

Statistics: The Science of Decisions Project Instructions

Background Information

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.

Questions For Investigation

As a general note, be sure to keep a record of any resources that you use or refer to in the creation of your project. You will need to report your sources as part of the project submission.

1. What is our independent variable? What is our dependent variable?

The independent variable is the congruence between the word shown and the ink it is printed in. That is, if the word matches the color it's written in or not.

The dependent variable is the time it takes the participant to correctly identify the ink color.

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

Null Hypothesis (H_0): Incongruence between color words and the ink they are printed doesn't affect the time it takes a participant to correctly identify the ink color.

Alternative Hypothesis (H_A):

- Incongruence between ink color and color words affects the time it takes a participant to correctly identify the ink color.

- Incongruence between ink and color increases the time it takes the participant to correctly identify the ink color.
- Incongruence between ink and color decreases the time it takes the participant to correctly identify the ink color (although highly improbable).

To analyze significance, I would perform a dependent samples (paired) T-test between the times recorded in the congruent and incongruent tasks. The T-test has to be paired because we are measuring the same participant twice, one time for each task. As the H_A go either above and beyond the H_0 , I would perform the T-Test 2-tailed.

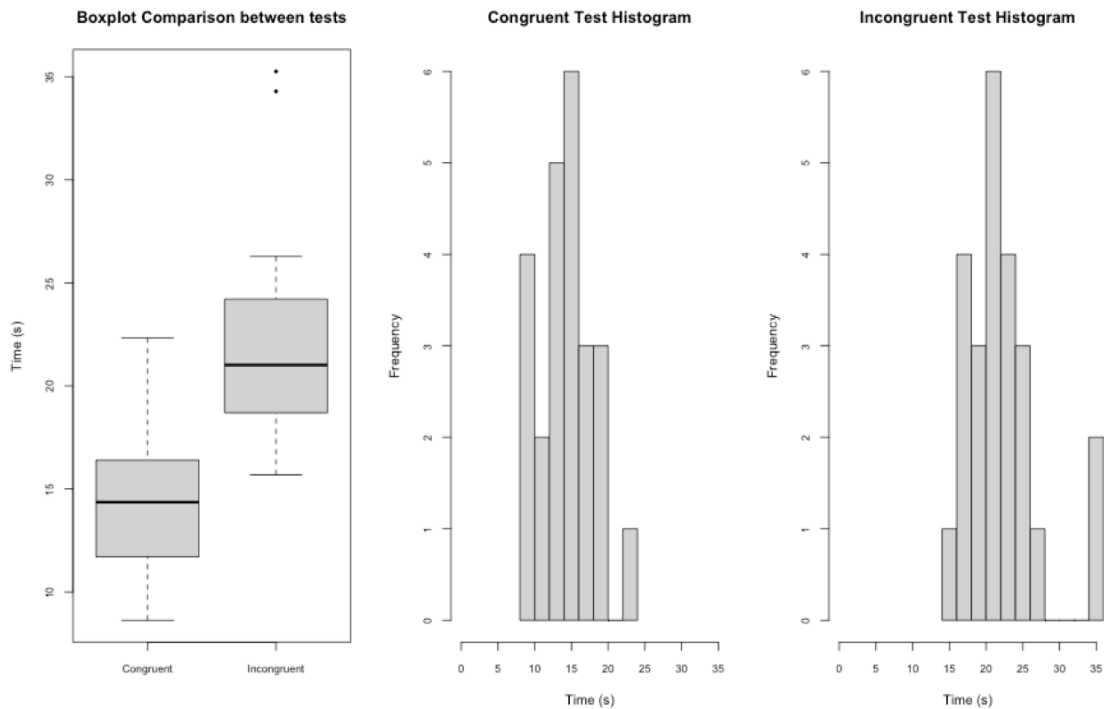
3. Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability.

I will use R to do the analyses, as I'm more comfortable than with Google Sheets. Here is code I used and a table with the results:

```
> congruent_times <- c(12.079, 16.791, 9.564, 8.630, 14.669, 12.238, 14.692, 8.987,
9.401, 14.480, 22.328, 15.298, 15.073, 16.929, 18.200, 12.130, 18.495, 10.639,
11.344, 12.369, 12.944, 14.233, 19.710, 16.004)
> incongruent_times <- c(19.278, 18.741, 21.214, 15.687, 22.803, 20.878, 24.572,
17.394, 20.762, 26.282, 24.524, 18.644, 17.510, 20.330, 35.255, 22.158, 25.139,
20.429, 17.425, 34.288, 23.894, 17.960, 22.058, 21.157)
> mean(congruent_times)
[1] 14.05113
> mean(incongruent_times)
[1] 22.01592
> median(congruent_times)
[1] 14.3565
> median(incongruent_times)
[1] 21.0175
> var(congruent_times)
[1] 12.66903
> var(incongruent_times)
[1] 23.01176
> sd(congruent_times)
[1] 3.559358
> sd(incongruent_times)
[1] 4.797057
```

	Congruent	Incongruent
Mean	14,051	22,016
Median	14,357	21,018
Variance	12,669	23,012
StDev	3,559	4,797

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.



Using a boxplot, the increased time to perform the incongruent task becomes apparent. Using histograms, we can see that the distribution of the task duration in both the congruent and incongruent tests approaches very roughly a normal distribution. As in the boxplot, the increase on the time to perform the task in the incongruent task is apparent.

```
> layout_matrix <- matrix(c(1, 2, 3), nrow = 1)
> layout(layout_matrix)
> boxplot(congruent_times, incongruent_times, main = "Boxplot Comparison between
tests", ylab = "Time (s)", names = c("Congruent", "Incongruent"), pch = 20, col =
"lightgrey")
> hist(congruent_times, breaks = 8, main = "Congruent Test Histogram", xlim = c(0,
35), xlab = "Time (s)", col = "lightgrey")
> hist(incongruent_times, breaks = 8, main = "Incongruent Test Histogram", xlim =
c(0, 35), xlab = "Time (s)", col = "lightgrey")
```

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?

```
> t.test(congruent_times, incongruent_times, alternative = "two.sided", paired = TRUE, conf.level = 0.95)
```

```
Paired t-test

data: congruent_times and incongruent_times
t = -8.0207, df = 23, p-value = 4.103e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -10.019028 -5.910555
sample estimates:
mean of the differences
      -7.964792
```

Confidence level = 0.95

Critical Statistic value = -8.0207

With a p-value of 4.103e-08, we can reject the null hypothesis and confirm that there is a significant effect of the congruence between words and ink and the time it takes a participant to determine the color of the ink. As determined by the statistics above, this effect is an increase in the time to perform the task.

6. Optional: What do you think is responsible for the effects observed? Can you think of an alternative or similar task that would result in a similar effect? Some research about the problem will be helpful for thinking about these two questions!

There are several theories as per why the Stroop effect happens, such as a higher processing speed for words than colors or the fact that we are more used to read words than to determine its color and this task requires more attention and dedication. However, there is not a consensus of a single process being entirely responsible for this effect.

Similar to the Stroop Effect, another cognitive test based on incongruence and respond times is the Simon Effect. In this case, the congruence (and incongruence) of the Simon Effect involves spatial clues instead of reading words.

Note: In this project I have not used any external resource, as I was already familiar with the Stroop Effect and the required statistics due to my formal education.