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 words (congruent/incongruent). The dependent variable is the response time to name 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.

   Our null hypothesis, H_0, is that the population's mean response time under a congruent condition is greater than or equal to the population's mean response time under an incongruent condition. Our alternative hypothesis, H_1, is that the two means come from different populations and that the population mean response time under congruency is less than that population mean response time under incongruence.

   $$H_0: \mu_1 \geq \mu_2$$
   $$H_1: \mu_1 < \mu_2$$

   If our sample means show a significant difference based on a particular threshold, we can assume the two sets of data come from two separate populations and reject the null hypothesis.

   Here we can perform a one-tailed paired samples t-test. We use the paired samples t-test as it assumes that each pair of sample data is dependent on one another.

Each individual participated in both the congruent and incongruent conditions and as such the data in each condition is not independent.

If the null hypothesis were merely that there is no difference between the population means, we would want to perform a two-tailed t-test. There is little evidence suggesting incongruent word pairs would decrease response time. The incongruent condition adds new information that conflicts with the written word in a task that measures response time. This conflict is assumed to only result in longer response times. As such we will perform a one-tailed paired samples t-test.

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.

	Congruent	Incongruent
Mean	14.051	22.016
Variance	12.669	23.012
SD	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.

Participant Response Times by Congruency Condition
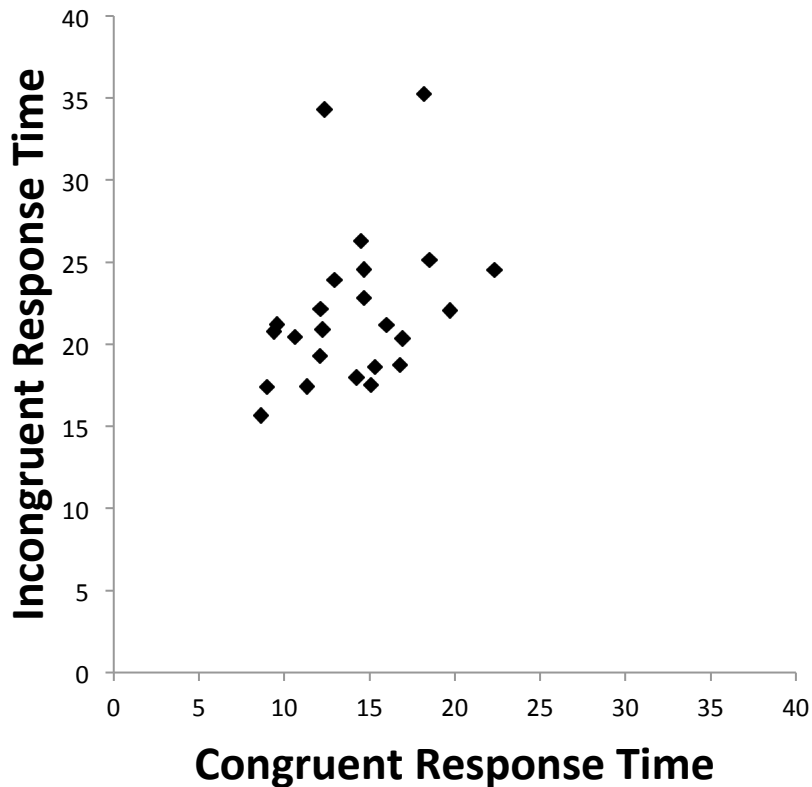
The scatterplot here shows the relationship between response times in the congruent and incongruent conditions. Namely, it illustrates by participant the difference in response times between the conditions. The data show that every participant recorded response times greater in the incongruent condition as compared to the congruent condition.

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?

At a confidence level of 99% and alpha of .01, the t-statistic is 8.021 with p < 0.01. The critical t-statistic for a p < 0.01 result is 2.50. Given this result is statistically significant,

we reject the null hypothesis that the incongruent word condition will not result in longer response times. The data suggest that the incongruent condition increases response time as compared to the congruent condition for the Stroop task. The results confirm our expectations such that incongruence between the written word and the color representation of that word leads to increased time to report the color of the ink.

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!

What I believe to be responsible for the effect is the extra processing required in interpreting the incongruent condition. Absent any color information beyond the written word, no extra processing is required. With congruent color and word information, no extra processing is required. The color information is merely redundant. However, adding a different represented color to the written word adds new information, which takes time to be processed and conflicts with the written word. Given reading speed is faster than color naming speed, even more time is required for the color naming process to catch up and align with the goal of the task.

An alternative task may be with numbers and words. The study participant may be asked to respond to the number of items presented. In a congruent condition the word four may be written four times. In the incongruent condition the word four may be written twice.

RESOURCES:

For Stroop Task explanation: http://staff.itee.uq.edu.au/janetw/cmc/chapters/Stroop/

For paired samples t-test information in Python: http://docs.scipy.org/doc/scipy-0.15.1/reference/generated/scipy.stats.ttest_rel.html