

# ***PROJECT REPORT***

*On*

***Stroop Task***

*(To Test a Perceptual Phenomenon)*

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*As a part of AIRBUS Data Analyst Nanodegree*

## **Table of Revision**

<b>Issue No.</b>	<b>Issue Date</b>	<b>Reason for Revision</b>
1.0	19 <sup>th</sup> of April, 2020	First submission

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## 1. Background Information

In psychology, the **Stroop effect** <sup>[1]</sup> is a demonstration of cognitive interference where a delay in the reaction time of a task occurs due to a mismatch in stimuli.

This effect has been used to create a psychological test (the **Stroop task** or test) that is widely used in clinical practice and investigation.

A basic task that demonstrates this effect occurs when there is a mismatch between the name of a color (e.g., "blue", "green", or "red") and the color it is printed on (i.e., the word "red" printed in blue ink instead of red ink). When asked to name the color of the word it takes longer and is more prone to errors when the color of the ink does not match the name of the color.

The task has two conditions: a **congruent** words condition, and an **incongruent** words condition. In the *congruent words* condition, the words being displayed are color words whose names match the colors in which they are printed: for example RED, BLUE. In the *incongruent words* condition, the words displayed are color words whose names do not match the colors in which they are printed: for example PURPLE, ORANGE. In each case, we measure the time it takes to name the ink colors in equally-sized lists. Each participant will go through and record a time from each condition.

For this project report I downloaded the test result dataset from [here](#). Although one can try and take this test by using this interactive [link](#) <sup>[6]</sup>. When I tested myself, response time for congruent set of words was 25.864 seconds and for incongruent set of words was 29.109 seconds. It was evident from my results that I took more time for incongruent words compared to congruent words.

## 2. Question-1:

**What is our independent variable? What is our dependent variable?**

In any experiment the variables which are controlled or changed are called independent variables and the effect of changes is then seen on dependent variable. Ideally the phenomenon or result of experiment is measured with change in dependent variable.

For Stroop task:

- **Response time is dependant variable;** and
- **Congruent and Incongruent words condition are independent variables.**

## 3. Question-2:

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

As already described in Stroop task that incongruent words has higher response time compared to congruent words and I also experienced the same when I took the test personally. So I would like to test this phenomenon. Hence the appropriate set of hypotheses would be like:

**Null Hypothesis ( $H_0$ ):** There is no significant difference or negative difference in response time for incongruent words against congruent words.

**Alternate Hypothesis ( $H_1$ ):** There is significant positive difference in response time for incongruent words against congruent words.

$$H_0: \mu_i - \mu_c \leq 0$$

$$H_1: \mu_i - \mu_c > 0$$

Where,  $\mu_i$  is sample mean response time for incongruent words condition and  $\mu_c$  is sample mean response time for congruent words condition.

I plan to conduct **dependant t-test** (one-tailed) on this provided data because the available literature of stroop test says, incongruent words need higher response time compare to congruent words. Moreover the dataset has only 24 data points and we can derive only sample parameters from these. Population parameters are not available; hence a z-test cannot be applied. The participants of this test first went through one set of words and it may have prepared them to undertake the second set of words. Making it a dependant test and may or may not have influence on the results.

**Assumptions:**

- i. Normal distribution: The distribution of the differences in the dependent variable (response time) between the two related groups (same participants, incongruent and congruent word conditions) should be normally distributed. Normal distributions are symmetric around the center (mean) and follow a 'bell-shaped' distribution.
- ii. Random sample: The observations are independent of one another.
- iii. Scale of measurement: Dependent variable (response time) should be measured on a continuous scale. The dependent t-test requires the sample data to be numeric and continuous, as it is based on the normal distribution.
- iv. Homogeneity: Homogenous or equal variance exists when the standard deviations of samples are approximately equal.
- v. There should be no significant outliers in the differences between the two related groups.

#### 4. Question-3:

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

Below descriptive statistics were calculated using Microsoft Excel spreadsheet application and reported values below are rounded to two-decimal place. The excel file (*Stroop\_Data\_Analysis\_Iss1.0.xlsx*) is also submitted with this report. Refer to sheet "stroopdata" for more details.

- Sample size ( $n$ ) = 24
- Degree of freedom ( $df$ ) =  $n-1$  = 23

- Sample mean of response time to congruent set of words ( $\mu_c$ ) = 14.05
- Sample mean of response time to incongruent set of words ( $\mu_i$ ) = 22.02
- Median response time to congruent set of words = 14.36
- Median response time to incongruent set of words = 21.02
- Range of time to congruent set of words = 8.63 – 22.33
- Range of time to incongruent set of words = 15.69 – 35.26
- Variance of time to congruent set of words ( $S_c^2$ ) = 12.67
- Variance of time to incongruent set of words ( $S_i^2$ ) = 23.01
- Standard deviation of time to congruent set of words ( $S_c$ ) = 3.56
- Standard deviation of time to incongruent set of words ( $S_i$ ) = 4.8

### 5. Question-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.

Three plots were generated for the dataset using Microsoft Excel application and its Analysis ToolPak Add-in [2][3]. One can find these two plots below and also in sheet “charts” of the excel file (*Stroop\_Data\_Analysis\_Iss1.0.xlsx*) submitted along with this report.

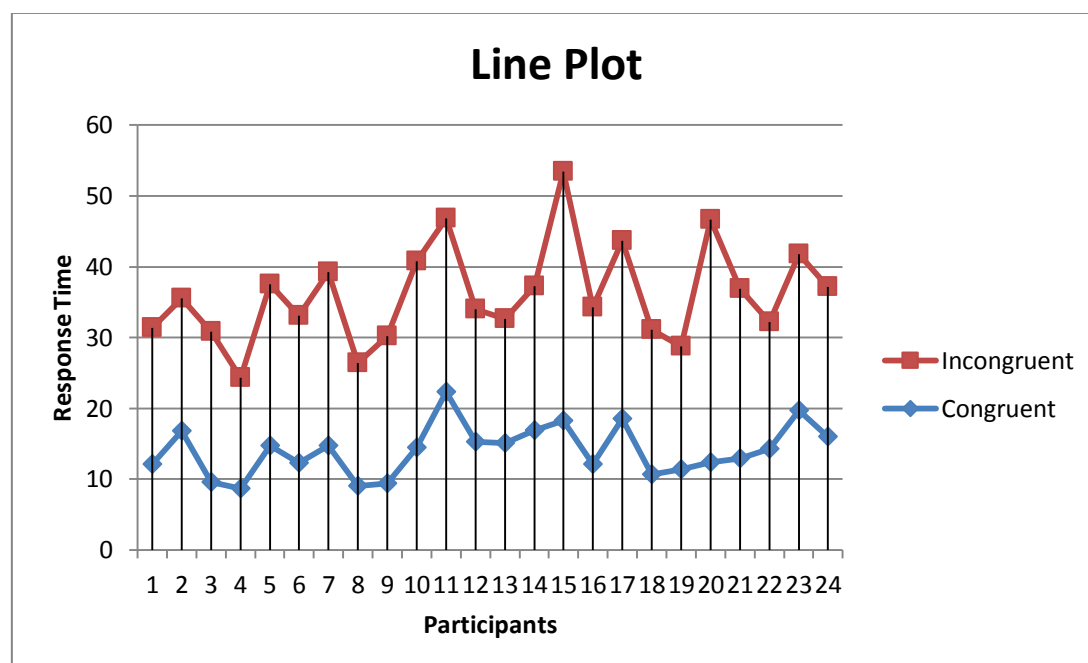


Figure 1: Response Time Line plot for Congruent vs Incongruent

Above line plot (**Figure 1**) clearly shows that for our samples the response time for incongruent words condition is on the higher end compared to congruent words condition. Visually from above plot the difference in response time is positive for each participant.

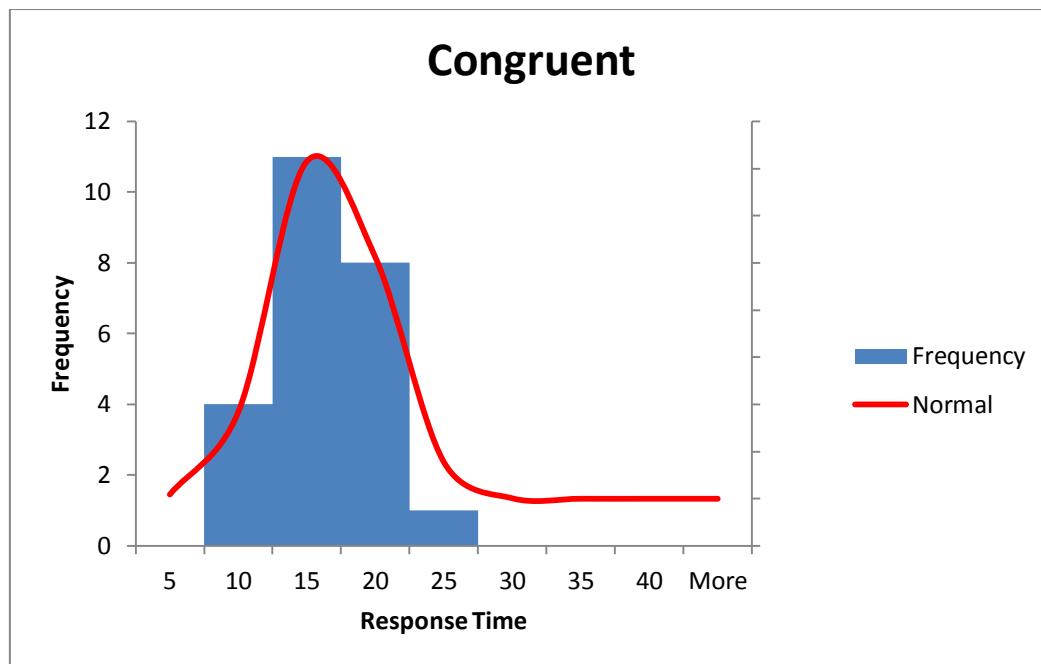


Figure 2: Histogram Congruent Response Time

Two histograms with superimposed normal curves, one each for Congruent and Incongruent time values in **Figure 2** & **Figure 3** supports the fact that the distribution is more or less a normal one. Also the mean for congruent condition is less than 20 with higher frequency in bin 15-20. Whereas the incongruent condition is positively skewed with mean more than 20 and higher frequency observed in bin 20-25.

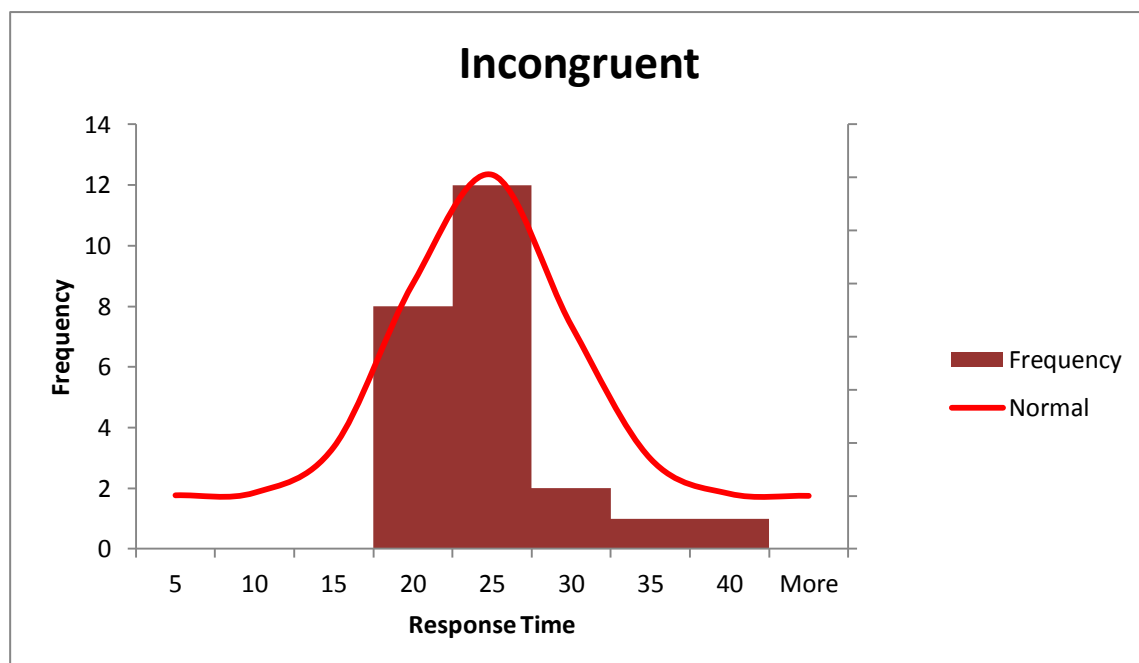


Figure 3: Histogram Incongruent Response Time

## 6. Question-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?

I will perform dependant statistical one-tailed t-test as justified in my answer to Question-2 in section-3 of this report. I will use **95% confidence level (CI)**.

Degree of freedom for this test is 23, as mentioned in in answer to Question-3 in section-4 of this report.

From t-table<sup>[4]</sup> the t-critical ( $t_c$ ) value is identified as 1.714.

The mean response time difference, **MD** = mean ( $\mu_i - \mu_c$ ) = 7.96.

Now the sample standard deviation of response time difference, **S<sub>d</sub>** = 4.86.

Let's calculate the t-statistic using,  $t = \frac{MD}{\frac{S_d}{\sqrt{n}}} = 8.02$ .

$t(23) = 8.02$  with the  $p$ -value is  $< .00001$ . The result is significant at  $p < .05$ .<sup>[5]</sup>

By conventional criteria, this difference is considered to be extremely statistically significant.

Since t-statistic (8.02) is less than t-critical (1.714) at CI of 95%, we **reject the null hypothesis ( $H_0$ )** and accept the alternate hypothesis ( $H_1$ ) that there is a positive response time difference between incongruent and congruent word condition during a stroop task.

Even with a CI of 99.95% where t-critical value is 3.768, we will reject  $H_0$  and accept  $H_1$ .

### **Conclusion:**

In other words, response time is higher for incongruent word condition compared to less response time to congruent word condition during a stroop test. This was as expected and inline to what I personally experienced when I tested myself<sup>[6]</sup>. Also the line plot was clearly showing what I experienced personally was in line with the dataset.

## 7. References

- [1] Stroop effect – Wikipedia: [https://en.wikipedia.org/wiki/Stroop\\_effect](https://en.wikipedia.org/wiki/Stroop_effect)
- [2] Histogram in Excel – Youtube: <https://www.youtube.com/watch?v=79ZdVqr62hg>
- [3] Normal curve in Excel – Youtube: <https://www.youtube.com/watch?v=iHJYWg99rPk>
- [4] t-Table: <https://s3.amazonaws.com/udacity-hosted-downloads/t-table.jpg>
- [5] P value calculation: <https://www.socscistatistics.com/pvalues/tdistribution.aspx>
- [6] Interactive stroop test: <https://faculty.washington.edu/chudler/java/ready.html>
- [7] Assumptions of t-test : <https://www.investopedia.com/ask/answers/073115/what-assumptions-are-made-when-conducting-t-test.asp>