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Non-Parametric Tests in SPSS (between subjects)

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Introduction

- Non-parametric tests are based on ranks rather than raw scores:
  - SPSS converts the raw data into rankings before comparing groups (ordinal level)
- These tests are advised when
  - scores on the DV are ordinal
  - when scores are interval, but ANOVA is not robust enough to deal with the existing deviations from assumptions for the DV distribution (check "assumptions of ANOVA")
- If the underlying data meet the assumptions of parametricity, use parametric tests – they have more power

Introduction

- These are sometimes referred to as "distribution free" tests, because they do not make assumptions about the normality or variance of the data

- If you have decided to use a non-parametric test then the most appropriate measure of central tendency will probably be the median

Limitations of non-parametric methods

- Converting ratio level data to ordinal ranked data entails a loss of information
- This reduces the sensitivity of the non-parametric test compared to the parametric alternative in most circumstances
  - sensitivity is the power to reject the null hypothesis, given that it is false in the population
  - lower sensitivity gives a higher type 2 error rate
- Many parametric tests have no non-parametric equivalent
  - e.g. Two way ANOVA, where two IV's and their interaction are considered simultaneously

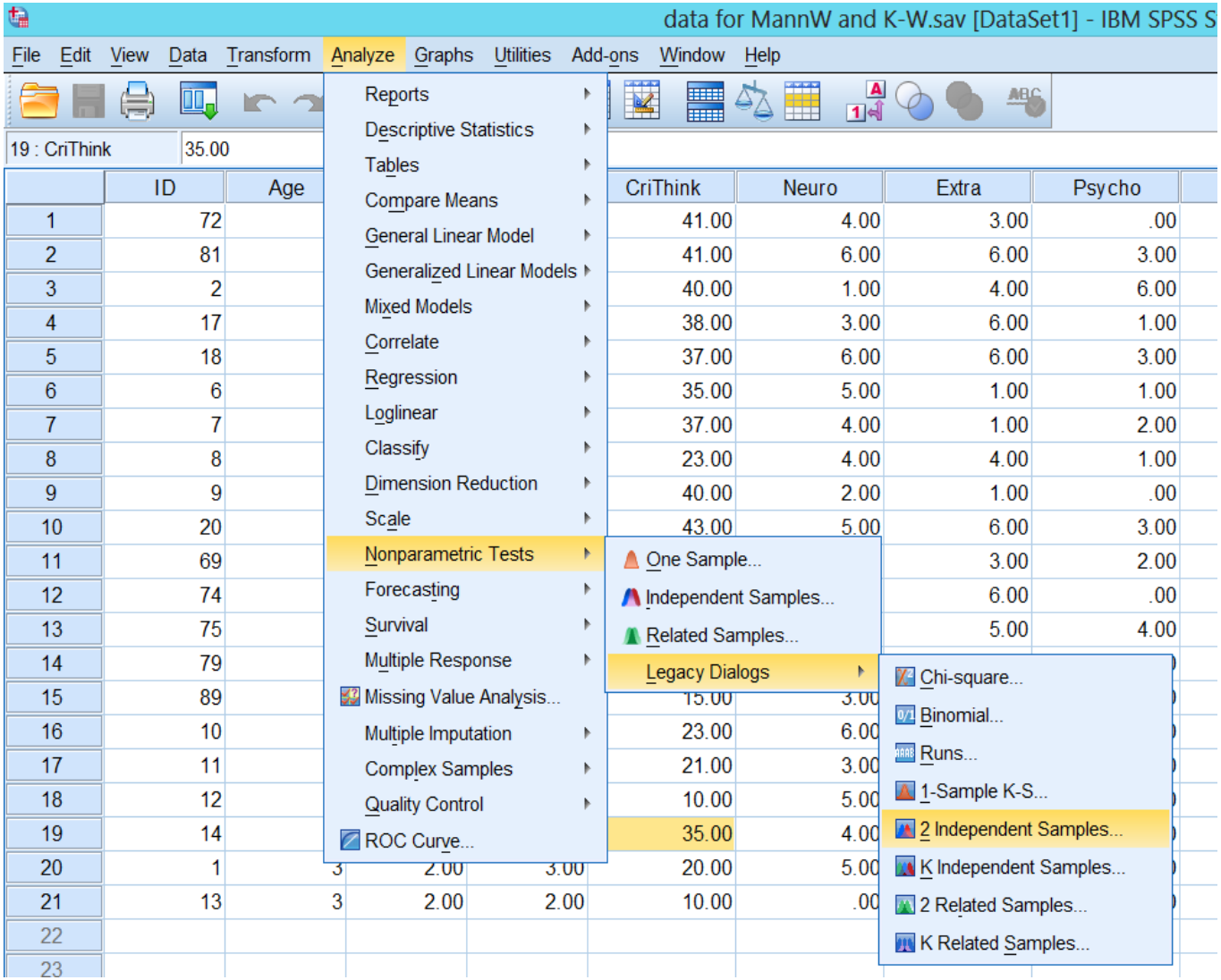
Mann-Whitney U

- Design: Non-parametric
  - 1 continuous DV (criminal thinking)
  - 2 comparison groups (IV) - different participants in each group (violent and non-violent offenders)

- Purpose: To determine if there is a significant difference in level of criminal thinking between violent and non-violent offenders

SPSS Procedure

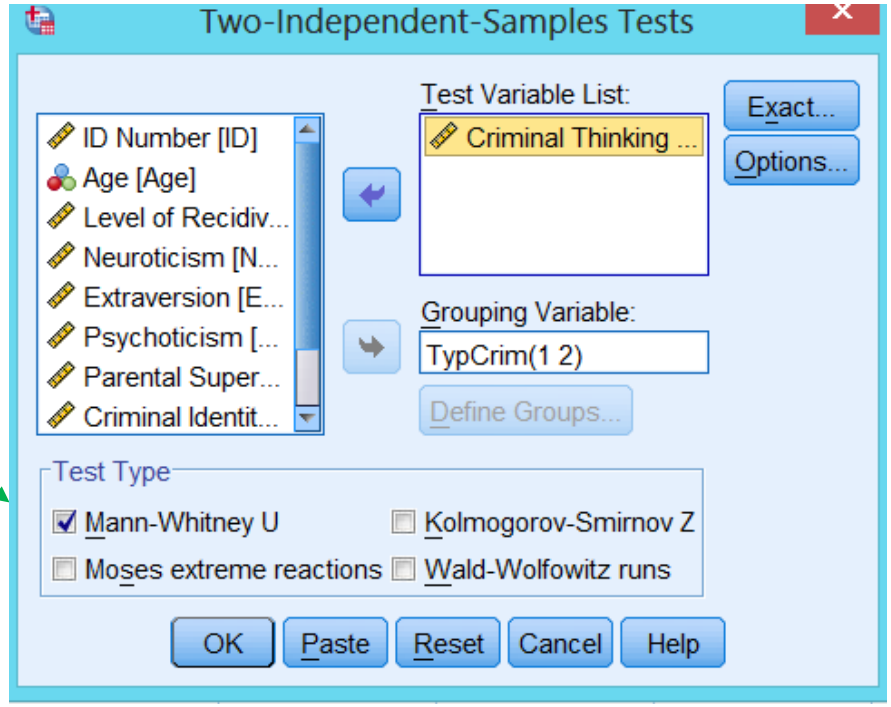
- Click **Analyze**
- **Nonparametric Tests**
- **Legacy Dialogs**
- **2 Independent Samples**



SPSS Procedure

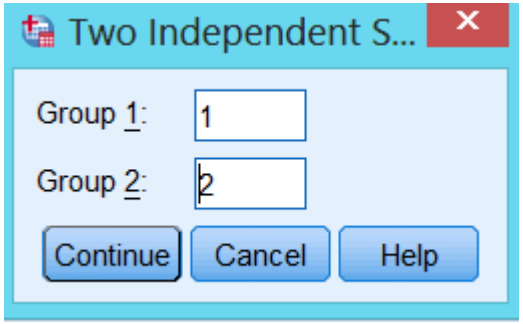
- Move the DV "Criminal Thinking" to the **Test Variable List**: box and the IV "TypCrim" to the **Grouping Variable:** box by using the SPSS right arrow button

Make sure that the Mann-Whitney U checkbox is ticked



SPSS Procedure

- Click on the **Define Groups** button
- Enter **1** into the **Group 1:** box and enter **2** into the **Group 2:** box.
- **Remember** that we labelled the non-violent group as 1 and the violent group as 2
- Click **Continue**

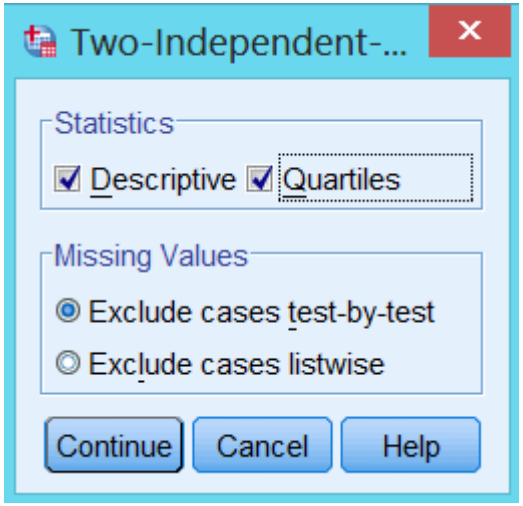


SPSS Procedure

- Click on the **Options** button and then tick **Descriptive** and **Quartiles** within the Statistics area

- Click **Continue**

- Then click **OK** button, which will get SPSS to generate the output for the Mann-Whitney U Test



SPSS Output

- Descriptive statistics

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
						25th	50th (Median)	75th
Criminal Thinking	21	28.8571	11.05118	10.00	43.00	20.5000	31.0000	39.0000
Type of Criminals	21	1.5238	.51177	1.00	2.00	1.0000	2.0000	2.0000

SPSS Output

- The **U-value** is calculated using a formula that compares the summed ranks of the two groups and takes into account sample size

Ranks

	Type of Criminals	N	Mean Rank	Sum of Ranks
Criminal Thinking	NonV	10	16.00	160.00
	Violant	11	6.45	71.00
	Total	21		

a

	Criminal Thinking
Mann-Whitney U	5.000
Wilcoxon W	71.000
Z	-3.529
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	b

Grouping Variable: Type of Criminals

Not corrected for ties.

Mann-Whitney U value should be reported

You should generally report the asymptotic *p* value

To calculate this SPSS converts the value of U to a Z score

The Z score is converted to a *p* value in the same way as for the Z test

Effect Size

- Must be calculated manually, using the following formula:

$$r = \frac{Z}{\sqrt{N}}$$

$$r = \frac{-3.529}{\sqrt{21}}$$

Use Cohen's effect size estimates to interpret the meaning of the r score

***r* = -.77 (large effect)**

Reporting Mann-Whitney U

- As the data was skewed the most appropriate statistical test was Mann-Whitney U. Descriptive statistics showed that non-violent offenders (median = 39.00; mean rank = 16.00) scored higher on criminal thinking than violent offenders (median = 21.00; mean rank = 6.45). Mann-Whitney U-value was found to be statistically significant $U = 5.00$ ($Z = -3.53$), $p < 0.01$, and the difference between the violent and non-violent groups was large ($r = -.77$)

Kruskal-Wallis H

- The Kruskal-Wallis test is the nonparametric test equivalent to the one-way ANOVA, and an extension of the Mann-Whitney U test
  - it allows the comparison of more than two independent groups

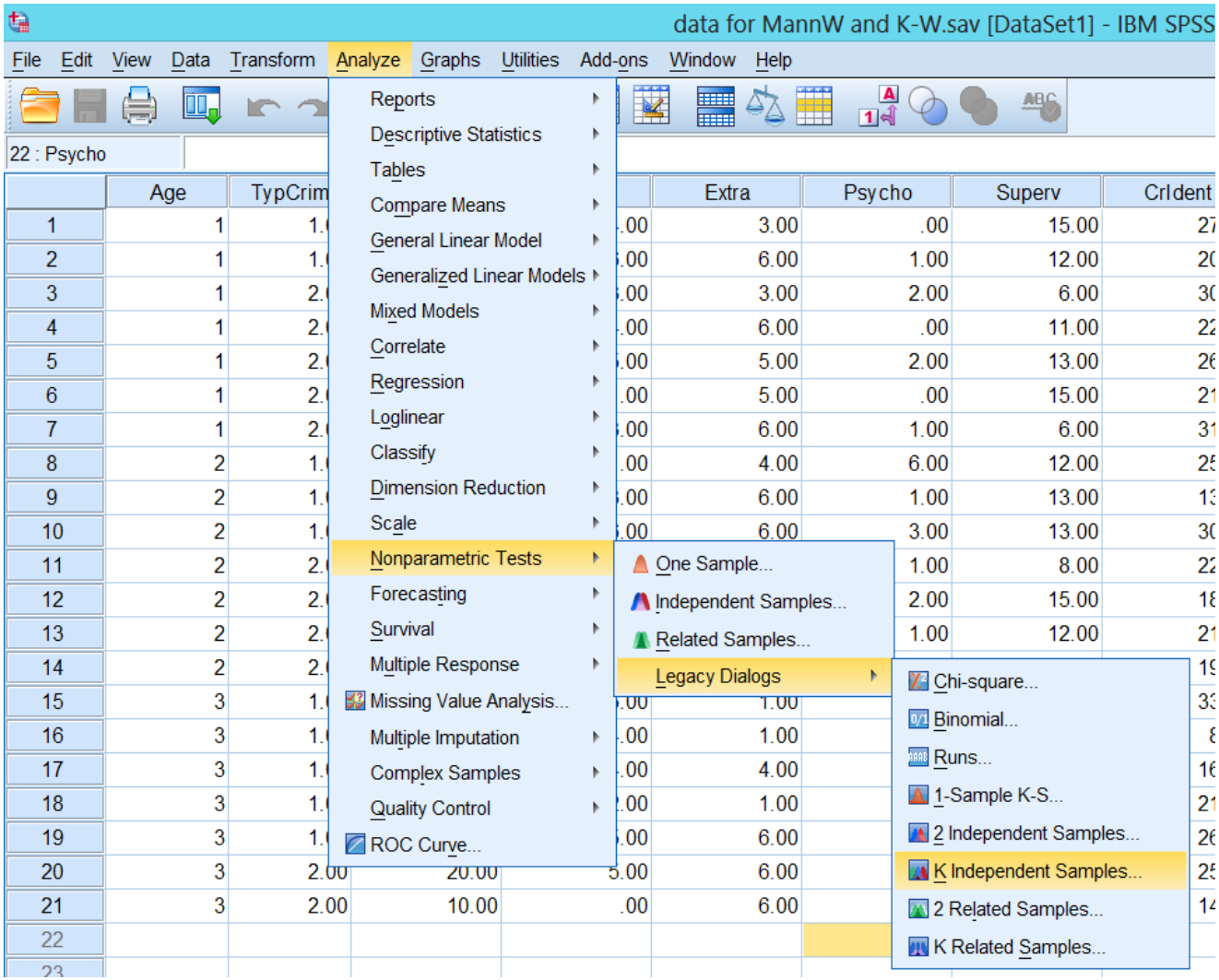
Kruskal-Wallis H

- Design: Non-parametric,
  - 1 continuous DV (psychoticism)
  - 2 or more comparison groups (3 age groups) different participants in each group

- Purpose: To determine if there is an overall effect of prisoners' age on level of psychoticism (i.e., if at least 2 groups are different from each other) while controlling for experiment-wise inflation of Type I error

SPSS Procedure

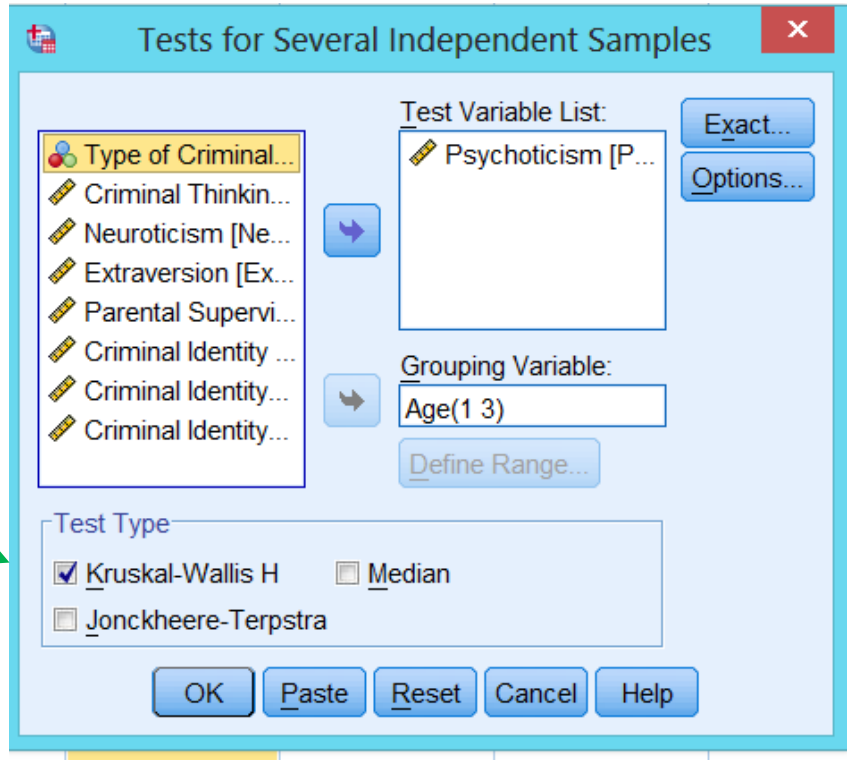
- Click **Analyze**
- **Nonparametric Tests**
- **Legacy Dialogs**
- **K Independent Samples**



SPSS Procedure

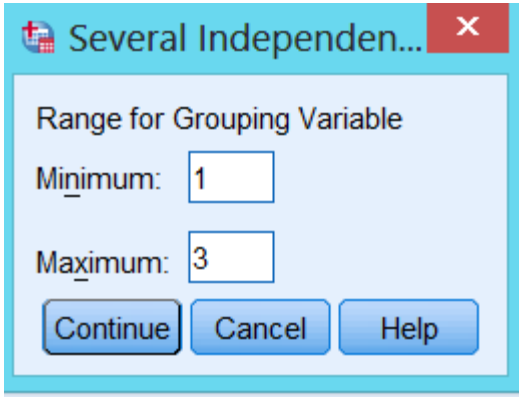
- Move the DV "Psychoticism" to the **Test Variable List**: box and the IV "Age" to the **Grouping Variable:** box by using the SPSS Right Arrow button

Make sure that the Kruskal-Wallis H checkbox is ticked



SPSS Procedure

- Click on the **Define Groups** button
- Enter **1** into the **Minimum:** box and enter **3** into the **Maximum:** box.
- **Remember** that we labelled the young offenders as 1; middle-age offenders as 2; and older offenders as 3
- Click **Continue**

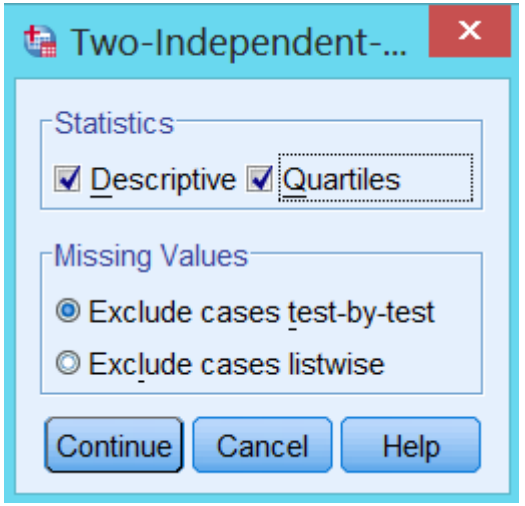


SPSS Procedure

- Click on the **Options** button and then tick **Descriptive** and **Quartiles** within the Statistics area

- Click **Continue**

- Then click **OK** button, which will get SPSS to generate the output for the test



SPSS Output

- Descriptive statistics

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
						25th	50th (Median)	75th
Psychoticism	21	2.6667	2.17562	.00	6.00	1.0000	2.0000	4.5000
Age	21	2.00	.837	1	3	1.00	2.00	3.00

SPSS Output

- The value is calculated using a formula that compares the summed ranks of the 3 groups and takes into account sample size

Ranks

	Age	N	Mean Rank
Psychoticism	18 - 25	7	5.86
	26 - 35	7	9.93
	36 and more	7	17.21
	Total	21	

a,b

	Psychoticism
Chi-Square	12.502
df	2
Asymp. Sig.	.002

Kruskal Wallis Test

Grouping Variable: Age

χ^2 value should be reported with degree of freedom

You should generally report the asymptotic *p* value

Following-up a Significant K-W Result

- If overall K-W test is significant, conduct a **series of Mann-Whitney** tests to compare the groups (to investigate which groups significantly differ) but with corrections to control for inflation of type I error
- No option for this in SPSS, so manually conduct a **Bonferroni correction** (α = .05 / number of comparisons) and use the corrected α -value to interpret the results
  - This example .05/3 = .016

Effect size

- SPSS has no options to calculate effect-size, so it must be done manually
- Kruskal-Wallis test gives you a chi-squared. However, its degree of freedom is more than 1, and thus it is not straightforward to convert the chi-squared into the effect size.
- Thus, we calculate the effect size for the post-hoc comparison (check Mann-Whitney U procedure)

Reporting Kruskal-Wallis

- In our example, we can report that there was a statistically significant difference between age groups on levels of psychoticism ($H(2) = 12.50$, $p = 0.002$) or ($\chi^2 (2) = 12.50$, $p = 0.002$) with a mean rank of 5.86 (median = 27) for young offenders, 9.93 (median = 35) for middle-age offenders and 17.21 (median = 27) for older offenders.
- Also report the post-hoc tests with effect size (see lecture on Mann-Whitney U)