Project 1: Test a Perceptual Phenomenon

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?

Independent variable
The "condition" of words (congruent/incongruent) i.e. whether the name of the color matches with the ink-color

Dependent variable
Time taken by a participant to name the *color of the ink* in equally-sized lists

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

For this task, the null and alternative hypotheses are as follows:

Null Hypothesis (H_0):
The mean time for colour recognition for congruent words is **equal to or greater than** the mean time for incongruent words.

Alternative Hypothesis (H_A):
The mean time for colour recognition for congruent words is **less than** the mean time for incongruent words.

H_0: $\mu_C \geq \mu_I$
H_A: $\mu_C < \mu_I$

   $\boldsymbol{\mu_C}$ = *population mean for congruent words condition*
   $\boldsymbol{\mu_I}$ = *population mean for incongruent words condition*

Based on above, we can conclude that a one-tailed, dependent sample t-test comparing the difference in means (the time to name the ink colors for congruent and incongruent words) should be performed.

By performing this 1-tailed test, we aim to find out whether it was just a matter of chance that the mean time taken to name the ink-color of the congruent words was significantly less than that of incongruent words. Or, is there enough evidence to infer that the mean time for congruent words will be less than that of incongruent words for the entire population and not only the sample data.

As we don't know the population parameters (μ & σ) and we have paired sample data, a t-test for "within-subject designs" seems to be the correct choice. In this case, the within-subject design is two-conditions (each subject assigned 2 conditions in random order).

Additionally, we only need to perform a 1-tailed dependent t-test for paired samples as we are only interested in finding out whether ink-color of congruent words are easier to read as compared to incongruent words or not.

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.

Statistic	Congruent (x_c)	Incongruent (x_i)	Difference (x_c - x_i)
Median	14.357	21.018	-7.667
Mean	14.051	22.016	-7.965
Sample Variance (s2)	12.669	23.012	23.667
Sample Std Dev (s)	3.559	4.797	4.865
Standard Error	0.726	0.979	0.993

n = 24   **df** (*degrees of freedom*) = 23   **Point Estimate** = -7.965

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.

The min and max values of congruent data are 8.63 and 22.328, whereas for incongruent data, they are 15.687 and 35.255. So, the consolidated bucket range is 8 seconds to 36 seconds.
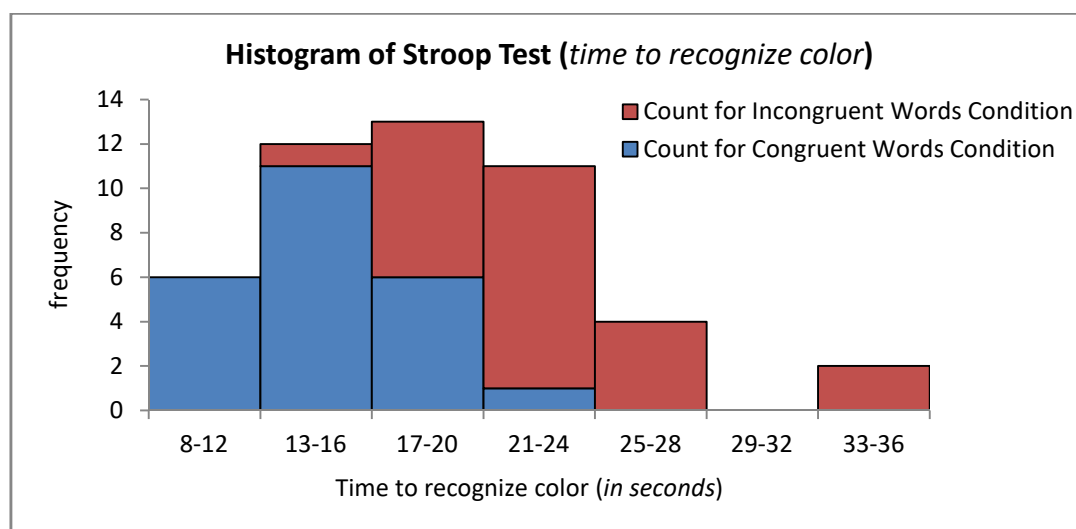
As per the above histogram, the first bar which is the fastest is completely blue (*congruent*). This means the words which took least amount of time to recognize their color were all congruent.

On the other hand, the last couple of bars to the extreme right of this plot to have recorded the maximum time are completely red (*incongruent*). This means the words which took the most amount of time to recognize their color were all incongruent.

Also, as the time on the x-axis increases, the height of blue bars starts diminishing, whereas the height of red bars grows taller. This means that the more time a participant took in recognizing the color of a particular word, the higher the chance of that word being incongruent.

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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?

Let's consider alpha level as .01 i.e. $\alpha = .01$

Degrees of freedom (df) = 23

$t_{critical}$ = -2.50

$t_{statistic}$ = -8.021

p-value ≤ .0001

Cohen's d (effect size measure) = 1.637

At **99% confidence interval** with degrees of freedom as 23, the **t-critical** value for 1-tailed test in negative direction is **-2.50**. However, the calculated t-statistic based on the provided paired samples data is -8.021.

As our t-statistic is way past the t-critical, we will **reject the null**. This means that similar to what we had expected, participants took significantly less time when reading out the color of the ink of congruent words compared to the incongruent words. Since this was an experimental design, we can make causal statements. So we can say that the congruency (congruent or incongruent) had a causal effect on the time taken to read out the color of the ink in which the word was printed.

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!

Well, when I took the test, I could significantly experience a lag in the brain's ability to recognize the color of the word, whereas the brain was able to read the words faster. This definitely supports the idea that word processing is significantly faster than color processing.

REFERENCES:
Stroop Effect - http://www.psytoolkit.org/lessons/stroop.html