

P1: Test a Perceptual Phenomenon

Stroop Effect

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.

What is our independent variable & dependent variable?

Independent Variable : Condition (Congruent/Incongruent)
Dependent Variable : Time Taken to Name Ink Colors

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

Let $\mu_D = \mu_i - \mu_c$

Where μ_i is population mean for time taken for color identification in incongruent condition.

μ_c is population mean for time taken for color identification in congruent condition.

H_o : $\mu_D = 0$

H_a : $\mu_D \neq 0$

H_o : There is no significant difference between two population means

H_a : The population means are different

A suitable statistical test to use is a **two-tailed dependent t-test**.

- i. The test should be two-tailed due to the *possible difference between the congruent and incongruent words condition's response times in the sample can be either positive or negative.*
- ii. The test should be dependent as the *same sample performs the congruent & incongruent tasks.*

- iii. The test should be a t-test as *no population parameters are provided*. Also, given the sample size is small, the population cannot be assumed to be distributed normally.

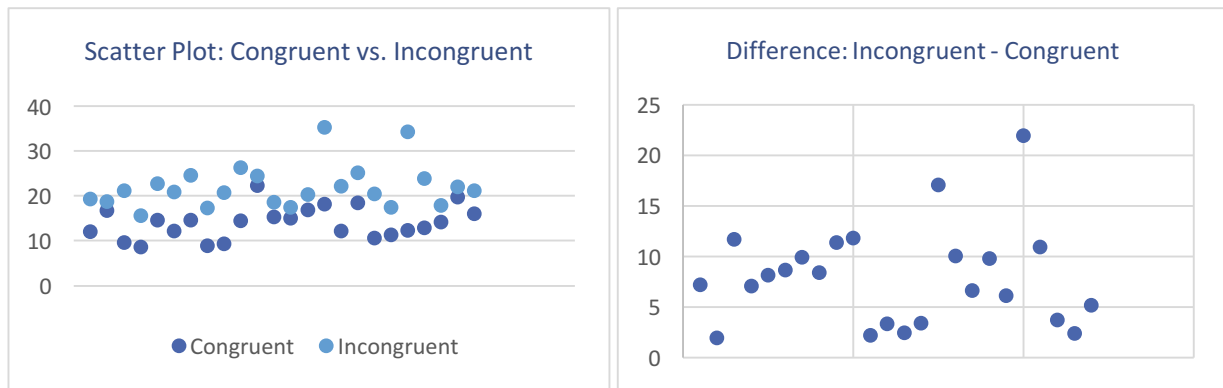
Now, it's your chance to try out the Stroop task for yourself. Go to [this link](#), which has a Java-based applet for performing the Stroop task. Record the times that you received on the task (you do not need to submit your times to the site).

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.

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

Measurement	Congruent	Incongruent
Mean	14.05	22.02
Median	14.36	21.02
Range	13.70	19.57
Standard Deviation	03.56	04.80

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.



The above plots clearly suggest that congruent tasks appear to be consistently completed faster than incongruent tasks.

- i. *The points for incongruent tasks in the scatter plot lie (completely) above the points that represent the time taken for congruent tasks.* This indicates that the time taken for color identification in case of incongruent tasks is more than in the case of congruent tasks.
- ii. *Majority of the differences lie above the 5 second mark with none of them below 0.* This strengthens the alternative hypothesis i.e. there is a significant difference in the time to name the colors in-case of congruent & incongruent tasks.

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?

μ_c	:	14.05
μ_i	:	22.02
x_d	:	-7.96
s	:	4.8648
n	:	24
df	:	23
t	:	-8.02
α	:	0.05
P	:	< 0.00001
t^*	:	-2.069; 2.069
95% CI	:	(-25.35, 9.42)

$$t = \frac{x_d}{s/\sqrt{n}} = \frac{-7.96}{4.8648/\sqrt{24}} = -8.02$$

With a t-value of -8.02 that is less than the t-critical of -2.064 [3], the **null hypothesis is rejected** with a 95% confidence. People do not name colors at the same speed when the word's meaning and its color match, as when they do not match.

The obtained statistical evidence matches my intuitive expectations & also the deductions obtained from the created visualizations.

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!

Before researching, the immediate reasoning that I thought of is – we tend to process words faster than colors. Furthermore, if we were trying to state the color of the word, the word is probably distracting us as we try to dismiss it and focus on the color. This site [1] calls this “Speed of Processing Model”.

On further research, I came across ‘Numerical Stroop Effect’ which is based on the mingling of numerical values and their size [2].

References

[1] <https://www.rit.edu/cla/gssp400.sbackground.html>

[2] https://en.wikipedia.org/wiki/Numerical_Stroop_effect

[3] <https://s3.amazonaws.com/udacity-hosted-downloads/t-table.jpg>