Statistics Project: The Stroop Test

1. What is our independent variable? What is our dependent variable?

The independent variable is whether the font name and color are the same or different. The dependent variable is the time it takes for the participant to name the ink colors.

2. What is an appropriate set of hypotheses for this task? What kind of statistical test do you expect to perform? Justify your choices.

Participants will take more time to say color of the word in the stroop test when the color of the word and the word itself are incongruent. For example, participants will take longer to identify the color of the word RED than the word GREEN. In more precise language, I expect the difference between the congruent words and the incongruent words to be statistically significant. The reason I think this is (1) I've done the test myself and it takes more time to me to process the color of a word when the color of the word and the actual word don't align and (2) I think we've been conditioned to see words either in black ink or in the ink that matches the word itself.

I expect to perform a dependent t-test for paired samples because I've been given a sample of data that includes two data points per person (where each person is given two conditions) and we'd like to make inferences about a population based on this sample. A t-test is used to do this because we don't know the population parameters.

For our t-test, we will be using the following null and alternative hypothesis

$$H_0 : \mu_d = 0 \text{ or } \mu_c - \mu_i = 0$$
$$H_a : \mu_d \neq 0$$

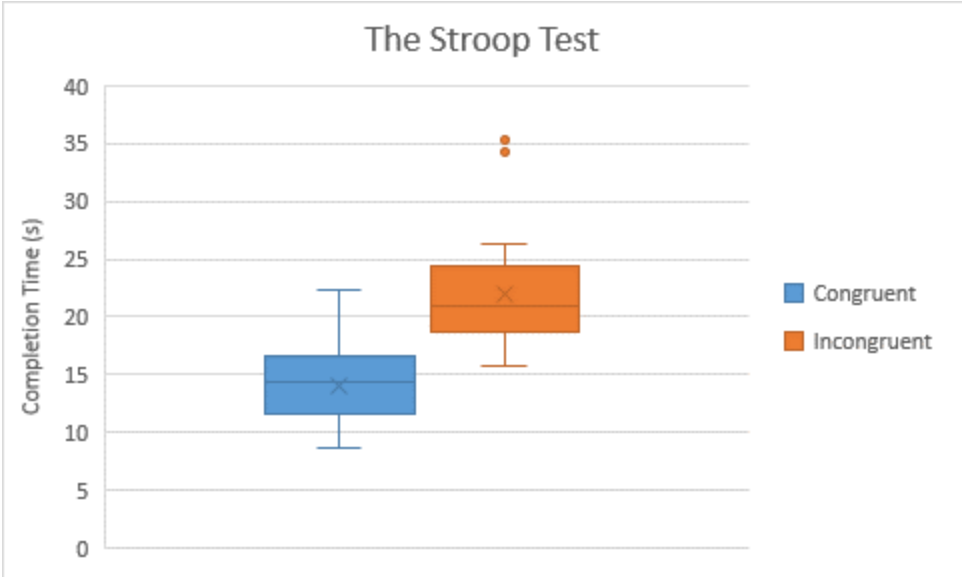
where μ_d is the difference of the means for the incongruent and congruent sections of the Stroop test. The variables μ_c and μ_i are the mean values for the congruent case and the incongruent case respectively. The null hypothesis states that the difference between the means of the congruent test and the incongruent test is nothing (which essentially means that there's no difference between the two conditions). The alternative hypothesis states that the difference between the means is likely something other than 0.

3. Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability.

	Congruent Data	Incongruent Data	Difference Data
Mean	14.05	22.02	-7.96
Median	14.35	21.02	-7.67
Standard Deviation	3.56	4.80	4.86

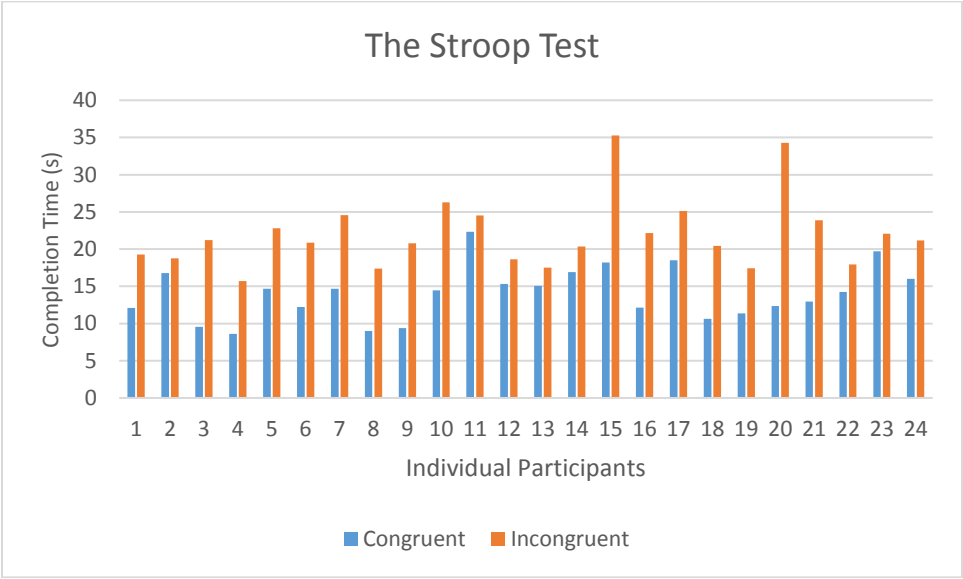
4. Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

Graph #1- Box Plot



This graph is probably the more informative graph to be made for this type of data. It readily shows the difference in the two samples. One can clearly see that the medians for each group are more than 5 seconds apart and that the middle 50% of the data for one condition doesn't overlap the middle 50% of the data for the other condition.

Graph #2 – Comparative Bar Graph



Although this graph is probably not the most informative graph, one observation to be made is in every case, the individual participant took longer when the words were incongruent than when the words were congruent. This is something you wouldn't be able to see with a box plot.

5. Now, perform the statistical test and report your results. What is your confidence level and your critical statistic value? Do you reject the null hypothesis or fail to reject it? Come to a conclusion in terms of the experiment task. Did the results match up with your expectations?

For our t-test, let's let our $\alpha = .01$. With our degrees of freedom being one less than the sample size which is 24 the t-table gives us a t-critical value of -2.492. This means that if we find a t value of less than -2.492 then the

probability that the data we've obtained occurring (assuming there's no difference in the congruent Stroop test and the incongruent Stroop test) is less than 1%. Let's calculate our t value:

$$t = \frac{mean\ difference - 0}{standard\ deviation\ of\ the\ differences/\sqrt{number\ of\ samples}}$$

$$t = \frac{-7.96 - 0}{4.86/\sqrt{24}}$$

$$t = -8.02$$

Since we've found that our t-value is less than our t-critical value then we reject the null hypothesis in favor of the alternative. This means that there is a statistically significant difference between the congruent case and the incongruent case, that is, it takes people more time to identify the colors of the ink when the ink doesn't match the word itself. This confirms what was stated above.

Additionally, we will be using a 99% confidence interval on the mean difference. Here are the calculations:

$$Confident\ interval = mean\ difference\ \pm t\left(\frac{standard\ deviation}{\sqrt{n}}\right)$$

$$Confident\ interval = -7.96\ \pm 2.807\left(\frac{4.86}{\sqrt{24}}\right)$$

This gives a confidence interval of (-10.744, -5.175). This means that we can be 99% certain the true mean lies somewhere within these numbers.