Paired Samples t Test

```
> ### Descriptive Statistics

> lapply(PairedData, function(x) c(length(x), mean(x), sd(x)))

$Outcome1
[1] 4.00000 2.00000 2.44949

$Outcome2
[1] 4.00000 6.00000 2.44949

> ### Inferential Statistics

> t.test(Outcome2,Outcome1,paired=TRUE)

        Paired t-test

data:  Outcome2 and Outcome1
t = 3.266, df = 3, p-value = 0.04692
alternative hypothesis: true mean difference is not equal to 0
95 percent confidence interval:
 0.1023152 7.8976848
sample estimates:
mean difference
         4
```

These statistics are calculated separately for each variable.

The Mean Difference is simply the difference between the two means listed above. However, the "SE" 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:

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

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

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

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 3.226 has a two-tailed probability (p) of .047, a statistically significant finding.

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 ("Diff") 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 0.1.02 to 7.898 (knowing that the estimate could be incorrect).