The Stroop test is a widely used measure of selective attention that requires interference resolution, response inhibition, and response selection. It measures the ease with which a person can shift his/her perceptual set to changing demands, and critically, to suppress a habitual response in favour of an unusual one. This test usually has two condition one wherein the name and color of the word matches(congruent words) and the other is an intervention (incongruent words) i.e. name and color of the word does not match

The reaction time is observed to increase after interference. A sample dataset of 24 individuals related to this test with the two conditions is provided. To prove that the difference between the two sets is of statistical significance, we have to set a hypothesis and perform statistical analysis.

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

The independent and dependent variables are as follows:

Independent variable:

The Independent variable is whether the name and color of the word are similar or different.

Dependent Variable:

The Dependent variable is the time required to name the color.

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

We are given a sample dataset of 24 individuals. The dataset has two time based conditions one for the congruent words and other for the incongruent words for same individual. We have to analyse whether the time required to name color in one condition with reference to other is statistically significant or not.

So here the null hypothesis will state that there is no statistical difference between the congruent word mean ($\bar{x}_c$) and incongruent word mean($\bar{x}_{ic}$)

Ho : $\overline{x_c} = \overline{x_{ic}}$

Whereas the alternative hypothesis will state $\bar{x}_c$ less than $\bar{x}_{ic}$ since the stroop effect states that on an average the time required to name the color after the intervention is increased

Ha : $\overline{x_c} < \overline{x_{ic}}$

Statistical hypothesis can be tested using dependent, paired t-test since we have only sample data and not population data, also same participant undergoes both the conditions.
So as per alternative hypothesis the test will be one tailed test at significance (alpha/α) level of 0.05 in the positive direction as the time required is supposed to increase after intervention

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

Descriptive statistics for this test includes central tendency and variability.
Central Tendency:
Central tendency for the given dataset can be measured in terms of mean.
Mean is summation of all the measures divided by total no of sample.
I.e. $\bar{x} = (\Sigma x_n)/n$

Mean for congruent words = $\overline{x_c} = (\Sigma x_i)/n$ **= 14.05s**

Mean for incongruent words = $\overline{x_{ic}} = (\Sigma x_i)/n$ **= 22.02s**

Variability:
Variability can be measured in terms of Variance and Standard deviation
Variance of a data set gives you a rough idea of how spread out your data is. It is average squared deviation
For congruent words:

$$Variance_c = \Sigma(x_i - \overline{x_{ic}})^2 / (n-1) = \mathbf{12.67}$$

For incongruent words:

$$Variance_{ic} = \Sigma(x_i - \overline{x_{ic}})^2 / (n-1) = \mathbf{23.01}$$

Since this a sample from whole population, variability in the sample is less than the variability of entire population. Hence we use Bessel's correction to correct this gap by using **n-1** instead of n

Standard deviation is another test for variability, it gives you a rough idea of how spread out your data is. It is the square root of variance:

Standard Deviation (σ) = $\sqrt{Variance}$

So for congruent words:

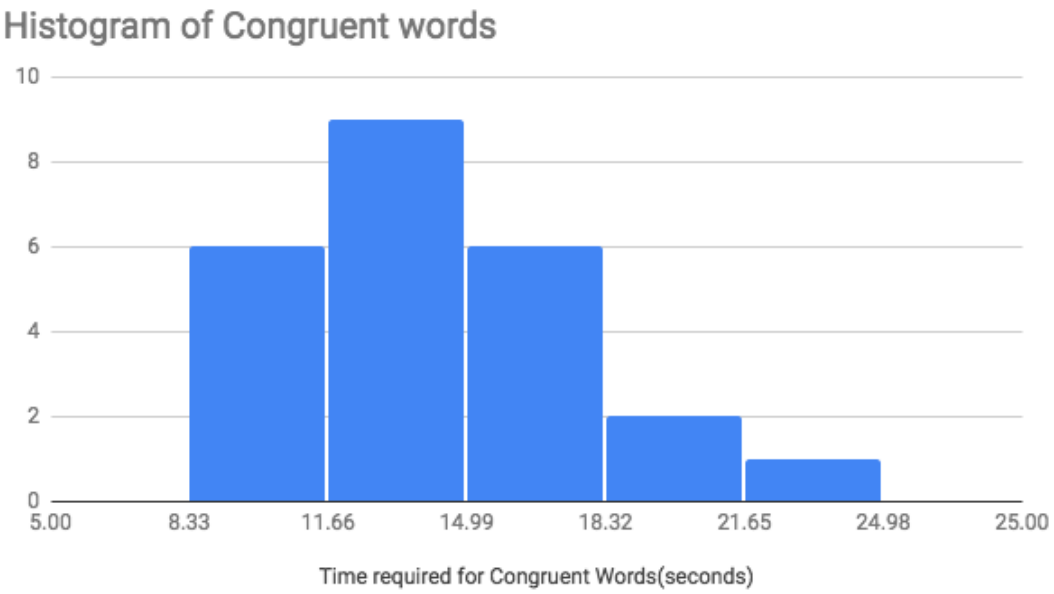
SD $\sigma_c = \sqrt{Variance_c}$ **= <u>3.559</u>**

For incongruent words:

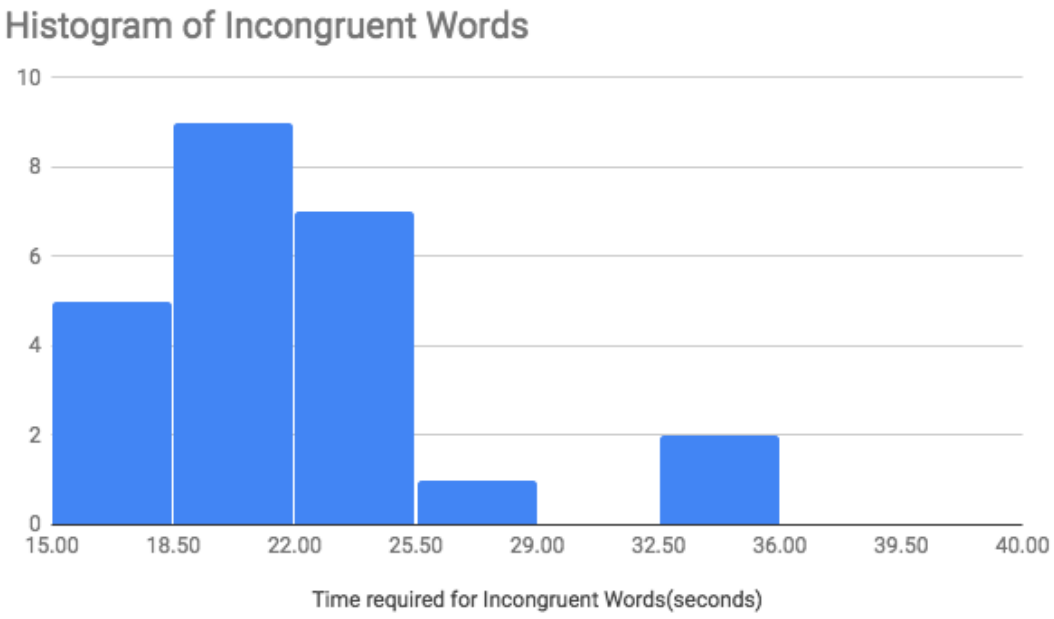
SD $\sigma_{ic} = \sqrt{Variance_{ic}}$ **= <u>4.797</u>**

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.

The data for for congruent words can be displayed using a histogram chart



The above histogram shows the given sample is of normal distribution
The data for incongruent words can be displayed using a histogram chart



The above histogram shows that the given sample is slightly positively skewed distribution

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?

As mentioned earlier to prove statistical significance we will perform dependent-paired t-test at α level = 0.05, so the confidence level will be at 95%

We have already calculated mean and standard deviation for congruent and incongruent words above for sample n=24.

Now calculate $\overline{X_d}$ - difference between means of congruent and incongruent words
SD_d - difference between standard deviations of congruent and incongruent words

$$\overline{X_d} = \overline{x_{ic}} - \overline{x_c} = \mathbf{22.02 - 14.05 = \underline{7.96}}$$

$$\mathbf{SD_d}\ (s_d) = \sqrt{(\sigma_c)^2 + (\sigma_{ic})^2} = \sqrt{(3.559)^2 + (4.797)^2} = \mathbf{\underline{5.97}}$$

Since the mean time increases after intervention both $\overline{X_d}$ and SD_d will be positive
Calculate $\mathbf{t_{statistic}}$ using following formula:

$$\mathbf{t_{statistic} = (\overline{X_d} - 0) \div (s_d \div \sqrt{n}) = (7.96 - 0) \div (5.97 \div \sqrt{24}) = \underline{6.471}}$$

So $t_{critical}$ at α level = 0.05 and 95% confidence level for one tailed test with Degree of freedom(df) = n-1 = 23 can be found using t-table

$$\mathbf{t_{critical}} = 1.714$$

Since $\mathbf{t_{statistic}}$ lies in the $\mathbf{t_{critical}}$ region, alternative hypothesis $H_A : \overline{x_c} < \overline{x_{ic}}$ is true
The difference in time required for congruent words and incongruent words is statistically significant.
Hence we reject null hypothesis.

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!

The causes for stroop effect is that the interference between the different information (what the words say and the color of the words) your brain receives causes a problem.
There are two theories that may explain the Stroop effect:
Speed of Processing Theory: the interference occurs because words are read faster than colors are named.
Selective Attention Theory: the interference occurs because naming colors requires more attention than reading words.

The Erikser flanker test is another interference task similar to stroop effect where different inputs compete with the target, slowing down the response speed. The basic variant of such test uses arrows. In this test subject is supposed to identify the direction of the CENTER arrow as fast as one can.

Resources:
https://en.wikipedia.org/wiki/Stroop_effect
http://cognitivefun.net/
https://en.wikipedia.org/wiki/Eriksen_flanker_task
https://s3.amazonaws.com/udacity-hosted-downloads/t-table.jpg
https://faculty.washington.edu/chudler/words.html