# Paired Samples t Test

**(Note that some aspects of this output have been rearranged for the sake of presentation!)**

These descriptive statistics are calculated separately for each variable.

Descriptives

| | N | Mean | SD | SE |
|---|---|---|---|---|
| Outcome1 | 4 | 2.000 | 2.449 | 1.225 |
| Outcome2 | 4 | 6.000 | 2.449 | 1.225 |

These are the standard errors for each variable calculated separately. For the first variable:

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

Notice that the standard errors are equal because the variables have the same standard deviation.

Paired Samples T-Test

| | | t | df | p | Mean Difference | SE Difference | Cohen's d | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Lower | Upper |
| Outcome1 | - Outcome2 | -3.266 | 3 | 0.047 | -4.000 | 1.225 | -1.633 | -7.898 | -0.102 |

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

$$t = \frac{M_D}{SE_D} = \frac{-4.000}{1.225} = -3.226$$

The *t* statistic follows a non-normal (studentized or *t*) distribution that depends on degrees of freedom. Here, *df* = *N* – 1 = 4 – 1 = 3. A *t* with 3 *df* that equals -3.27 has a two-tailed probability (*p*) of .047, a statistically significant finding.

The “Mean Difference” is simply the difference between the two means listed above. However, the “SE Difference” is not determinable from the summary statistics presented here but rather the raw data.

The Std. Deviation of the differences can be determined from this information:

$$SD_D = (SE_D)(\sqrt{N})$$
$$SD_D = (1.225)(\sqrt{4}) = 2.449$$

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

$$d = \frac{M_D}{SD_D} = \frac{-4.000}{2.449}$$
$$d = -1.633$$

Given Cohen’s heuristics for interpreting effect sizes, this would be considered an extremely large effect.

This confidence interval is centered on the “Mean Difference” of the two variables. Calculation requires the appropriate critical value. Specifically, the *t* statistic (with 3 *df*) that has a probability of .05 equals 3.182. As a result:

$$CI_D = M_D \pm (t_{CRITICAL})(SE_D)$$
$$CI_D = -4.00 \pm (3.182)(1.225)$$

Thus, the researcher estimates that the true population mean difference is somewhere between -7.898 to -0.1.02 (knowing that the estimate could be incorrect).