Statistics: The Science of Decisions Project Instructions

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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 type of task, say out loud the color of the ink in which the word is printed, a participant takes; congruent words or incongruent words.

Dependent variable: The time it's taken for a participant to finish saying out loud of the *color of the ink* in which the word is printed for the congruent words list and the incongruent words list separately.

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

μ_I: The population mean for the time taken to complete the **C**ongruent words task.

μ_C: The population mean for the time taken to complete the **I**ncongruent words task.

$\mu_D = \mu_I - \mu_C$

H_0: Using the mean difference of time taken for both tasks, congruent and incongruent, samples, there is no difference in population means of the time taken for both tasks, congruent and incongruent; the two populations means are equal.

$\mu_I = \mu_C$; $\mu_I - \mu_C = 0$; $\mu_D = 0$.

H_A: Using the mean difference of time taken for both tasks, congruent and incongruent, samples, there is difference in population means of the time taken for both tasks, congruent and incongruent; the two populations means are not equal.

$\mu_I \neq \mu_C$; $\mu_I - \mu_C \neq 0$; $\mu_D \neq 0$.

We are going to perform a two tailed t-test, since we are working with a within subject design, two conditions samples. We do not know the population parameters, mean and standard deviation. We have a sample of 24 of the whole population so since the sample size is low we are using the t-test. We are also assuming the population distribution is normal. We are using an α **= 0.05** for the test to have a better understanding of the population parameters and to conclude on the hypothesis we have set. If the p-value is less than α = 0.05 we are going to reject the null hypothesis because we have statistically significant evidence to support the alternative hypothesis.

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.

$$\bar{x}_C = \frac{\sum_{i=0}^{24} x_{ci}}{n} \ , \ \bar{x}_I = \frac{\sum_{i=0}^{24} x_{Ci}}{n} \ , \ \bar{x}_D = \frac{\sum_{i=0}^{24} (x_{Ii} - x_{Ci})}{n} = \bar{x}_I - \bar{x}_C .$$

$$SD_C = \sqrt{\frac{\sum_{i=0}^{24} (x_{ci} - \bar{x}_C)^2}{n-1}} \ , \ SD_I = \sqrt{\frac{\sum_{i=0}^{24} (x_{Ii} - \bar{x}_I)^2}{n-1}} \ , \ SD_D = \sqrt{\frac{\sum_{i=0}^{24} ((x_{Ii} - x_{Ci}) - \bar{x}_D)^2}{n-1}}$$

**Values in the equations are not rounded. The values presented next have been rounded for the sake of presenting the calculations. Values are rounded at the last step of the test.

$n = 24$

$\bar{x}_C = 14.05$ *and* $SD_C = 3.56$, $\bar{x}_I = 22.02$ *and* $SD_I = 4.80$, $\bar{x}_D = 7.96$ *and* $SD_D = 4.86$.

$Q_{1-C} = 11.7115, Q_{2-C} = 14.3565, Q_{3-C} = 16.3975.$ $IQR_C = Q_{3-C} - Q_{1-C} = 16.3975 - 11.7115 = 4.686$

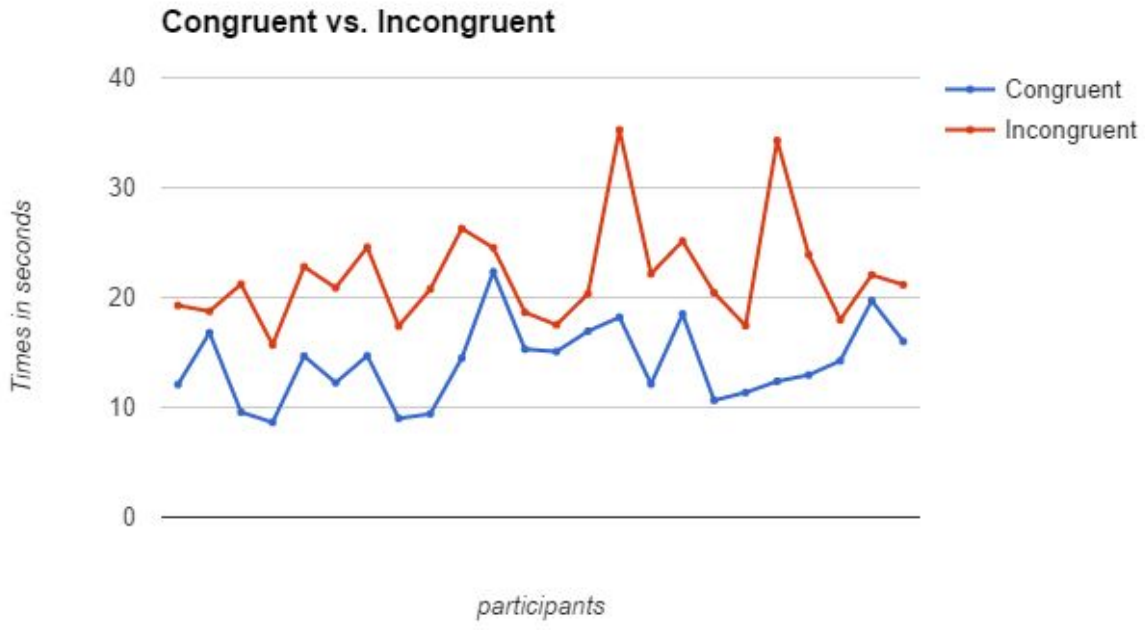
$Q_{1-I} = 18.6925, Q_{2-I} = 21.0175, Q_{3-I} = 24.209.$ $IQR_I = Q_{3-I} - Q_{1-I} = 24.209 - 18.6925 = 5.5165$

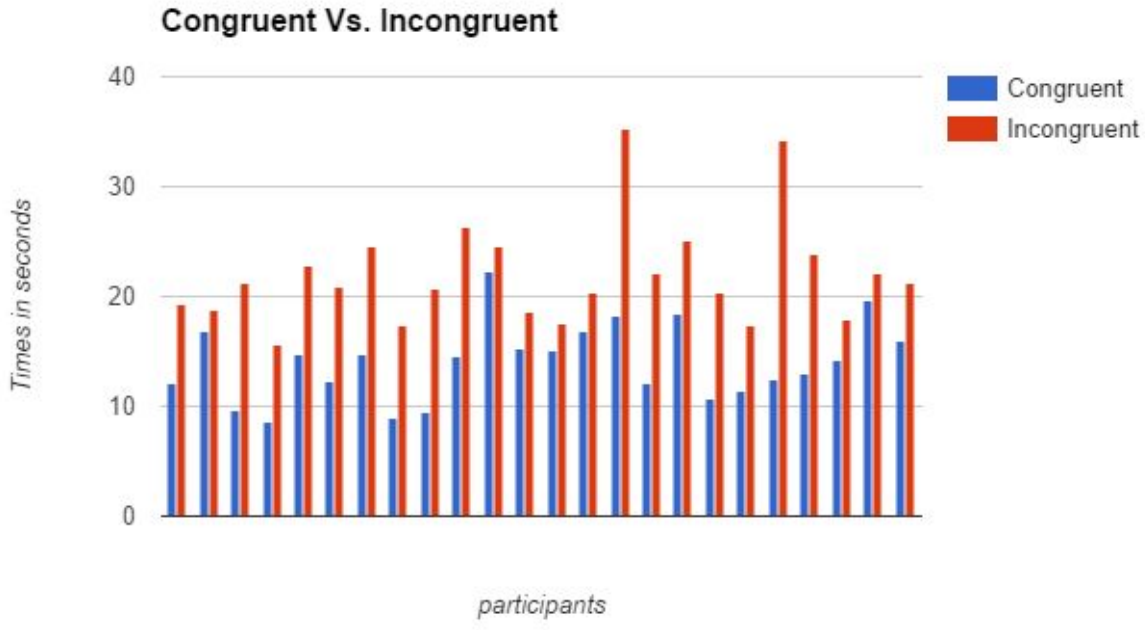
There were no outliers in the congruent task data but there were two outliers in the incongruent task list; data (34.288 and 35.255) were both greater than $(Q_{3-I} + (1.5 * IQR_I) = 32.484$.

$Q_{1-D} = 3.564, Q_{2-D} = 7.6665, Q_{3-D} = 10.489.$ $IQR_D = Q_{3-D} - Q_{1-D} = 10.489 - 3.564 = 6.925$

There was an outlier in the time differences data between the two tasks; 21.919 is greater than $(Q_{3-D} + (1.5 * IQR_D) = 20.8765$.

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.





We see from the two graphs that the participants take more time to complete the incongruent task than the congruent task. We also see that some participants had very close times for the two tasks while others had great difference in time to complete the two tasks.

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?

$$t = \frac{\bar{x}_D}{(\frac{SD_D}{\sqrt{n}})} = \frac{7.96}{(\frac{4.86}{\sqrt{24}})} = 8.02$$

Confidence level = 95%.
Critical statistic value t(23)= 2.069

Since the t-value is large we can't find its p-value in the t-table. Using graphpad.com we found that the P-value for 8.02 and 23 df is less than 0.0001.(graphpad.com)
Conclusion: We conclude that we have to reject the null hypothesis since the p-value < 0.0001 < α = 0.05. There is statistically significant evidence to reject the null hypothesis using a two tailed test.

The result matched my expectations. I did the task myself and I saw that it is taking me more time to complete the incongruent task than congruent 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!

Citations

http://www.graphpad.com