Evaluating the Stroop Task

Eric Jones. 22 August 2017

1. What is our independent variable? What is our dependent variable?

The independent variable is the task configuration. There are only two options: incongruent or congruent. The dependent variable is the time to complete each task.

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

The null hypothesis is that there is no difference in time to complete the two configurations of the task, with an alternative hypothesis that the time to complete one task is different from the other. While personally I think that I would be slower to complete the incongruent task, I think it is appropriate to use a two-sided t-test here because there is not an explicitly stated goal for the different tasks. Stated in statistical terms:

$$H_0: \mu_i = \mu_c$$

$$H_A: \mu_i \neq \mu_c$$

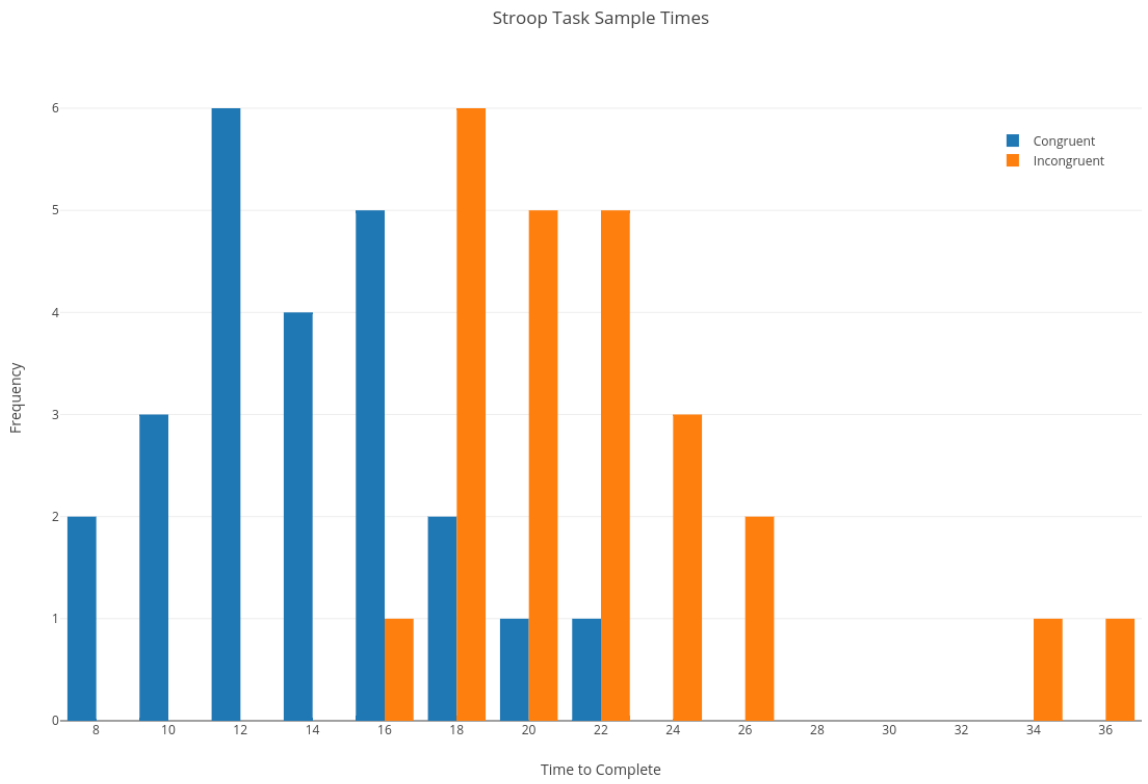
Where μ_i is the population mean time to complete the incongruent version of the task and μ_c is the population mean time to complete the congruent version of the task.

To test this, I expect to perform a two tailed t-test for dependent samples. This situation has dependent samples because the sample data provided is for a set of people who each completed both versions of the task. There are some limitations here such as order of the tasks possibly affecting results, but this design does help to control for differences between individuals. I'm using a two-tailed test because I'm making no assumptions about how the population might be able to complete either task, and therefore want to check for the mean moving in either direction.

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

n=24	Congruent	Incongruent	Difference
Sample Mean ($\bar{x}$)	14.051	22.016	-7.965
Sample Standard Deviation (s)	3.559	4.797	4.865

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 congruent times have a roughly normal distribution, while the incongruent times are skewed to the left. There is some overlap between the two sample distributions (some people were able to complete the incongruent task as quickly as some people completed the congruent task), but that overlap appears small. This visualization matches up with the sample mean and standard deviation calculated for #3.

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?

Difference in sample means: $\bar{x}_{diff} = -7.965$

Standard Error of the Mean: $SEM_{diff} = \frac{4.865}{\sqrt{24}} = 0.993$

For a two-sided t-test with α = .05 and *df* = 24-1 = 23, the t critical values are: ± 2.069

The t value here is: $t = \frac{\bar{x}-\mu}{SEM} = \frac{-7.965-0}{0.993} = -8.02$

Because the t value is more extreme than the t critical value, I reject the null hypothesis that the population means are equal.

Using GraphPad, the P value for this t value and 23 degrees of freedom is $P < .0001$

The 95% confidence interval: $CI: (-7.965 - 2.069 * 0.993,\ -7.965 - 2.069 * 0.993)$

$$CI: (-10.02, -5.91)$$

Calculate the r^2 statistic: $r^2 = \frac{t^2}{t^2+df} = \frac{-8.02^2}{-8.02^2+23} = .737$

Based on this value of r^2, I can say that almost 74% of the difference between the times for the two tasks can be explained by the difference between the tasks rather than other affects or random chance. My conclusion is that there is a significant difference between the two tasks, which is what I expected. I'm actually a bit surprised by how high the r^2 value is, and that even the shorter side of the 95% CI is nearly 6 seconds of difference: I suspected that personal differences might mean that a number of people report similar times on both tasks, but that does not appear to be the case from the data available.

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!

There is clearly something going on in how the human brain is processing information that makes the incongruent task more difficult. Reading is a common task, whereas recognizing and naming colors is simple but much less common, resulting in it being a slower task. The real trick is that resolving these two tasks in tandem when the brain is fed incongruent information is difficult.

I think the reading portion of this is important, but I'm curious if a similar task could be constructed by asking for spellings and misspellings of words (some purposefully jumbled) in a sentence rather than asking for names of colors printed out. I'm not sure this would work, it might just be another way to debunk the idea that people can read jumbled words. (More on reading jumbled words here: https://www.mrc-cbu.cam.ac.uk/people/matt.davis/cmabridge/)

Resources

Project instructions: https://docs.google.com/document/d/1-OkpZLjG_kX9J6LIQ5IltsqMzVWjh36QpnP2RYpVdPU/pub?embedded=True

Sample Data: https://drive.google.com/file/d/0B9Yf01UaIbUgQXpYb2NhZ29yX1U/view

t-table: https://s3.amazonaws.com/udacity-hosted-downloads/t-table.jpg

GraphPad P calculator: http://www.graphpad.com/quickcalcs/pValue2/

Stroop Effect Research: https://en.wikipedia.org/wiki/Stroop_effect

Stroop Effect Research: https://www.verywell.com/what-is-the-stroop-effect-2795832

Stroop Effect Research: https://imotions.com/blog/the-stroop-effect/