (e.g., t-tests, ANOVA) are parametric, they need to fulfil a number of criteria before we use them
- These criteria include satisfying the assumptions of outliers, linearity, normality, homoscedasticity, to name a few
- If the data do not fulfil the criteria to conduct the parametric tests, we can opt for non-parametric tests, which do not require those assumptions
- Do note that non-parametric tests make *less* assumptions, not *no* assumptions!
- The trade-off is that non-parametric tests are generally lower in power

Types of Non-parametric Tests

- In this set of slides, the focus is on 4 non-parametric tests
- Each of these 4 tests is a non-parametric version of *t*-tests and ANOVAs

Parametric Test		**Non-parametric Test**
Between Subjects t-test	→	Mann-Whitney *U* Test
Within Subjects t-test	→	Wilcoxon Signed Ranked Test
One-way Between Subjects ANOVA	→	Kruskal-Wallis One-way ANOVA
One-way Within Subjects ANOVA	→	Friedman's ANOVA

Mann-Whitney *U* Test



Location of SPSS Data Files for Practice

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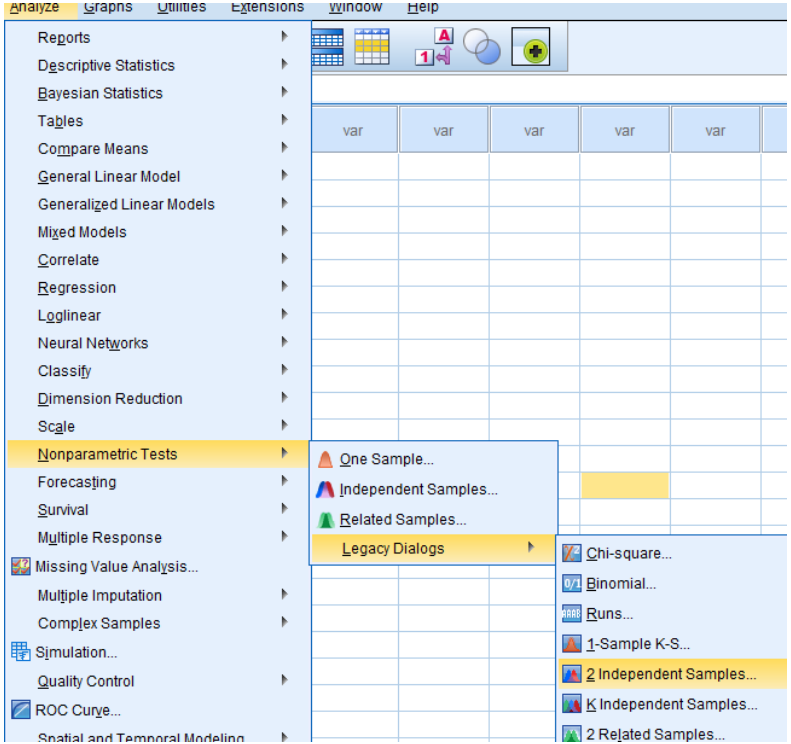
Example SPSS data for practice are available on LearnJCU:

Log in to LearnJCU -> Organisations -> Learning Centre JCU Singapore -> Statistics Support -> Statistics Resources -> SPSS Data for Practice

Mann-Whitney *U* Test - SPSS

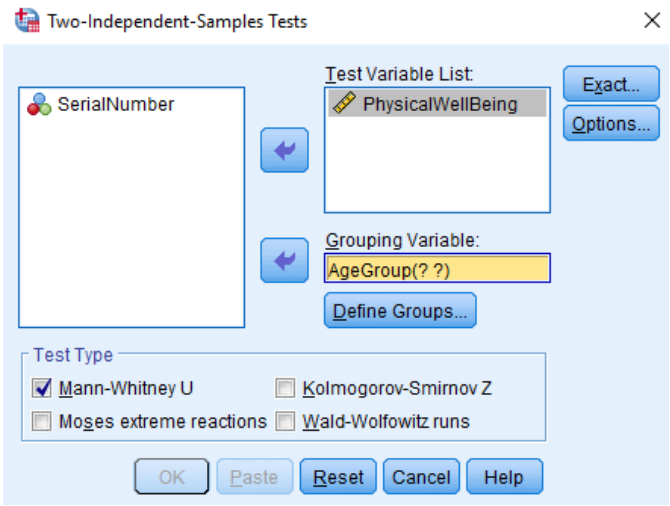
Assume that the data has multiple outliers, which is why the researcher opted to conduct a Mann-Whitney *U* test, rather than a t-test.

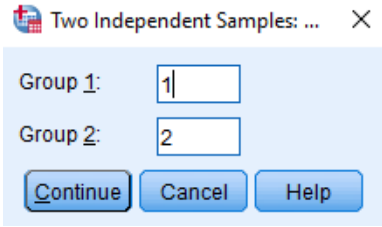
Analyze -> Nonparametrics Tests -> Legacy Dialogs -> 2 Independent Samples…



Mann-Whitney *U* Test - SPSS

1. Move *PhysicalWellBeing* (DV) to the right under Test Variable List
2. Move *AgeGroup* (IV) as our Grouping Variable
3. Then define groups by clicking on **Define Groups**
4. Input ‘1’ and ‘2’ as groups 1 and 2 respectively
5. Continue and OK!





Mann-Whitney *U* Test - SPSS

In a Mann-Whitney test, SPSS ranks the data (e.g., the lowest score of physical wellbeing gets a rank of 1, the next lowest score gets a rank of 2.

The value here displays the average of the rankings

This is the sum of all rankings in each group of the IV

Mann-Whitney Test

Ranks

	AgeGroup	N	Mean Rank	Sum of Ranks
PhysicalWellBeing	Teenager	10	13.45	134.50
	Adult	10	7.55	75.50
	Total	20		

Test Statistics[a]

	PhysicalWell Being
Mann-Whitney U	20.500
Wilcoxon W	75.500
Z	-2.238
Asymp. Sig. (2-tailed)	.025
Exact Sig. [2*(1-tailed Sig.)]	.023[b]

a. Grouping Variable: AgeGroup

b. Not corrected for ties.

Mann-Whitney *U* score = 20.5, $p = .03$

Given an alpha value of .05, there is a significant difference in teenagers' and adults' self reported physical wellbeing

Looking at the mean ranks, on average, teenagers reported higher physical wellbeing than adults

Write-Up

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An example write-up can be found on:

JCUS Learning Centre website -> Statistics and Mathematics Support

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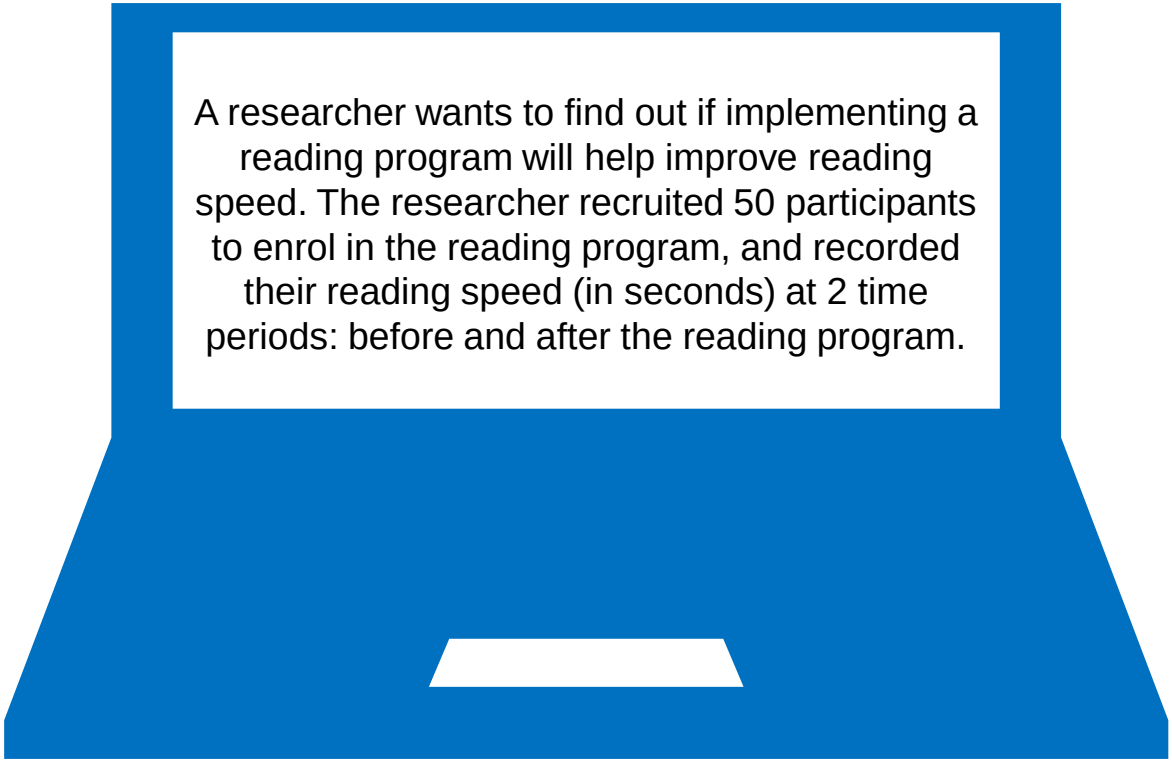
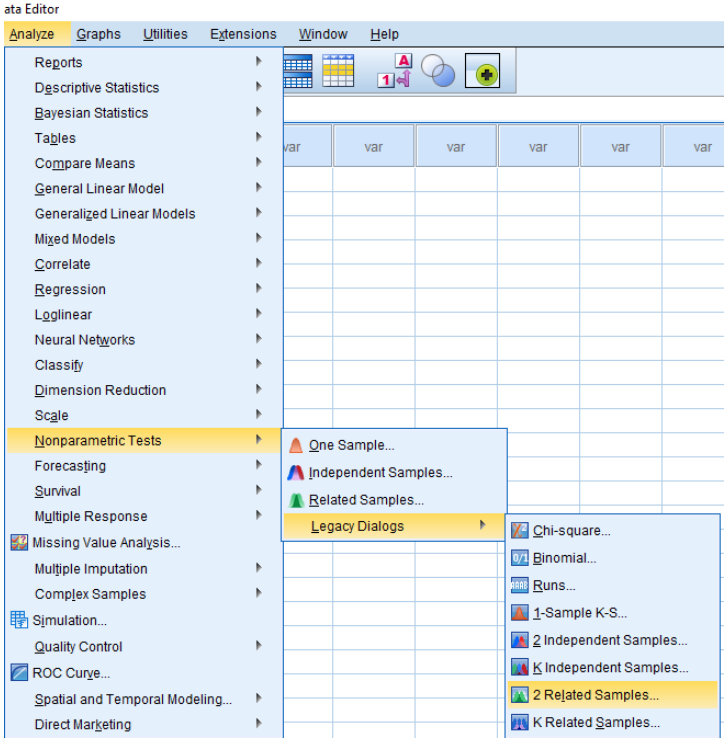
Wilcoxon Signed-Ranks Test



Wilcoxon Signed-Ranks Test - SPSS

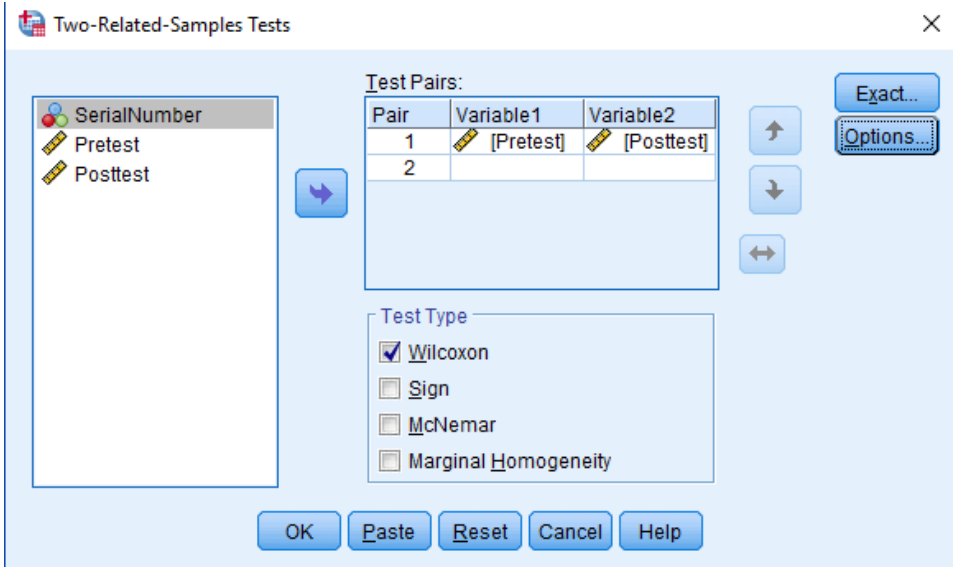
Assume that the researcher only managed to recruit 10 participants, and opted to conduct a Wilcoxon signed ranked test, rather than a within subjects *t*-test.

Analyze -> Nonparametrics Tests -> Legacy Dialogs -> 2 Related Samples….



Wilcoxon Signed-Ranks Test - SPSS

1. Move *Pretest* and *Posttest* as Pair 1
2. Tick **Wilcoxon** in Test type
3. OK!



Wilcoxon Signed-Ranks Test - SPSS

The legend shows how negative, positive, and tied ranks are calculated. For example, there are 9 cases where a posttest score is lower than a pretest score. This means that in 9 of the 10 participants, reading speed improved after intervention

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
Posttest - Pretest	Negative Ranks	9[a]	6.00	54.00
	Positive Ranks	1[b]	1.00	1.00
	Ties	0[c]		
	Total	10		

a. Posttest < Pretest
b. Posttest > Pretest
c. Posttest = Pretest

Test Statistics[a]

	Posttest - Pretest
Z	-2.701[b]
Asymp. Sig. (2-tailed)	.007

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.

We are interested in the test statistic, which is -2.70 (Do note that in this case, this value is based on positive ranks)

p value is .007

Given an alpha value of .05, there is a significant difference between pre-test and posttest scores

Based on mean ranks, participants' reading speed improved after the reading program

Write-Up

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Kruskal-Wallis One-Way ANOVA

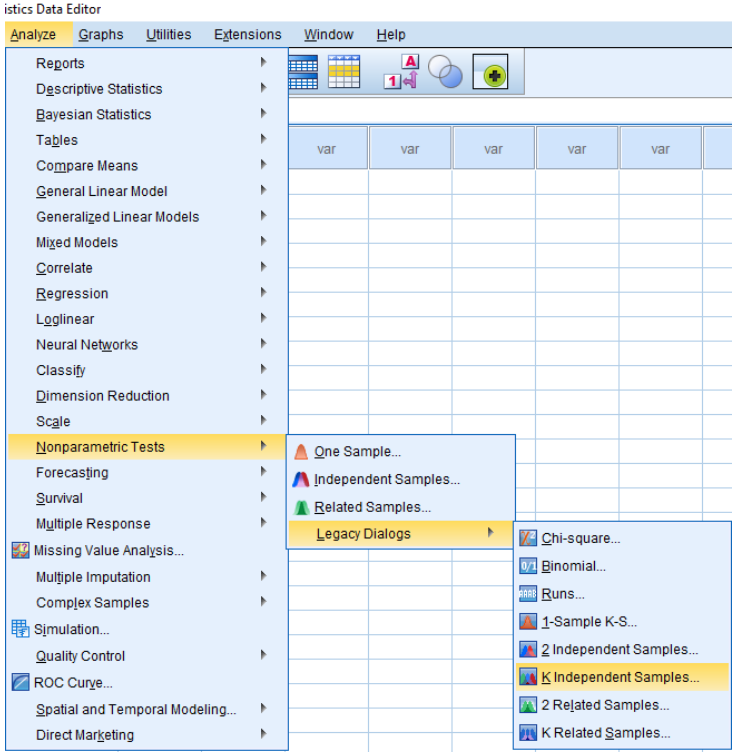
A researcher is interested in finding out if there is a difference in physical well-being (rated 1-100) among teenagers, young adults, and seniors. He recruited 10 teenagers, 10 adults, and 10 seniors for the experiment.

In this case, the IV is age group, and DV is physical well-being

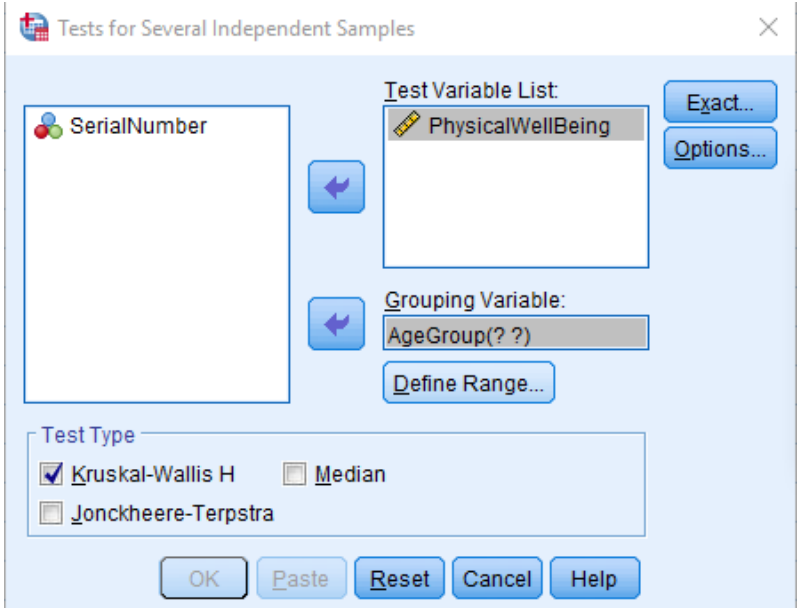
Kruskal-Wallis One-Way ANOVA

Assume that the data did not meet the criteria of parametric tests, thus the researcher opted to conduct a Kruskal-Wallis test.

Analyze -> Nonparametrics Tests -> Legacy Dialogs -> K Independent Samples….

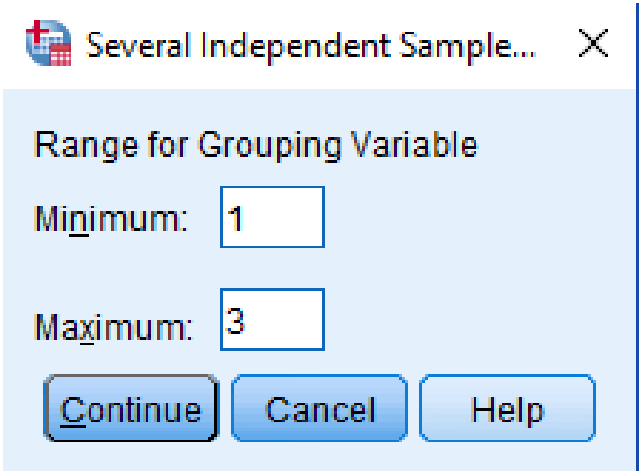


Kruskal-Wallis One-Way ANOVA



1. Move *PhysicalWellBeing* into the test variable list box, and *AgeGroup* into the grouping variable box
2. Tick Kruskal-Wallis H under Test type
3. Then define the grouping variable (**Define Range**)
4. Go to **Options** and select Descriptives

Kruskal-Wallis One-Way ANOVA



To define groups:

5. In our dataset, Teenagers were coded as ‘1’, Adults as ‘2’, and Seniors as ‘3’
6. Hence, the range for our grouping variable is 1-3; with a minimum of 1 and maximum of 3
7. Click Continue, and OK

Kruskal-Wallis One-Way ANOVA

Similar to Mann-Whitney *U* tests, SPSS ranks the data (e.g., the lowest score of physical wellbeing gets a rank of 1, the next lowest score gets a rank of 2.

The value here displays the average of the rankings

Kruskal-Wallis Test

Ranks

	AgeGroup	N	Mean Rank
PhysicalWellBeing	Teenager	10	21.70
	Adult	10	12.65
	Senior	10	12.15
	Total	30	

Test Statistics[a,b]

	PhysicalWell Being
Kruskal-Wallis H	7.501
df	2
Asymp. Sig.	.024

a. Kruskal Wallis Test

b. Grouping Variable: AgeGroup

Kruskal-Wallis H score = 7.50, p = .024

Given an alpha value of .05, there is a significant difference between teenagers', adults', and seniors' self reported physical wellbeing

However

- Although we now know that there is a significant difference between the 3 groups, we do not know exactly where the difference(s) lie
- It could lie between teenagers and adults, adults and seniors, teenagers and seniors, or even all of the above
- To test this, we conduct a post-hoc series of Mann-Whitney *U* tests to find out the answer (you can find out more on Mann-Whitney *U* tests in the earlier example)

Write-Up

An example write-up can be found on page 294 in

Allen, P., Bennett, K., & Heritage, B. (2019). *SPSS Statistics: A Practical Guide* (4th ed.). Cengage Learning.

Types of Non-parametric Tests

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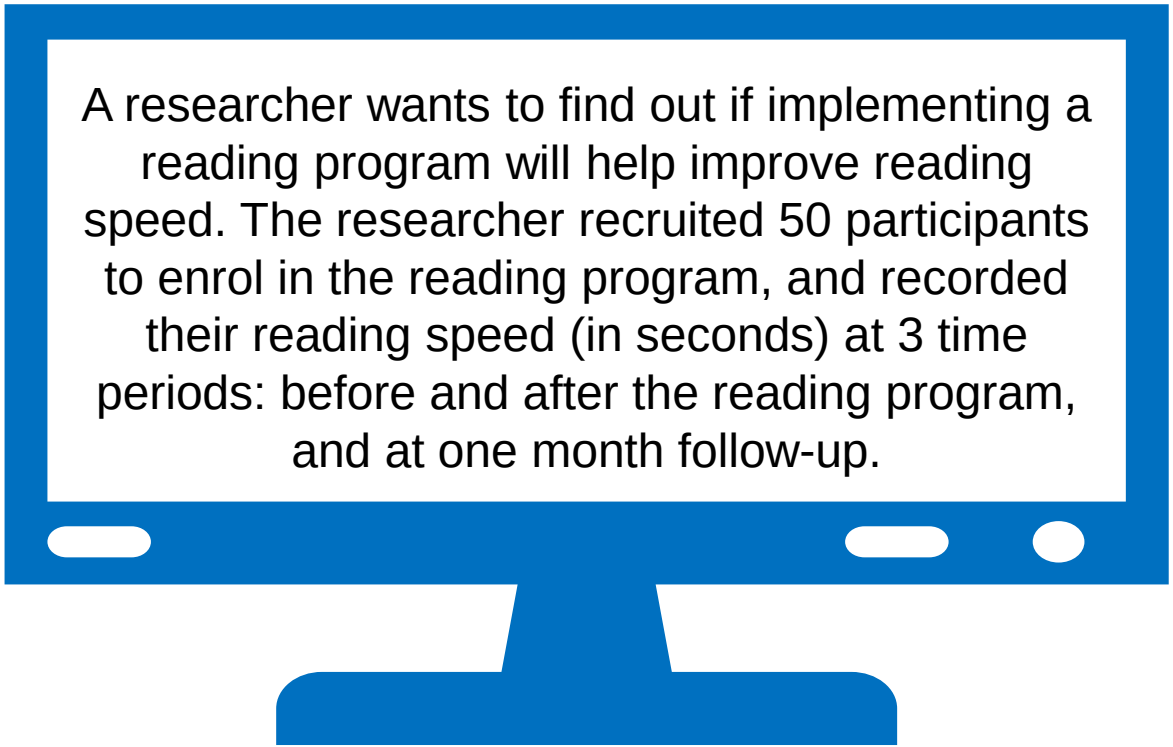
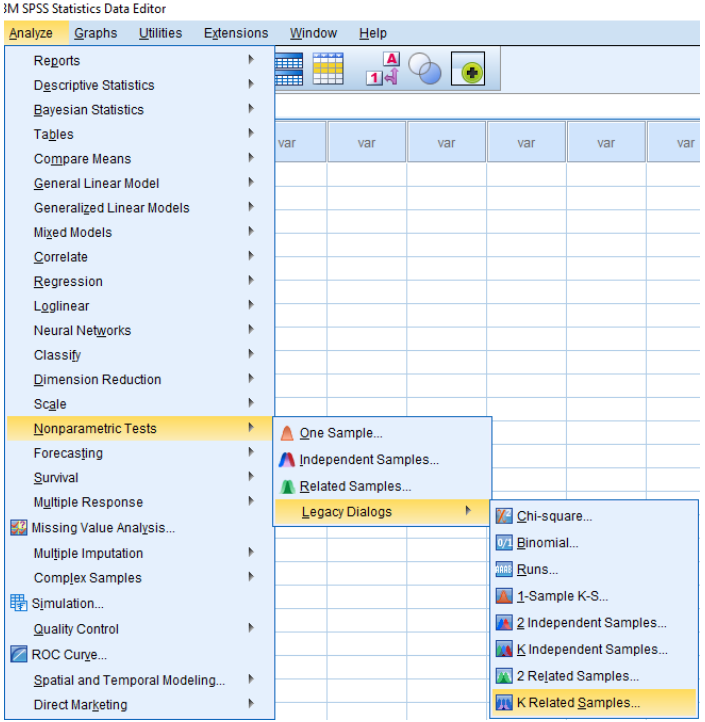
Friedman's ANOVA



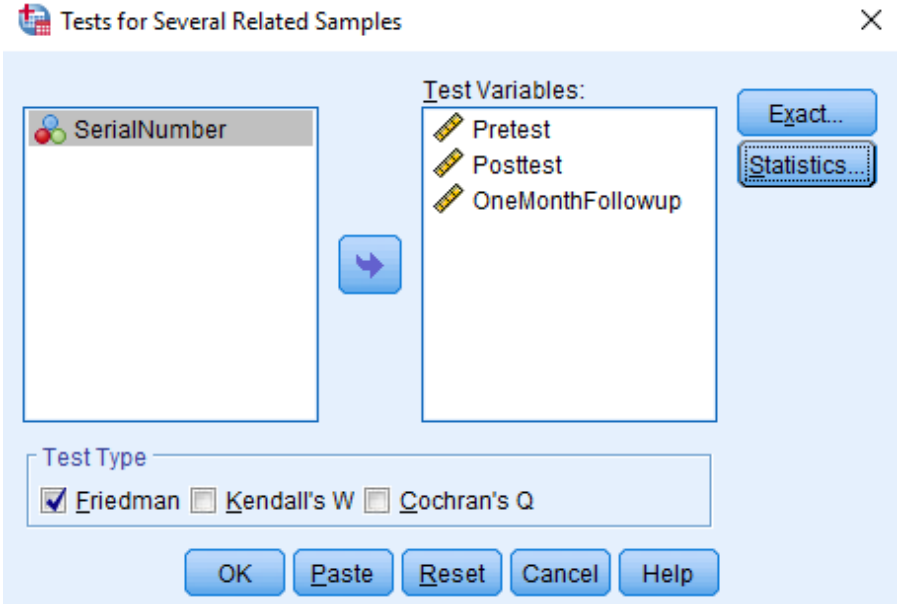
Friedman's ANOVA - SPSS

Assume that the data did not meet the criteria of parametric tests, thus the researcher opted to conduct a Friedman's ANOVA.

Analyze -> Nonparametrics Tests -> Legacy Dialogs -> K Related Samples….



Friedman's ANOVA - SPSS



1. Move *Pretest*, *Posttest*, and *OneMonthFollowup* inot the test variables box
2. Tick Friedman in Test type
3. Go to **Statistics** and select Descriptives
4. OK!

Friedman's ANOVA - SPSS

Friedman Test

Ranks

	Mean Rank
Pretest	2.90
Posttest	1.60
OneMonthFollowup	1.50

Test Statistics[a]

N	10
Chi-Square	12.200
df	2
Asymp. Sig.	.002

a. Friedman Test

Chi-square statistic = 12.2, *p* = .002

Given an alpha value of .05, there is a significant difference between pre-test, postttest, and the one month follow up

However

- Just like the Kruskal-Wallis test, although we now know that there is a significant difference between the three groups, we do not know exactly where the difference(s) lie
- Simply by eyeballing the mean ranks, we can probably guess that the difference comes from the improvement from pre-test to post-test (2.9 vs 1.6), but not so much from the post-test to one month follow-up (1.6 vs 1.5)
- To confirm this, we can conduct a series of post-hoc Wilcoxon Signed Ranks tests (you can find out more in the earlier example on Wilcoxon)

Write-Up

An example write-up can be found on page 305 in

Allen, P., Bennett, K., & Heritage, B. (2019). *SPSS Statistics: A Practical Guide* (4th ed.). Cengage Learning.

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Questions?

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