Online Resource

# Chapter 7: Statistical tests for one independent variable

## Post hoc testing

One of the (many) frailties of null hypothesis testing is that the more of it you do, the more likely you are to make an error. If you run half a dozen separate tests, the chances of making a Type I error somewhere amongst them are uncomfortably high (26%). So, when doing null hypothesis testing, it is important to be economical with tests.

In the case of a categorical IV with 6 different categories and an interval DV, in theory we can do 6\*5 = 30 different t-tests between the categories. If we did that, we would have a 79% chance of making a Type I error. So, we mustn’t. But imagine that we had 6 categories because we were genuinely interested in all 6. It would seem that we are caught between two different issues. This is why the 1-way ANOVA exists.

A 1-way ANOVA tests the general proposition that the mean is the same for all 6 groups (or whatever number we have in mind). If we get a significant result, then we can say that one or more of the 6 groups are different from the others. Given that crucial piece of information, we can now proceed to do post hoc pairwise tests to track down where the difference lies. The term ‘post hoc’ means more or less ‘with hindsight’.

Since we are still doing lots of tests, albeit post hoc ones, we must still be aware that simply running of loads of pairwise t-tests could be misleading, so some care in both the analysis and the reporting of the analysis procedure is required.

Various post hoc tests exist. The most commonly used ones are these:

1. Fisher’s LSD test (Least Significant Difference). Not recommended. In this, one calculates the critical value of a t statistic that would count as just significant and then applies it to all pairwise differences between means.

2. Tukey’s HSD test (Honest Significant Difference). Better than LSD. In this, there is a degree of compensation to keep the Type I error rate at 0.05 (alpha).

3. Scheffe’s test. Probably the most commonly used. A little more conservative than Tukey’s.

Typically, instructions for post hoc testing can be found alongside instructions for running the initial matching statistical test. Our preferred option, [Laerd](https://statistics.laerd.com/), provides post hoc instructions where needed.

## Assumptions and nonparametric tests

The parametric tests (where the IV is interval) all have a final step where a test-statistic (t or F, which is t2) is used to calculate a p-value. The calculation is exactly correct only when certain conditions are fulfilled. It is reasonably and acceptably correct for a more relaxed set of conditions. The key conditions are:

1. The participants in the sample are all independent of each other. This assumption is crucial and is rarely really adhered to.

2. The scale used for the DV is continuous and the variable is Interval. This condition means that the arithmetic mean makes sense.

3. The residuals are normally distributed. This assumption is not so critical and with realistic sample sizes most samples are close to normal.

Please note that the assumption concerns the residuals, not the measured variables.

4. The variance of the residuals does not depend on the corresponding value of the IV. This is often described as equal variance in the different groups for a t-test or ANOVA. Equal variance is called Homoscedasticity.

There are circumstances where these conditions are not exactly met. However, parametric tests are robust, which means that they can still operate reasonably despite some deviation from these assumptions. The only conditions which are not safe to violate are:

1. Independence of sample.

2. Validity of the mean as a measure of central tendency. Distributions such as the Cauchy which can have infinite values are not safe – but are extremely rare.

If you wish to err on the side of safety, then the best option is to use an equivalent nonparametric test. These are tests that compare medians and/or frequencies rather than means. They are safe provided the following assumption is met:

1. Independence of sample

## APA-format resources

Typically your institution will provide access to some kind of reference manager, which can generate references in their preferred style. To learn more about the most commonly used referencing style, APA, have a look through the following resources.

<https://www.mendeley.com/guides/apa-citation-guide>

<https://www.apastyle.org/>

## SPSS walkthrough resources

This link will take you to the landing page for our favourite SPSS walkthrough website, Laerd. You can pay to access their extended explanations of statistical tests and SPSS processes, or use their basic free pages.

<https://statistics.laerd.com/>

We have included links to each individual test page below too for quick navigation:

Pearson’s correlation:

<https://statistics.laerd.com/spss-tutorials/pearsons-product-moment-correlation-using-spss-statistics.php>

Independent samples t-test:

<https://statistics.laerd.com/spss-tutorials/independent-t-test-using-spss-statistics.php>

Paired samples (dependent) t-test:

<https://statistics.laerd.com/spss-tutorials/dependent-t-test-using-spss-statistics.php>

One-way ANOVA:

<https://statistics.laerd.com/spss-tutorials/one-way-anova-using-spss-statistics.php>

Logistic regression:

<https://statistics.laerd.com/spss-tutorials/binomial-logistic-regression-using-spss-statistics.php>

Chi-square test:

<https://statistics.laerd.com/spss-tutorials/chi-square-test-for-association-using-spss-statistics.php>

## Extra activity

Match each pair of variables to the correct test: choose from the multiple choice answers.

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| --- | --- | --- |
| **Variable pair**  | **Correct answer** | **Alternative answers** |
| Two-group Categorical IV, Interval DV | t-test | One-way ANOVAPearson’s correlation |
| Five-group Categorical IV (between groups), Interval DV | One-way ANOVA | Pearson’s correlationChi-square test |
| Three-group Categorical IV (within groups), Interval DV | One-way repeated measures ANOVA | One-way ANOVALogistic regression |
| Interval IV, two-group Categorical DV | Logistic regression | Chi-square testPearson’s correlation |
| Three-group Categorical IV, four-group Categorical DV | Chi-square test | Logistic regressionOne-way repeated-measures ANOVA |
| Interval IV, Interval DV | Pearson’s correlation | t-testChi-square test |
| Ordinal IV, Ordinal DV | Nonparametric tests | One-way ANOVAChi-square test |