Stroop Effect Analysis

Introduction

The Stroop Effect is a phenomenon discovered by John Ridley Stroop in 1935. This effect is a demonstration of interference in the reaction time of a task. In his experiment, he used three types of stimuli: neutral, congruent, and incongruent. Neutral stimuli was the presence of text or color, but not both. Congruent stimuli are words where text matches the color (Blue), and incongruent stimuli are words where the text does not match the color (Red).

We will be performing our own experiment and analysis of the Stroop Effect.

Hypothesis

The question that we want this experiment to explore is: Does the presence of incongruent stimuli increase the time it takes to recite the colors of words, compared to one with congruent stimuli?

Our null hypothesis (H_0) is that the incongruency of the words does not increase the time it takes to recite the colors on the list.

Our alternative hypothesis (H_A) is that incongruency of the words increases the time it takes to recite the colors on the list.

$$H_0: \mu_c \geq \mu_i$$

$$H_A: \mu_c < \mu_i$$

For the above equations, μ_c represents the average time to recite the list of congruent words, and μ_i represents the average time it takes to recite the list of incongruent words

Experiment

This experiment was conducted where a participant is given two lists of words. Each list has 25 colored words of the following text/colors: Red, Green, Blue, Yellow, Pink, Orange, Brown, White.

The independent variable is the congruency of the words. The dependent variable that we are measuring is the amount of time it takes for each participant to recite the list of words.

In the first half of the experiment, the color of the words matches the text of the words (*congruent test*): RED, BLUE, ORANGE. In the second half of the experiment, the color of the words is different than the text of the words (*incongruent test*): RED, BLUE, ORANGE. The time it takes to recite each set of words is recorded for each participant.

There were 24 participants in this experiment.

Analysis

Descriptive Statistics

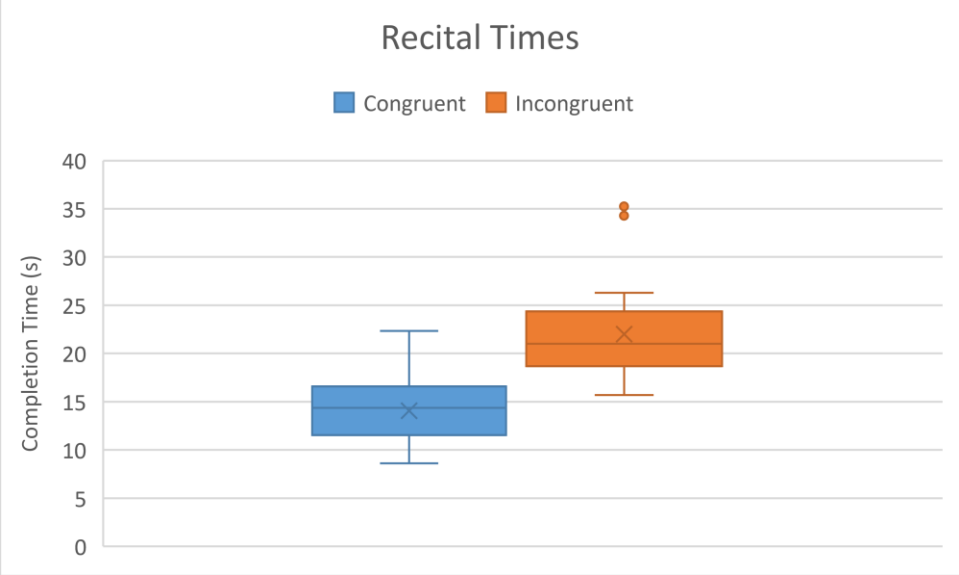
Below is a table with the descriptive statistics for this dataset.

	Congruent Test	Incongruent Test	Difference
Average Completion Time (s)	14.0511	22.0159	7.9648
Minimum Completion Time (s)	8.6300	15.6870	1.9500
Maximum Completion Time (s)	22.3280	35.2550	21.9190
Standard Deviation	3.5594	4.7971	4.8648

The average completion time for the incongruent test is 7.9648 seconds longer than the average congruent test. Additionally the differences in the minimum and maximum completion times is distinct as well.

The standard deviation is also larger for the incongruent test, meaning that the variability in time increased when the words did not match the colors.

Lets look at a boxplot of the dataset:



From this boxplot, it appears that the amount of time to recite the incongruent list is significantly longer compared to the congruent list. The lowest completion time for the incongruent list is higher than the average completion time for the congruent list. Additionally, the first quartile for the incongruent test is greater than the third quartile for the congruent test.

The range for the incongruent test is a much larger as well. There are two outliers for that dataset, while the congruent test had no outliers.

Staistical Test

Because we have one sample group that was tested twice, we need to ensure that the correct statistical test is being used. Since the population statistics are unknown and our sample size is less than 30, a z-test cannot be conducted. Therefore, a dependent t-test for paired samples will be utilized.

For this test, we will set the critical region to a probability of 0.01 ($\alpha = 0.01$). Since we are testing to see if the incongruency of the words increases the completion time, this will be a one-tailed test. With a sample size (n) of 24, and 23 degrees of freedom (df), the critical value for our t-test is 2.4999.

The average difference ($\bar{x}_D$) between the two tests is 7.9648 seconds.

The standard deviation (S_D) of the differences is 4.8648 seconds.

$$SE = \frac{S_D}{\sqrt{n}} = \frac{4.8648}{\sqrt{24}} = 0.9930$$

The standard error (SE) is 0.9930.

$$t = \frac{\bar{x}_D}{SE} = \frac{7.9648}{.9930} = 8.0207$$

The calculated t-Statistic (t) is 8.0207.

The P-Value is effectively 0.0000 because the T-Statistic is so large. This puts the probability well within the critical region.

$$r^2 = \frac{t^2}{t^2 + df} = \frac{8.0207^2}{8.0207^2 + 23} = .7366$$

The r^2 value is .7366. This means that the incongruency of the words contributes to about 73.66% of the increase in time it takes to recite the list of words.

Conclusion

Because the Critical Value for the T-Test is 2.4999, and the calculated T-Statistic is 8.0207, the null hypothesis must be rejected. The probability of obtaining a T-Statistic of 8.0207 is 0.0000, which makes the null hypothesis, that the incongruency of the words does not increase the time it takes to recite the colors on the list, extremely unlikely.

While the Stroop Effect may cause a significant increase in the amount of time it takes to recite the list of words, this experiment does not address the reason why this occurs.