Post Hoc Comparisons

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> ### Descriptive Statistics

> by(Outcome,Factor,sd)

> mean(Outcome)

[1] 5

> tapply(Outcome, Factor, function(x) c(length(x), mean(x), sd(x)))

$`1`
[1] 4.00000 2.00000 2.44949

$`2`
[1] 4.00000 6.00000 2.44949

$`3`
[1] 4.00000 7.00000 2.44949

> ### Inferential Statistics

> TukeyHSD(Results)

  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = Outcome ~ Factor)

$Factor
    diff        lwr      upr     p adj
2-1    4 -0.8358956 8.835896 0.1055254
3-1    5  0.1641044 9.835896 0.0431300
3-2    1 -3.8358956 5.835896 0.8352889
```

These values of the group statistics are calculated separately for each group. They are not identical to the values obtained from analyzing the variable as a whole.

A grand mean can be determined by taking the weighted average of all of the group means:

$$M_{TOTAL} = \frac{\sum n(M_{GROUP})}{N} = \frac{4(2)+4(6)+4(7)}{4+4+4} = 5.000$$

The “Standard Errors” are for the difference between the two group means. The values are a function of the MS_{WITHIN} (from the ANOVA) and the sample sizes:

$$SE_{DIFF} = \sqrt{\left(\frac{MS_{WITHIN}}{n_{GROUP}}\right) + \left(\frac{MS_{WITHIN}}{n_{GROUP}}\right)} = \sqrt{\left(\frac{6}{4}\right) + \left(\frac{6}{4}\right)} = 1.732$$

In this case, because all groups are of the same size, the standard error for each comparison is the same.

An HSD value is conceptually similar to a *t* statistic in that it is a function of the “Diff” and the “SE”. For the first comparison in the example:

$$HSD = \frac{M_2 - M_1}{SE_{DIFF}} = \frac{4.000}{1.732} = 2.309$$

The “p adj” column provides the probability of the HSD statistic. An HSD of -2.309 (with 2 $df_{BETWEEN}$ and 9 df_{WITHIN} like in the ANOVA source table) has a two-tailed probability (*p*) of .106, a finding that is not statistically significant.

This section provides confidence intervals around (centered on) the Mean Differences. Calculation requires the appropriate critical value. Specifically, the HSD statistic (with 2 $df_{BETWEEN}$ and 9 df_{WITHIN}) that has a probability of .05 equals 3.068. For the first comparison in the example:

$$CI_{DIFF} = M_{DIFF} \pm (HSD_{CRITICAL})(SE_{DIFF})$$
$$CI_{DIFF} = 4.000 \pm (2.792)(1.732)$$

Thus, the estimates that the true population mean difference is somewhere between -8.836 and 0.836 (knowing that the estimate could be incorrect).