Introduction

Prerequisites
Variance, Significance Testing, All Pairwise Comparisons among Means

Analysis of Variance (ANOVA) is statistical method used to compare two or more means. It may seem odd that the technique is called "Analysis of Variance" rather than "Analysis of Means." As you will see, the name is appropriate because inferences about means are made by analyzing variance.

ANOVA is used to test general rather than specific differences among means. This can be seen best by example. In the case study Smiles and Leniency, the effect of different types of smiles on the leniency showed to a person was investigated. Four different types of smiles (neutral, false, felt, miserable, on leniency) were investigated. The chapter "All Pairwise Comparisons among Means" showed how to test differences among means. The results from the Tukey hsd test are shown in Table 1.

Table 1. Six pairwise comparisons.

Comparison	$M_i - M_j$	Q	p
False - Felt	0.46	1.65	0.649
False - Miserable	0.46	1.65	0.649
False - Neutral	1.25	4.48	0.010
Felt - Miserable	0.00	0.00	1.000
Felt- Neutral	0.79	2.83	0.193
Miserable - Neutral	0.79	2.83	0.193

Notice that the only significant difference is between the False and Neutral conditions.

ANOVA tests the non-specific null hypothesis that all four populations means are equal. That is

$$\mu_{false} = \mu_{felt} = \mu_{miserable} = \mu_{neutral}.$$

This non-specific null hypothesis is sometimes called the *omnibus null hypothesis*. When the omnibus null hypothesis is rejected, the conclusion is that at least one population mean is different from at least one other mean. However, since the ANOVA does not reveal which means are different from which, it offers less specific information than the Tukey hsd. The Tukey hsd is therefore preferable to ANOVA in this situation. Some textbooks introduce the Tukey test only as a follow-up to an ANOVA. However, there is no logical or

statistical reason why you should not use the Tukey test even if you do not compute an ANOVA. If you or your instructor do not wish to take our word for this, follow this link to an excellent article on this and other issues in statistical analysis.

You might be wondering why you should learn about ANOVA when the Tukey test is better. One reason is that there are complex types of analyses that can be one with ANOVA and not with the Tukey test. A second is that ANOVA is by far the most commonly-used technique for comparing means, and it is important to understand ANOVA in order to understand research reports.