Independent Samples t Test

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> ### Descriptive Statistics

> 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

> ### Inferential Statistics

> t.test(Outcome~Factor,var.equal=T)

      Two Sample t-test

data:  Outcome by Factor
t = -2.3094, df = 6, p-value = 0.06032
alternative hypothesis: true difference in means between group 1 and group 2 is not equal to 0
95 percent confidence interval:
 -8.2381756  0.2381756
sample estimates:
mean in group 1 mean in group 2 
              2               6 
```

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

The standard errors for each condition can be calculated separately but note that both groups have the same standard deviation and sample size.:

$$SE_M = \frac{SD}{\sqrt{N}} = \frac{2.449}{\sqrt{4}} = 1.225$$

The “SE” is a function of the two groups’ individual standard errors. When sample sizes are equal:

$$SE_{DIFF} = \sqrt{SE_1^2 + SE_2^2} = \sqrt{1.225^2 + 1.225^2} = 1.732$$

This value is important for both the significance test and the confidence interval. [Importantly, the computation of the standard error of the difference is more complex for unequal sample sizes.]

The “t”, “df”, and “p” values provide the results of the statistical significance test. First, *t* provides the standardized statistic for the mean difference:

$$t = \frac{M_{DIFF}}{SE_{DIFF}} = \frac{4.000}{1.732} = 2.309$$

The *t* statistic follows a non-normal (studentized or *t*) distribution that depends on degrees of freedom. Here, *df* = N – 2 = 8 – 2 = 6. A *t* with 6 df that equals 2.309 has a two-tailed probability (*p*) of .060, a finding that is not statistically significant.

This section provides a confidence interval around (centered on) the Mean Difference. Calculation requires the appropriate critical value. Specifically, the *t* statistic (with 6 *df*) that has a probability of .05 equals 2.447. As a result:

$$CI_{DIFF} = M_{DIFF} \pm (t_{CRITICAL})(SE_{DIFF})$$
$$CI_{DIFF} = 4 \pm (2.447)(1.732)$$

Thus, the researcher estimates that the true population mean difference is somewhere between -.238 and 8.238 (knowing that the estimate could be incorrect).

The pooled (or weighted average) Std. Deviation of the groups can be determined from the group descriptive statistics:

$$SD_{WITHIN} = \sqrt{\frac{(SD_1^2)(df_1) + (SD_2^2)(df_2)}{df_1 + df_2}} = \sqrt{\frac{(2.449^2)(3) + (2.449^2)(3)}{3+3}} = 2.449$$

Cohen’s “d” provides a standardized effect size for the difference between the two means:

$$d = \frac{M_{DIFF}}{SD_{WITHIN}} = \frac{4.000}{2.449} = 1.633$$