Test a Perceptual Phenomenon

Introduction

This project analyzes the results of a test meant to demonstrate the Stroop Effect, which can be read about on Wikipedia. In the task, a participant is given a list of words and is required to say out loud the ink color of each word. For example, if the word appeared as RED, the participant would have to say "blue". The participants were asked to perform the task in one condition and then perform the same task in a second condition. In one condition, the congruent words condition, the letters of each word spelled out the same color as the ink it was written in (RED, BLUE). In the incongruent words condition, the letters of each word spelled out a different color than the ink it was written in (PURPLE, ORANGE). The test measures the total time it takes the participant to say the color of each word in the list out loud for both conditions. Because the Stroop Effect proposes that an interference (such as an incongruence between the color and the text) will increase reaction time, participants are expected to perform worse (take more time) in the incongruent condition than in the congruent condition. I calculated descriptive statistics based on sample results from each condition (n = 24) and conducted a one-tailed t-test based on the hypotheses I proposed.

Variables

The independent variable in this experiment is the congruency of the color and the text. The dependent variable is the time it takes (in seconds) for the participant to name the color of the word.

Statistical Test and Hypotheses

I will perform a dependent, one-tailed t-test on the results. The test is dependent because the same person is being put into two conditions. A t-test is used because this is a case where the population parameters are not available. It will be one-tailed, because we are assuming a direction of the results here: that the incongruent words condition will take longer on average than the congruent words condition.

Let's call the mean of the incongruent words group μ_i and the mean of the congruent words group μ_c. We are using μ here to denote the population means,

which we are inferring from our sample means. The null and alternative hypotheses will be as follows:

H_0: $\mu_i \leq \mu_c$
H_a: $\mu_i > \mu_c$

In plain language, the null hypothesis states that the incongruent words task will not take more time on average than the congruent words task, and may even perform better. The alternative hypothesis states that the incongruent words task will take longer on average than the congruent words task.

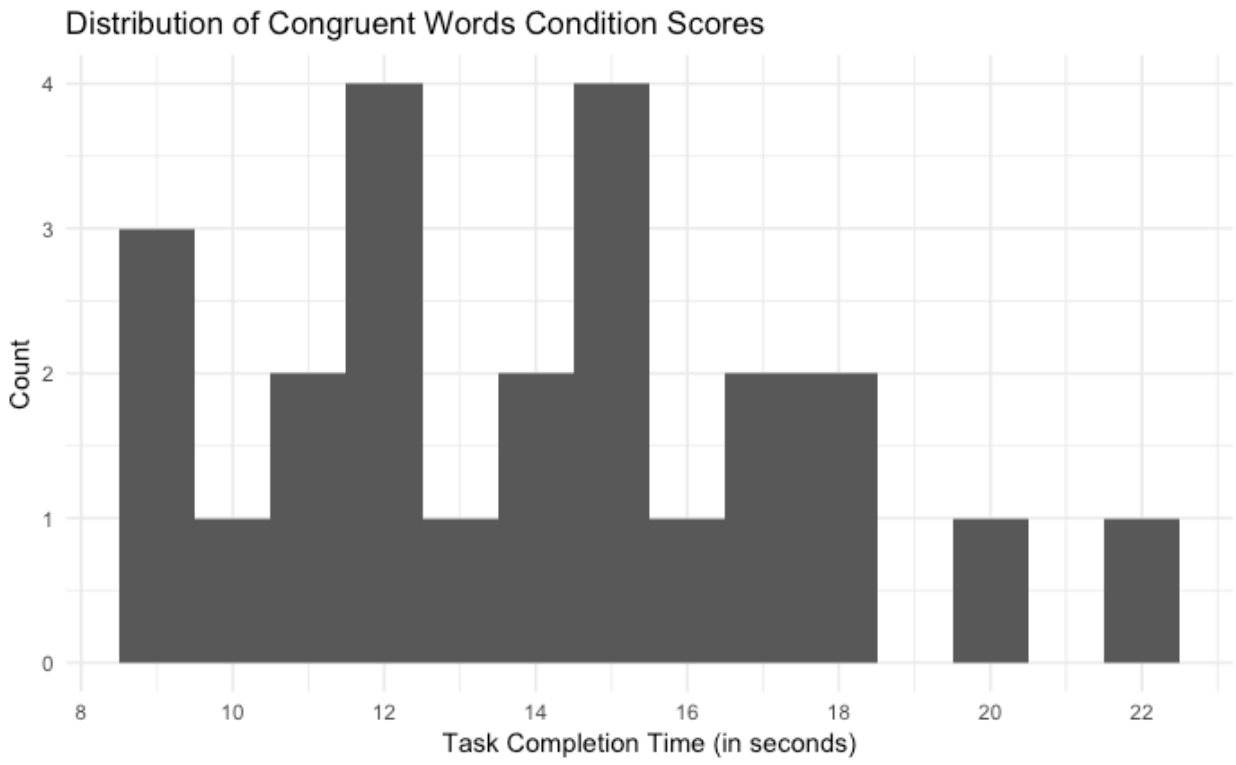
This test rests on three main assumptions. The first assumption, that these differences are being calculated on measurement variables, is met since time taken is the independent variable. The second assumption is that sampling is random and pairs of observations are independent. The sampling for this experiment is random and the observations are independent, since performance in one condition is not seen to affect performance in the subsequent condition. The final assumption is that the distribution of the mean differences is normal. Neither of the distributions of each condition is normal (see below) and the distribution of differences (not pictured here) is not normal either. However, due to the Central Limit Theorem, we can assume that as the sample size increases, the distribution of the differences approaches normal. Therefore, all three assumptions are satisfied.

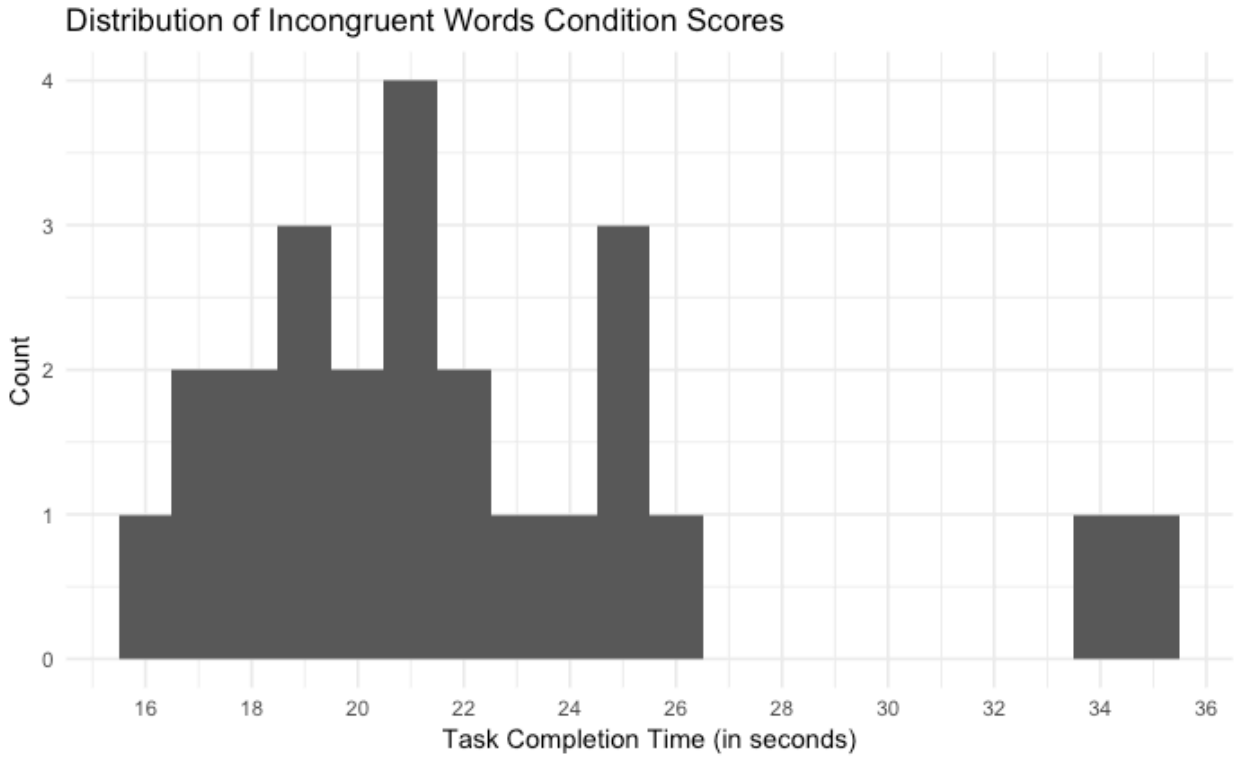
Descriptive Statistics

The mean amount of time taken for the congruent words task was 14.05 seconds, with a sample standard deviation of 3.56. For the incongruent words task, the mean was 22.02 seconds, with a sample standard deviation of 4.80. The sample standard deviation is computed by dividing the sum of squared deviations by n-1 (which was 23 in this case) and taking the square root of that result.

Distributions

Here are plots of the distributions of the two groups:


Distribution of Congruent Words Condition Scores
Count
0
1
2
3
4
8
10
12
14
16
18
20
22
Task Completion Time (in seconds)


Distribution of Incongruent Words Condition Scores
Count
0
1
2
3
4
16
18
20
22
24
26
28
30
32
34
36
Task Completion Time (in seconds)

Notice how the scores for the congruent words task ranges from approximately 9 to 22 seconds, while those for the incongruent words task ranges from approximately 16 to 35 seconds. Both distributions have their outliers, or participants who took about 4-9 seconds longer than the rest of the participants to complete the task.

Results

The mean difference was calculated by subtracting the mean of the congruent words condition from that of the incongruent words condition (22.02 – 14.05), and that turned out to be 7.97. The standard error was calculated by subtracting the values of the congruent words condition from those of the incongruent words condition in each row, and then using the regular formula for sample standard deviation on those differences. Using the mean difference of 7.97 and the standard error of 4.86, I calculated the t-statistic to be 8.03. At the $\alpha = 0.05$ significance level, the t critical value for a one-tailed test is 1.714. We reject the null hypothesis in favor of the alternative hypothesis, since the t-statistic is higher than the t critical value. The 95% confidence interval is in the range of (5.91,10.02).

Conclusions

The results of the experiment matched up with my expectations, because I was aware that the Stroop Effect was testing whether interferences had an effect on reaction times. I could also get a sense from the data that the times were significantly higher for the incongruent words condition. Still, it was fun to try the task on my own and then compare my results to those of the samples I was given.