



The following resources are associated:

One Way ANOVA quick reference worksheet and Mann-Whitney U Test worksheet

Kruskal-Wallis Test in SPSS (Non-parametric equivalent to ANOVA)

Research question type: Differences between several groups of measurements

Dependent variable: Continuous (scale) but not normally distributed or ordinal

Independent variable: Categorical (Nominal)

Common Applications: Comparing the mean rank of three or more different groups in scientific or medical experiments when the dependent variable ordinal or is not normally distributed.

Descriptive statistics: Median for each group and box-plot

Example: Alcohol, coffee and reaction times

Reaction time		
Water	Coffee	Alcohol
0.37	0.98	1.69
0.38	1.11	1.71
0.61	1.27	1.75
0.78	1.32	1.83
0.83	1.44	1.97
0.86	1.45	2.53
0.9	1.46	2.66
0.95	1.76	2.91
1.63	2.56	3.28
1.97	3.07	3.47

An experiment was carried out to see if alcohol or coffee affects driving reaction times. There were three different groups of participants; 10 drinking water, 10 drinking beer containing two units of alcohol and 10 drinking coffee. Reaction time on a driving simulation was measured for each participant.

The sample sizes are small and normality checks showed that the assumption of normality had not been met so an ANOVA is not suitable for comparing the groups. The Kruskal- Wallis test is the non-parametric equivalent to one-way ANOVA.

The median scores show that reaction time after coffee and alcohol is higher than for those drinking just water.

	Group		
	Water	Coffee	2 units of alcohol
	Median	Median	Median
Reaction_time	.85	1.45	2.25

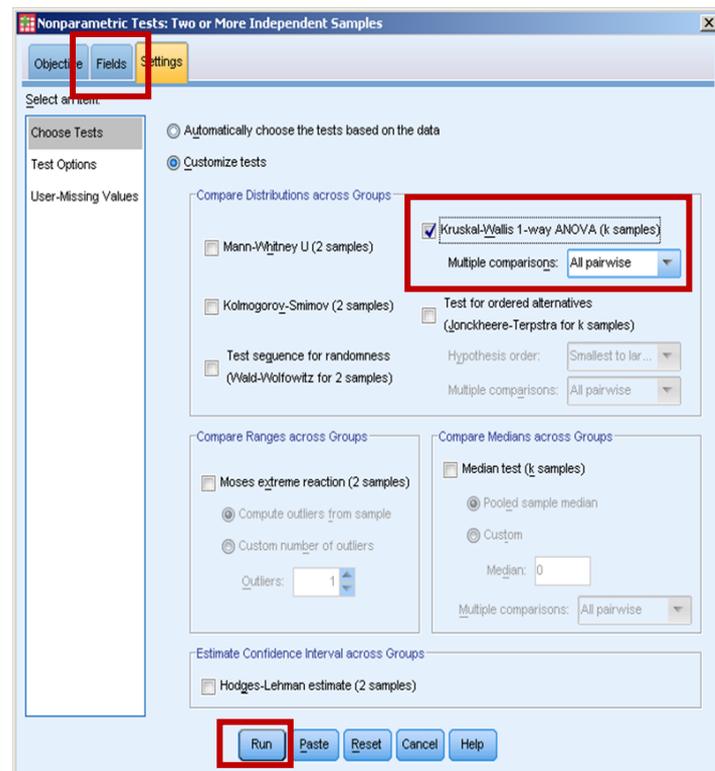
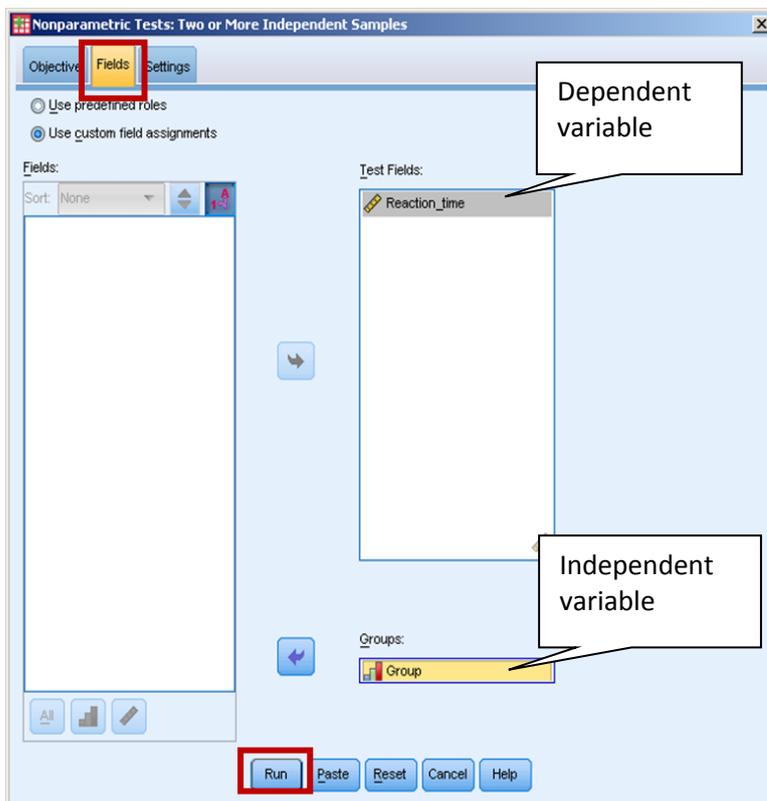
The Kruskal-Wallis test ranks the scores for the whole sample and then compares the mean rank for each group.

Carrying out the Kruskal-Wallis test

Select: *Analyze* → *Nonparametric Tests* → *Independent samples*

In the *Fields* tab, move the dependent variable to the 'Test Field' box and the grouping factor to the 'Groups' box.

Note: Even if your dependent variable is ordinal, it needs to be classified as 'Scale' in SPSS for this procedure to run. In the *Settings* tab choose to customise the tests and then select the Kruskal-Wallis test. Leave the multiple comparisons as 'All pairwise' and 'Run'.



Results

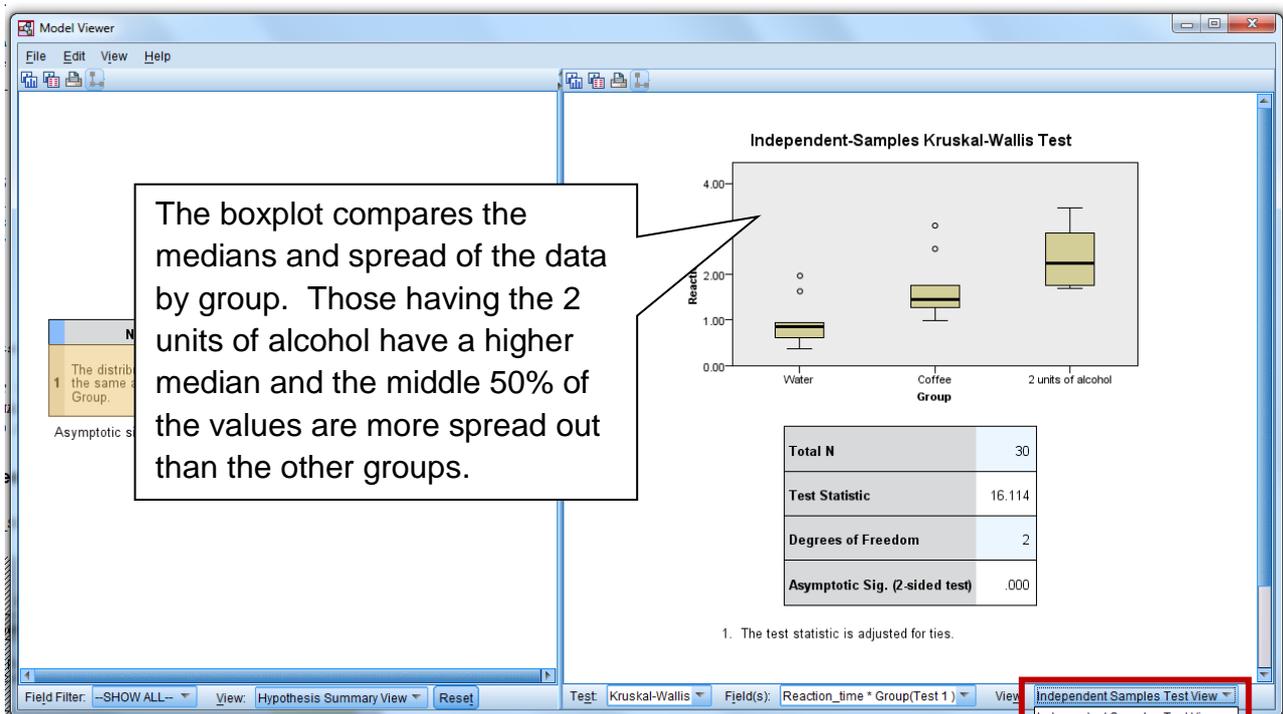
This 'Hypothesis Test Summary' box is given for the for the Kruskal-Wallis test.

As $p < 0.001$, there is very strong evidence to suggest a difference between at least one pair of groups, but which pair(s)?

Hypothesis Test Summary			p-value
Null Hypothesis	Test	Sig.	Decision
1 The distribution of Reaction_time the same across categories of Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

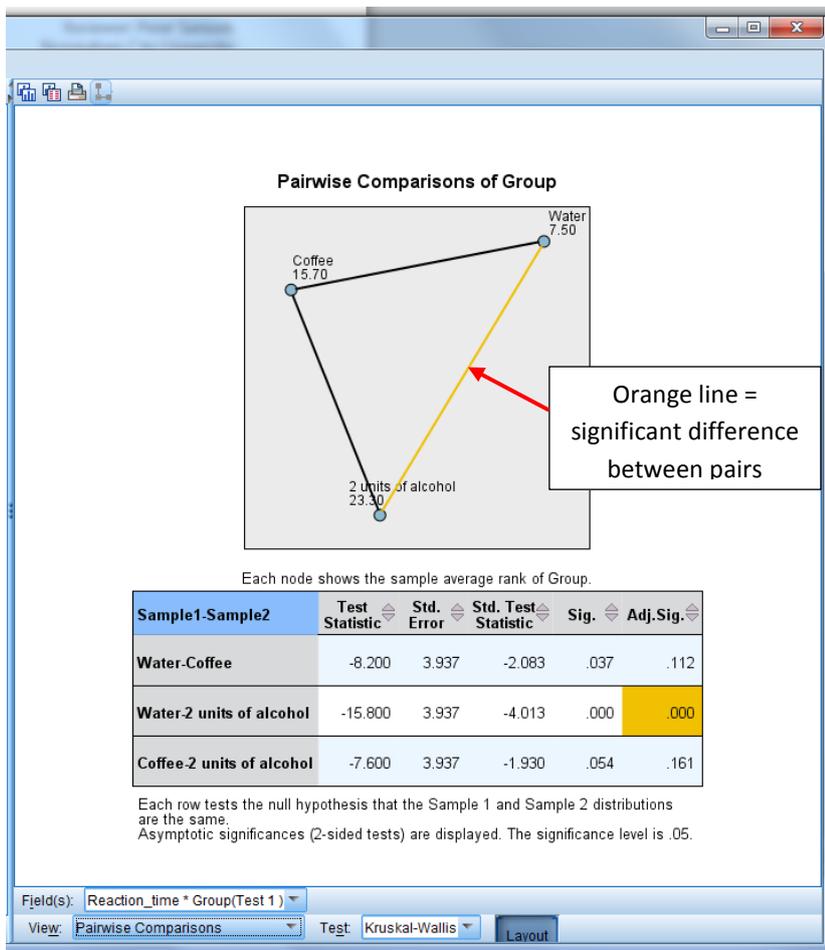
To find out, double click on the Hypothesis Test Summary box to open the **Model Viewer** screen below. Change the 'Independent Samples Test View' to 'Pairwise comparisons' in the bottom right corner.



Select 'Pairwise comparisons' from the 'View' options

Dunn's post hoc tests are carried out on each pair of groups. As multiple tests are being carried out, SPSS makes an adjustment to the p-value. The Bonferroni adjustment is to multiply each Dunn's p-value by the total number of tests being carried out.

The pairwise comparisons page below shows the results of the Dunn-Bonferroni tests on each pair of groups.



The Adj. Sig column makes the adjustments for multiple testing (using the Bonferroni error correction). Only the p-value for the test comparing the water and alcohol groups is significant ($p < 0.001$).

Significant differences are also highlighted using an orange line to join the two different groups in the diagram which shows the mean rank for each group.

Alternatively, if you wish to carry out pairwise Mann-Whitney U tests (usually slightly less conservative) instead of the Dunn-Bonferroni test you can do so using the nonparametric tests legacy dialog. You should then adjust the results by

multiplying the p-value (Sig. Value) by the number of pairs being tested.

Reporting the results

A Kruskal-Wallis test provided very strong evidence of a difference ($p < 0.001$) between the mean ranks of at least one pair of groups. Dunn's pairwise tests were carried out for the three pairs of groups. There was very strong evidence ($p < 0.001$, adjusted using the Bonferroni correction) of a difference between the group who had the water and those who had the beer with two units of alcohol. The median reaction time for the group having water was 0.85 seconds compared to 2.25 seconds in the group consuming two units of alcohol. There was no evidence of a difference between the other pairs.

References

Field, A. (2013) *Discovering Statistics using SPSS: (And sex and drugs and rock 'n' roll)*. 4th edn. London: SAGE.

IBM developerWorks (2015) *Bonferroni with Mann-Whitney?*

<https://www.ibm.com/developerworks/community/forums/html/topic?id=51942182-1ad0-4f26-9a49-56849775ac4f>.