

## P1: Test a Perceptual Phenomenon

# The Stroop Effect

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# Introduction

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, 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.

## Data Exploration

### Variables

The **independent variable** is the type of test; "congruent words condition" or "incongruent words condition"

The **dependent variable** is the time it takes to name the ink colors in seconds.

### Descriptive Statistics

On the "congruent words condition", the 24 participants had a mean time of 14.051 sec. (SD = 3.559). Scores of 11.528, 14.357, and 16.594 represented the 25th, 50th, and 75th percentiles, respectively.

On the "incongruent words condition", the 24 participants had a mean time of 22.016 sec. (SD = 4.797). Scores of 18.668, 21.018, and 24.367 represented the 25th, 50th, and 75th percentiles, respectively. We can notice from the Box Plot that there are two outliers (35.255 & 34.288).

The above statistics can be viewed in the following table.

	Congruent	Incongruent
<b>N</b>	24	24
<b>Min</b>	8.63	15.687
<b>25%</b>	11.528	18.668
<b>M</b>	14.051	22.016
<b>Median</b>	14.357	21.018
<b>75%</b>	16.594	24.367
<b>Max</b>	22.328	35.255
<b>IQR</b>	5.067	5.698
<b>Variance</b>	12.669	23.012
<b>SD</b>	3.559	4.797

*Table 1 - Congruent vs Incongruent condition statistics*

## Data Visualization

From the “congruent words condition” histogram, we can see that the sample data follow the normal distribution with a slight positive skew with a mode in the area of 14 - 16, including the mean (14.051) and the median (14.357).

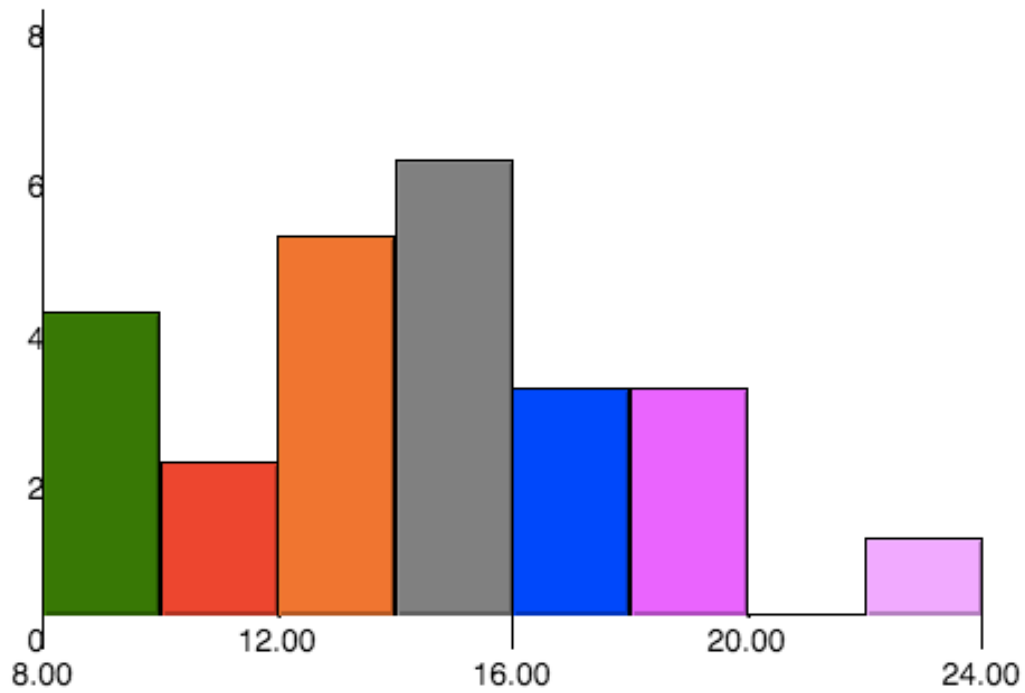


Figure 1 - Congruent words condition - Histogram

The box plot reveals as well the slight positive skew of the sample data.

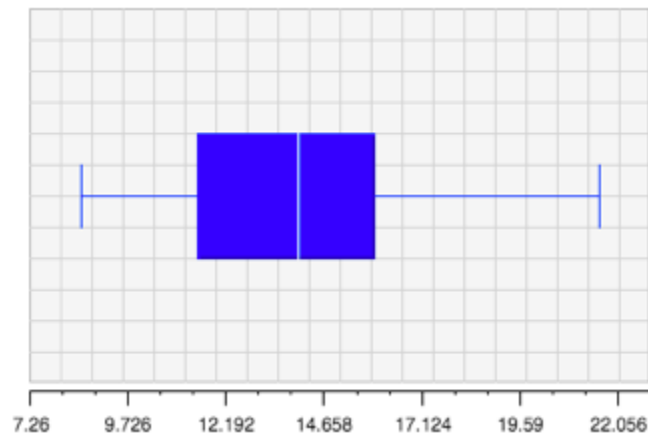


Figure 2 - Congruent words condition - Box Plot

“Incongruent words condition” histogram appears closer to the normal distribution with Mode being in the same area (20 - 24) with Mean and Median. On the far right, in the bin 34 - 36, there are two possible outliers.

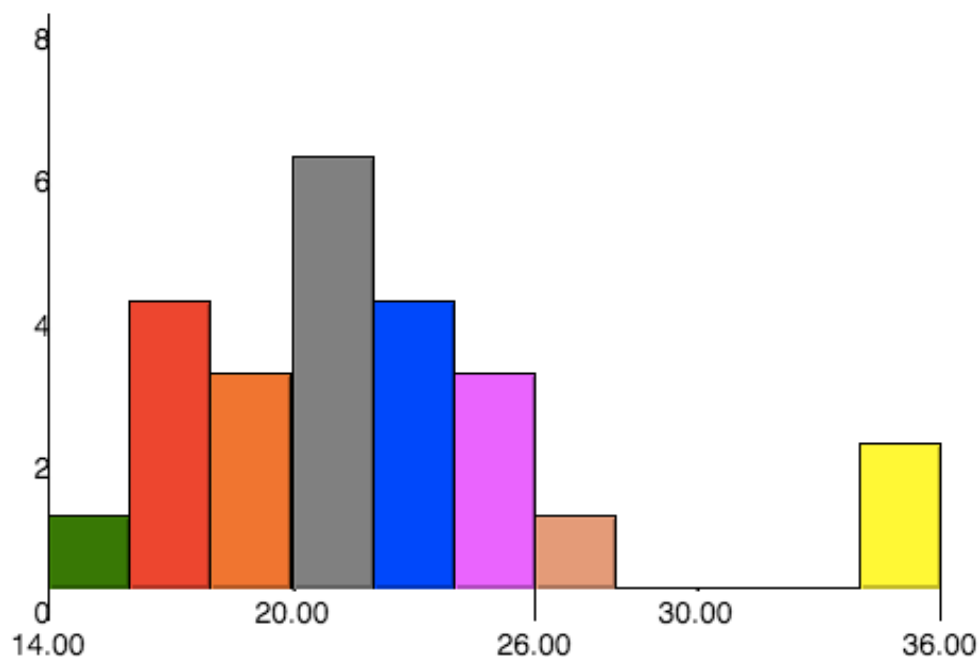


Figure 3 - Incongruent words condition - Histogram

The box plot verifies both that the sample data follow the normal distribution and that there are two outliers.

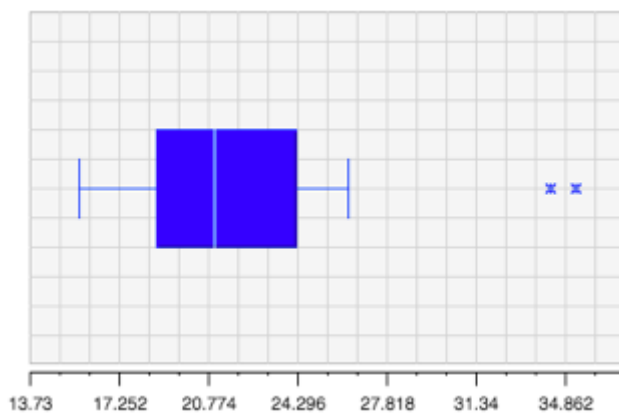


Figure 4 - Incongruent words condition - Box Plot

# Inferential Statistics

In the previous session we visualized the sample data and we noticed that their distribution is normal. Additionally, we don't know the population's standard deviation and the sample size is relatively small (24) to calculate it, thus the statistical test that is more proper to be conducted is a t-test. More specifically, since the participants execute the test on both conditions, the t-test will be a paired samples t-test (dependent samples t-test)2.

The null hypothesis for the test will be that the population mean time for completing the test under the congruent condition ( $\mu_c$ ) is the same as the population mean time for completing the test under the incongruent condition ( $\mu_i$ ). Thus:

$$H_0: \mu_c = \mu_i$$

The alternative hypothesis will be that the population mean time for completing the test is significantly different under the two conditions (congruent/incongruent). Thus:

$$H_1: \mu_c \neq \mu_i$$

$$\text{Standard Error: } SE = \frac{SD_{i-c}}{\sqrt{N}} = \frac{4.865}{\sqrt{24}} = 0.993$$

$$\text{t-statistic: } t = \frac{M_i - M_c}{SE} = \frac{22.016 - 14.051}{0.993} = 8.021$$

$$p=0.05$$

$$t(23) = 2.069$$

It appears that the population mean time it takes to read the words under the two conditions is statistically different at a significance level of 0.05 so we reject the null hypothesis.

# Conclusion

A two-samples, two-tailed t-test was conducted to compare the time it takes to name the ink colors in Stroop test for Congruent and Incongruent Word Conditions.

There was a significant difference in the time between Congruent Word Condition ( $M=14.051$ ,  $SD=3.559$ ) and Incongruent Word Condition ( $M=22.016$ ,  $SD=4.797$ ) conditions;  $t(23)=2.069$ ,  $p=0.05$ .

These results suggest that reading color words whose names match the colors in which they are printed, has a significant lower mean time than color words whose names do not match the colors in which they are printed.