2.4 Post Hoc Tests

If we are able to reject the null hypothesis in the ANOVA F test, it tells us not all group means are equal. In other words, there are some differences among group means. But we don't know where the difference is. This is where post hoc tests come in.

A post hoc test is used only after we find a statistically significant result and need to determine where our differences truly came from. The term “post hoc” comes from the Latin for “after the event”. There are many different post hoc tests that have been developed, and most of them will give us similar answers. We will only focus here on the most commonly used ones. We will also only discuss the concepts behind each and will not worry about calculations.

Bonferroni Test

A Bonferroni test is perhaps the simplest post hoc analysis. A Bonferroni test is a series of *t*-tests performed on each pair of groups. As we discussed earlier, the number of groups quickly grows the number of comparisons, which inflates Type I error rates. To avoid this, a Bonferroni test divides our significance level α by the number of comparisons we are making so that when they are all run, they sum back up to our original Type I error rate. Once we have our new significance level, we simply run independent samples *t*-tests to look for difference between our pairs of groups. This adjustment is sometimes called a Bonferroni Correction, and it is easy to do with statistical program as we compare obtained *p*-values to our the α level.

Tukey’s Honest Significant Difference

Tukey’s Honest Significant Difference (HSD) is a very popular post hoc analysis. This analysis, like Bonferroni’s, makes adjustments based on the number of comparisons, but it makes adjustments to the test statistic when running the comparisons of two groups. These comparisons give us an estimate of the difference between the groups and a confidence interval for the estimate. We use this confidence interval in the same way that we use a confidence interval for a regular independent samples t-test: if it contains 0.00, the groups are not different, but if it does not contain 0.00 then the groups are different.

Games-Howell Post Hoc Tests

Bonferroni and Tukey HSD post hoc tests can be used when the assumption of homogeneity of variance can be assumed across comparison groups. However, when the assumption of homogeneity of variance is violated, Games-Howell test is the typical post hoc analysis. Like the analyses mentioned above, it makes appropriate adjustments based on the number of tests when comparing differences of each pair of means. Games-Howell tests also provide confidence interval for group mean differences and show whether each pairwise comparison is statistically significant. If the confidence interval contains 0, then the groups are similar. If it doens't contain 0, then the groups are statistically different.