

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.

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?
  2. What is an appropriate set of hypotheses for this task? What kind of statistical test do you expect to perform? Justify your choices.
- Now it's your chance to try out the Stroop task for yourself. Go to [this link](#), which has a Java-based applet for performing the Stroop task. Record the times that you received on the task (you do not need to submit your times to the site.) Now, download [this dataset](#) which contains results from a number of participants in the task. Each row of the dataset contains the performance for one participant, with the first number their results on the congruent task and the second number their performance on the incongruent task.
3. Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability.
  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.
  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?
  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!
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1.

Independent variable: The words condition (congruent or incongruent)

Dependent variable: The time it takes to name the ink colors.

2.

a.

Null Hypothesis: Population mean of time (congruent words condition) EQUALS (=) population mean of time (incongruent words condition)

$H_0: \mu(\text{congruent}) = \mu(\text{incongruent})$  OR  $H_0: \mu(\text{congruent}) - \mu(\text{incongruent}) = 0$

Alternative Hypothesis: population mean of time (congruent words condition) LESS THAN (<) population mean of time (incongruent words condition)

$H_a: \mu(\text{congruent}) < \mu(\text{incongruent})$  OR  $H_a: \mu(\text{congruent}) - \mu(\text{incongruent}) < 0$

b.

For this experiment we will perform a one-tailed t-Statistic test since we can't obtain data for a complete population and our sample size is less than 30. The t-test to be performed is a dependent t-test since repeated measures are applied to the same sample of participants.

The choice to perform a one-tailed t-test rather than a two-tailed t-test is based on the fact that we are looking for effect in a specific direction which is the negative direction in our case.

3.

a-

The most helpful measure of central tendency is the median in our case since the mean is subject to the effect of outliers and the mode is only helpful if we round the scores to whole numbers which compromises accuracy.

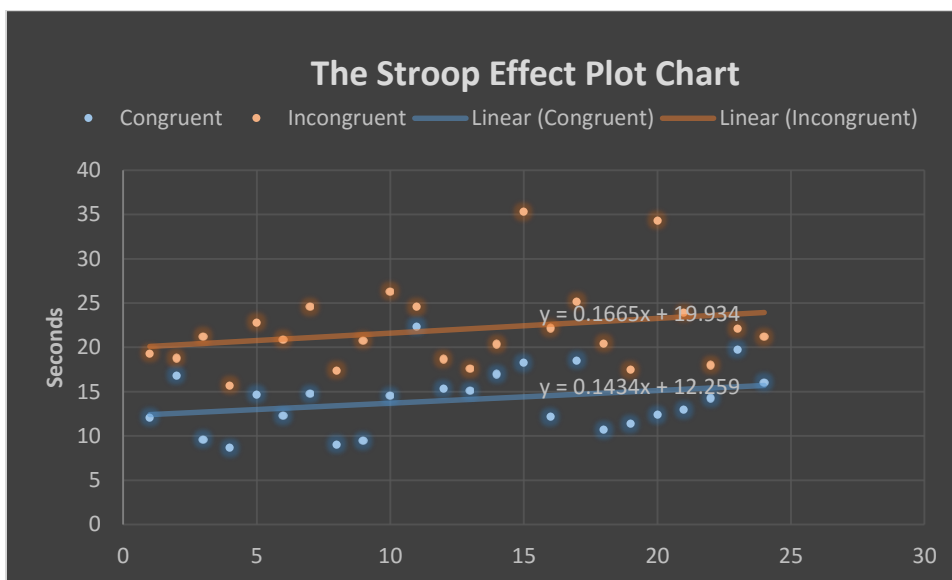
The median of the congruent data is: 14.36

The median of the incongruent data is: 21.02

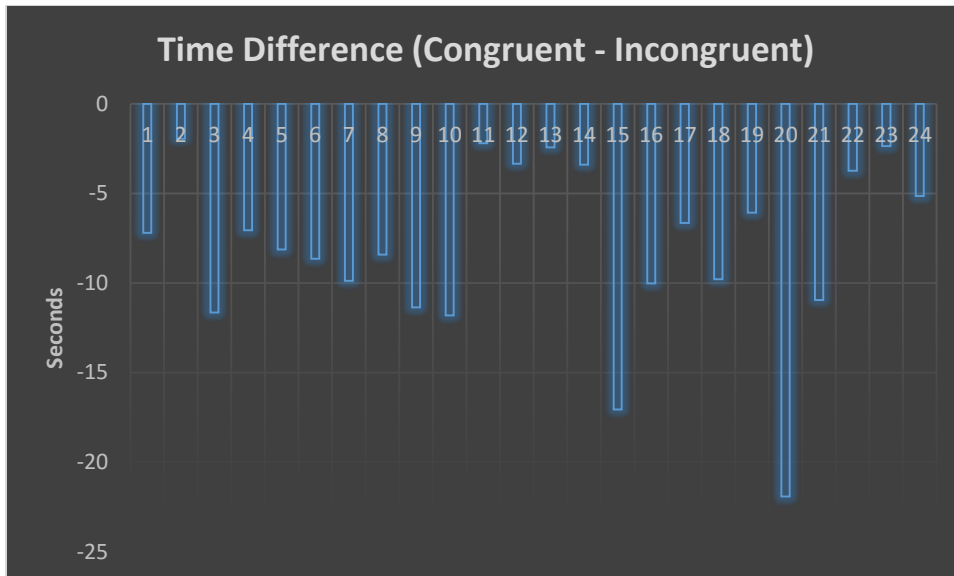
b-

As a measure of variability the standard deviation of the congruent data sample is 3.56 and the standard deviation of the incongruent data sample is 4.80

4.



In the above chart we notice that the slope of the incongruent word results trend line is higher than that of the congruent words trend line which indicate that participants have tendency to take more reciting incongruent words than they do reciting congruent words.



The above depicts the time difference in seconds between the time it takes to name congruent words and that of incongruent words for each participant. We notice that all the values fall in the negative region, thus all participant have taken less time to name congruent words vs. incongruent words.

5.

$H_0: \mu(\text{congruent}) = \mu(\text{incongruent})$  OR  $H_0: \mu(\text{congruent}) - \mu(\text{incongruent}) = 0$

$H_a: \mu(\text{congruent}) < \mu(\text{incongruent})$  OR  $H_a: \mu(\text{congruent}) - \mu(\text{incongruent}) < 0$

Based on the hypothesis we will conduct a one tailed t-test at a confidence level of 98% ( $\alpha = 0.01$ )

At  $\alpha$  level of 0.01 the **t-critical is -2.5** at a degree of freedom of 23, since we are conducting the test in the negative direction.

We have: SD (congruent) = 3.56

SD (Incongruent) = 4.80

Mean (congruent) = 14.05

Mean (Incongruent) = 21.02

In order to calculate the Standard Error, we need to find the Standard deviation of the Difference between the two samples.

$$\text{STD (Difference)} = 4.86$$

$$\text{SE} = \text{STD}/\sqrt{n} = 4.86/\sqrt{24} = \mathbf{0.99}$$

In order to calculate the t-statistic we need to find the mean of the difference between the two samples.

$$\text{Mean (Difference)} = -7.96$$

$$\text{t-statistic} = (\text{Mean (Difference)} - \mu)/\text{SE} = (-7.96 - 0)/0.99 = -8.02$$

The t-statistic falls in the critical region; thus we **reject the null hypothesis at  $\alpha = 0.01$**  ( $p < 0.01$ ).

There is a significant evidence that the time it takes to name the ink color is less in congruent words than in incongruent words.

This result was expected since it is intuitive that the visual aspect can assist when relevant or distract when irrelevant.

6.

A plausible explanation of the effects observed could be that the human brain has a memory related to the meaning of the word (semantic perception) and a memory related to the image that it triggers in mind, thus when the two types of memory contradict each other the brain needs to sort things out and detect which of the two is misleading. That might explain the delay in reaction time that happened recalling the incongruent words.

A similar experiment could be testing the time it takes to recognize a certain type of food. First testing the reaction time where the subjects can see and smell food types, then in the second treatment testing the reaction time where subjects can only see the food types.