Project 1: Stroop effect

Independent variable is congruent word condition

Dependent variable is the time

We are going to test whether the mean time to read congruent words is significantly different from incongruent words or not. This means that we want to see if the mean time to read incongruent words are significantly larger than the congruent words or not.

First since we don't know about the population parameters in this task, we use t test.

Since we measure the time for congruent and incongruent words for each participant, the measurements in each pair are related and dependent because actually the same subject or participant takes the test twice, so in this case, we use paired t test for this project.

μ_I : mean time to read the incongruent words (for population)

μ_C : mean time to read the congruent words (for population)

H0: $\mu_I - \mu_c = 0$

H1: $\mu_I - \mu_c > 0$

Since we don't know about the population parameters, we use t test. This is a one-tailed T test (upper tailed t test, actually because we want to test whether the mean time to read incongruent words is significantly larger than the time to read congruent words or not)

By considering significance level of $\alpha = 0.05$, we would run the upper tailed paired t test for this project

Now it's your chance to try out the Stroop task for yourself. Go to this link, which has a Java-based applet for performing the Stroop task. Record the times that you received on the task (you do not need to submit your times to the site.) Now, download this dataset which contains results from a number of participants in the task. Each row of the dataset contains the performance for one participant, with the first number their results on the congruent task and the second number their performance on the incongruent task.

Measure of center:
Mean time for reading in congruent condition = 14.051
Mean time for reading in incongruent condition = 22.016

Median for time to read congruent words =14.256
Median for time to read incongruent words =21.017

It was obvious that the mean time for reading incongruent words should be larger than the mean time for congruent words.

Measure of variability:
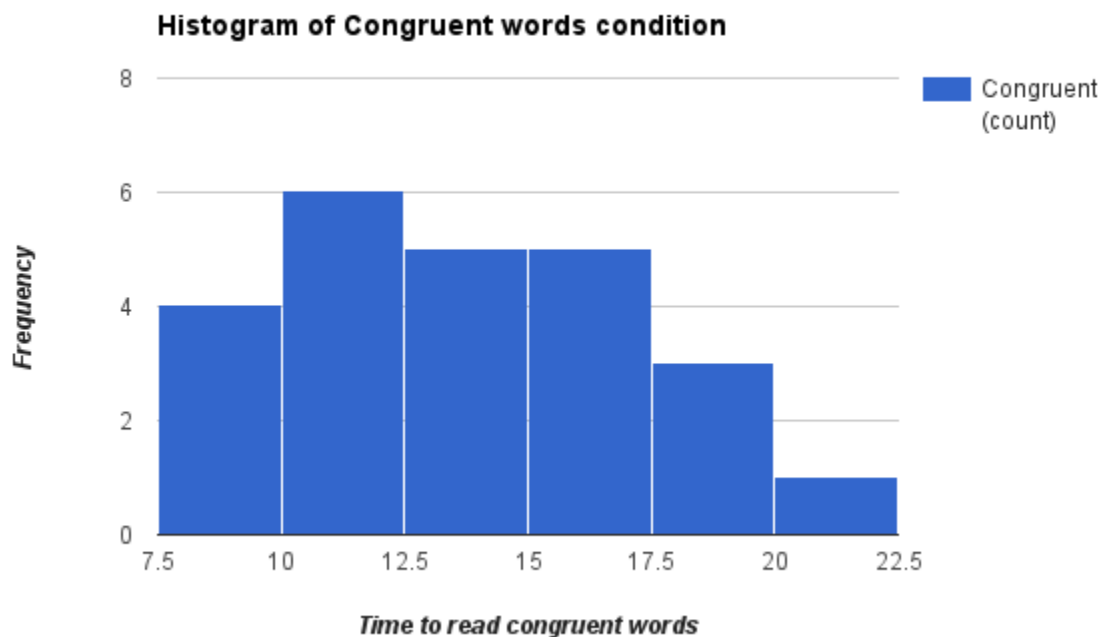Range for the dataset related to time to read congruent words=13.698
Range for the dataset related to time to read incongruent words=19.568

Standard deviation for time to read congruent words = 3.560
Standard deviation for time to read incongruent words = 4.797

The following visualizations are created in google spreadsheets.

For congruent words, we can see bell shaped histogram, but we cannot be sure about the normality. For testing the normality, normal probability plot or other tests are required. In this histogram the smallest bin contains just one item, which shows that the bin size is the smallest bin size we could have. We cannot make any conclusion about the distribution with this data, but we can say that there is no outlier in this dataset since there is no bin far from other bins.

Histogram of Incongruent words condition
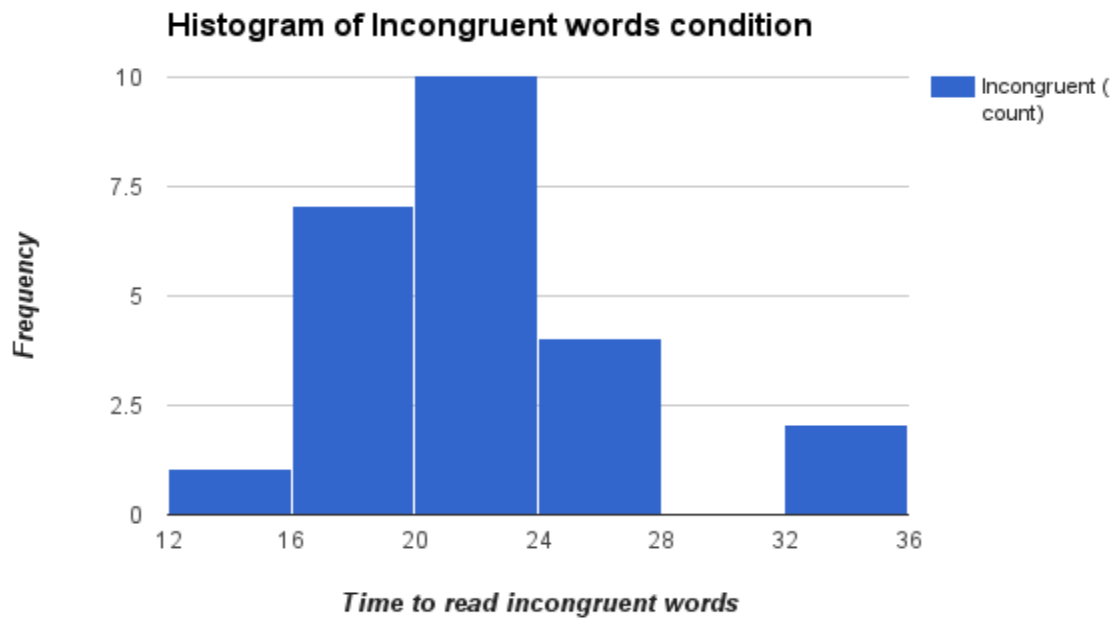
For incongruent words, we cannot see bell shaped histogram or any other special distribution so we cannot conclude any distribution from this dataset. In this histogram the smallest bin contains just one item, which shows that the bin size is the smallest bin size we could have.

Histogram of difference in time to read congruent and incongruent words
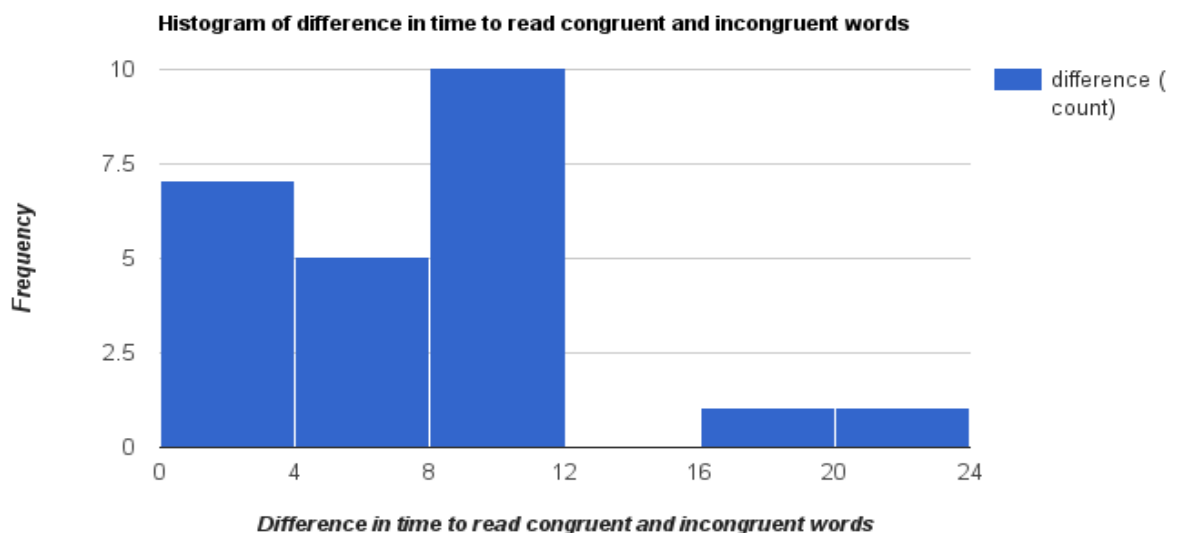
We expected the distribution of the differences be approximately normal to run the paired t test. But this histogram doesn't show normal distribution. In this case the deviations from normality are significant but not that significant that we cannot run the paired t test.
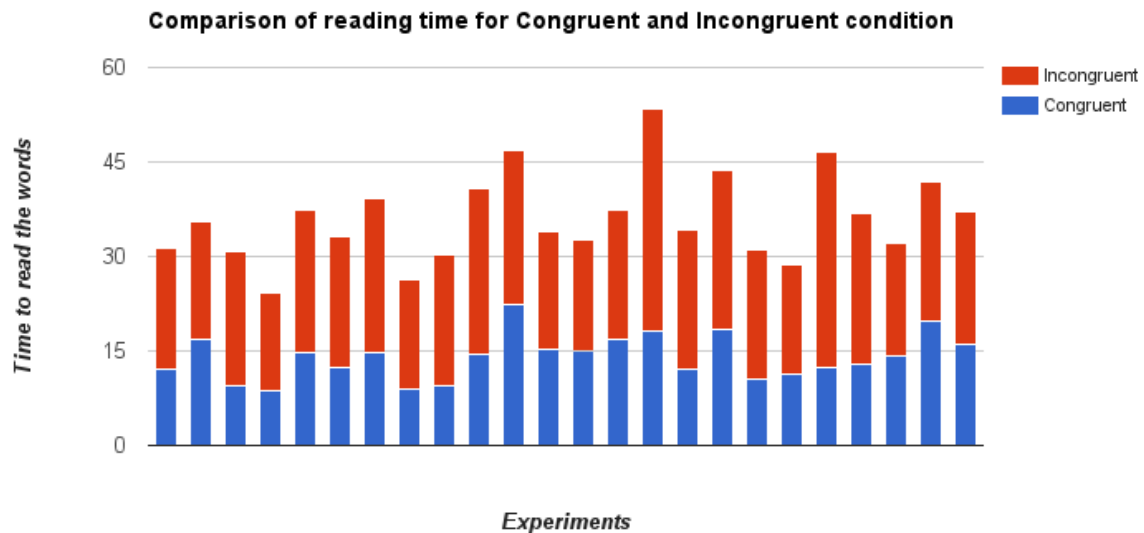
This bar chart compares the time for reading incongruent and congruent words in each pair of experiment or actually for each participant. This chart indicates that the time to read incongruent words is much larger than the time to read congruent words.

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?

Since we measure the time for congruent and incongruent words for each participant, the measurements in each pair are related and dependent because actually the same subject or participant takes the test twice, so in this case, we use paired t test for this project.

μ_I : mean time to read the incongruent words (for population)

μ_C : mean time to read the congruent words (for population)

H0: $\mu_I - \mu_c = 0$

H1: $\mu_I - \mu_c > 0$

This is a one-tailed T test (upper tailed t test)

By considering significance level of $\alpha = 0.05$, we would run the t test

Point estimate for $\mu_I - \mu_c$ is $\overline{X_D} = \overline{X_I} - \overline{X_C}$

$\overline{X_D}$ or M_D= mean of the difference in the time for reading congruent and incongruent words

= mean time to read incongruent words- mean time to read congruent words (sample)

S_D = standard deviation for the difference in the time for reading congruent and incongruent words

$\overline{X_D} = 7.965$

Standard deviation with Bessel's correction:

$S_D = 4.865$

SE(standard error)= $\frac{SD}{\sqrt{n}}$ = 0.993

T statistics: t= $\frac{\overline{X_D}}{SD/\sqrt{n}}$ = 8.021   P-value = 0.000

The critical value for one-tailed t test with degrees of freedom= n-1=23 and α = 0.05

T_{Critical} = 1.714

Pvalue is smaller than 0.05. so we reject the null hypothesis meaning that we conclude that the mean time to read incongruent words is significantly larger than the mean time to read congruent words.

Confidence interval for the difference in the mean time for reading incongruent and congruent words:

CI : [M_D − t_{Critical} *SE , M_D + t_{Critical} *SE] = [6.263 , 9.667]

Cohen's d = M_D/S_D = 1.673

Actually the results match up our expectations. We expected the mean time to read incongruent words be significantly larger than the time to read congruent words.

6. Optional: What do you think is responsible for the effects observed? Can you think of an alternative or similar task that would result in a similar effect? Some research about the problem will be helpful for thinking about these two questions!

Because the words and their colors are incongruent, it takes more time to do the test. Because the brain needs time to resolve the conflict. "The reason why it takes longer is because the brain has to suppress the wrong answer that interferes with the right answer, before the right answer comes through." .So it will take more time to do the task due to the fatigue and attention to the task[1]

References:

1. http://www.math.unt.edu/~tam/SelfTests/StroopEffects.html