

UDACITY NANODEGREE PROGRAM

DATA ANALYST NANODEGREE

STATISTICS PROJECT

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# Stroop Effect Report

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# 1 Background

In a Stroop task, participants are presented with a list of words, with each word displayed in a color of ink. The participant's task is to say out loud the color of the ink in which the word is printed. 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, one measures the time it takes to name the ink colors in equally-sized lists. Each participant goes through and records a time from each condition.

## 2 Preliminaries

This experiment assesses the impact of the Stroop Effect via statistical analysis. The independent variable is the congruency of a list of words. The dependent variable is the reaction time of a participant declaring the ink color. For the purposes of this experiment, a one-tailed dependent t-test in the positive direction is used.<sup>1</sup> The null hypothesis states that incongruency will have no impact on the population's reaction time, while the alternative hypothesis proposes an increase in the population's reaction time.

$$\begin{aligned}H_o &: \mu_i - \mu_c = 0 \\H_a &: \mu_i - \mu_c > 0\end{aligned}$$

Where  $H_o$  is the null hypothesis,  $H_a$  is the alternative hypothesis,  $\mu_i$  is the population mean for the incongruent data, and  $\mu_c$  is the population mean for the congruent data.

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<sup>1</sup>A t-test was deemed appropriate as the data set represents a sample with an unknown population. A single tail is used because it seems unlikely that incongruency will reduce reaction times. The test performed is dependent (also known as a repeated-measures test) because the same participants are used for both conditions (congruent and incongruent).

## 2.1 Descriptive Statistics

Below is the data provided for this analysis. Of particular note are the differences in sample means between the congruent and incongruent data, which imply that incongruent lists result in larger reaction times. The standard deviation of incongruent data is also somewhat larger. This suggests that the influence of incongruent lists may vary between person to person.

Congruent	Incongruent	Difference
12.079	19.278	7.199
16.791	18.741	1.950
9.564	21.214	11.650
8.630	15.687	7.057
14.669	22.803	8.134
12.238	20.878	8.640
14.692	24.572	9.880
8.987	17.394	8.407
9.401	20.762	11.361
14.480	26.282	11.802
22.328	24.524	2.196
15.298	18.644	3.346
15.073	17.510	2.437
16.929	20.330	3.401
18.200	35.255	17.055
12.130	22.158	10.028
18.495	25.139	6.644
10.639	20.429	9.790
11.344	17.425	6.081
12.369	34.288	21.919
12.944	23.894	10.950
14.233	17.960	3.727
19.710	22.058	2.348
16.004	21.157	5.153

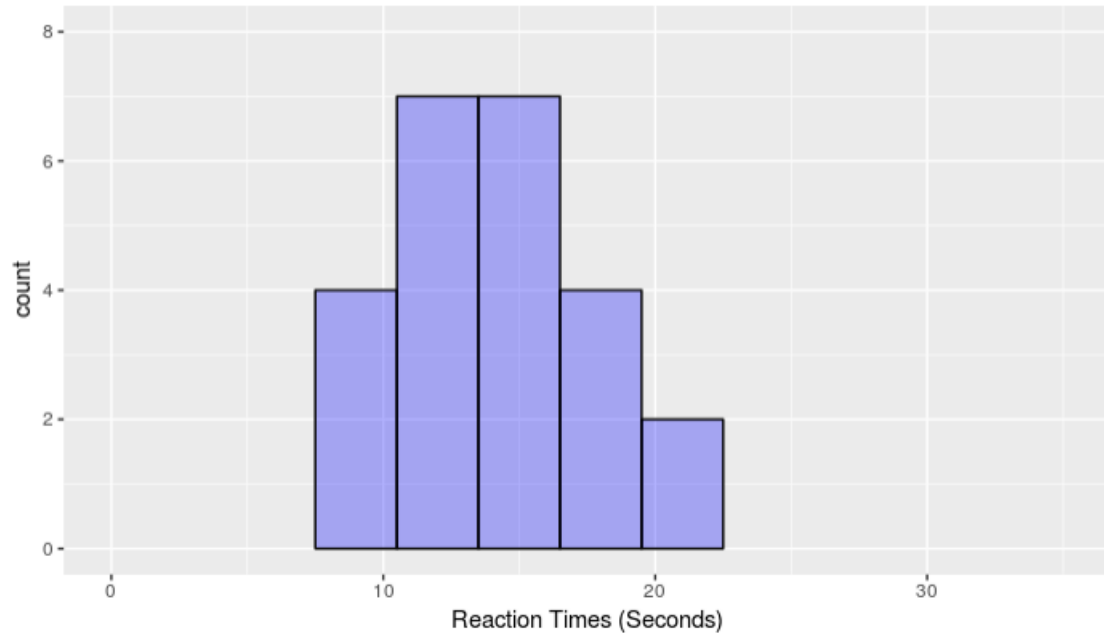
	Congruent	Incongruent	Difference
Average	14.051	22.016	7.965
Median	14.357	21.018	7.667
Std. Deviation	3.559	4.797	4.865

Histograms of the data reveals that it is right-skewed, with most values centering around the means of each set.<sup>2</sup>

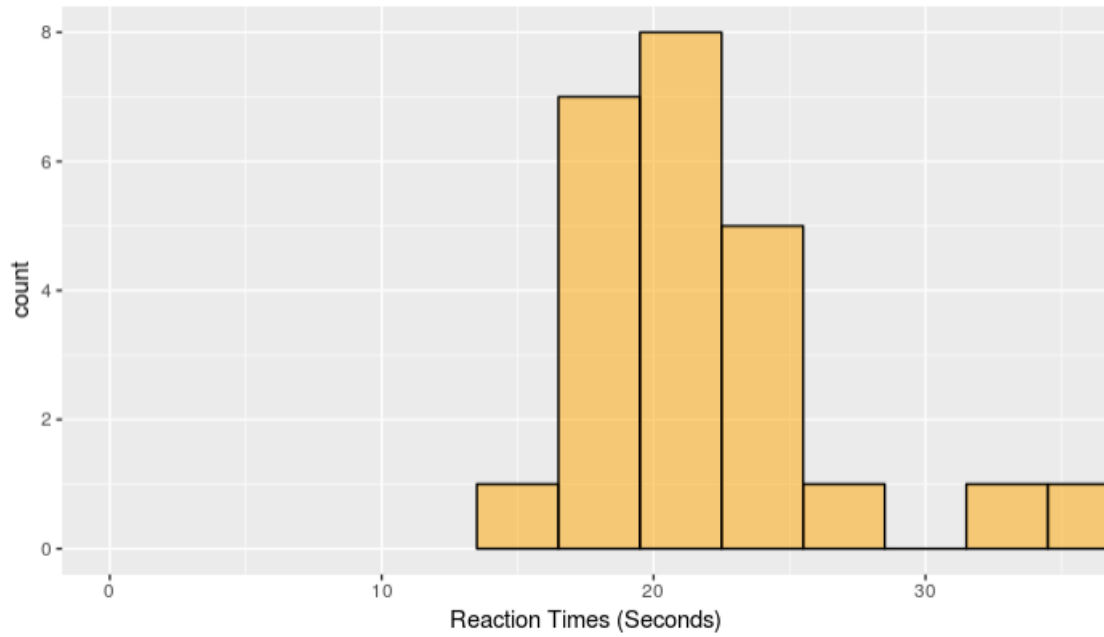
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<sup>2</sup>Visualizations created using RStudio and the ggplots library.

Congruent Data Reaction Times



Incongruent Data Reaction Times



## 2.2 Inferential Statistics

A formal analysis produces a t-value of 8.021, far above the t-critical of 1.714 (for an alpha of 0.05). It is thus statistically likely that incongruent data is related to an increase in reaction times.

$$t = \frac{\overline{x_i} - \overline{x_c}}{StandardError}$$

$$t = \frac{\overline{x_i} - \overline{x_c}}{s/\sqrt{n}}$$

$$t \approx \frac{22.016 - 14.051}{4.865/\sqrt{24}}$$

$$t \approx 8.021$$

The 95% confidence interval suggests that incongruent words result in, on average, a reaction time increase between 6.3 seconds and 9.7 seconds.

$$CI = ((\overline{x_i} - \overline{x_c}) - t_{crit} * StandardError, (\overline{x_i} - \overline{x_c}) + t_{crit} * StandardError)$$

$$CI \approx (7.965 - 1.714 * 0.993, 7.965 + 1.714 * 0.993)$$

$$CI \approx (6.263, 9.667)$$

## 2.3 Conclusion and Discussion

The null hypothesis is rejected in favor of the alternative hypothesis. Stated plainly, the average reaction time of participants identifying lists of incongruent words is 6.3 seconds to 9.7 seconds longer than congruent words. This matches what one would expect given the current understanding of the Stroop Effect.

While it is probable that this is the direct result of the Stroop Effect, other explanations could also reasonably justify the data. For instance, little is known about the conditions in which the data was gathered. The incongruent word lists may have had a smaller font size, or the ages of the participants could be uncontrolled.<sup>3</sup> It is difficult to make any generalized conclusions without further information about the sample.

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<sup>3</sup>The Stroop Effect is known to be more influential on children.