Test a Perceptual Phenomenon

Anne Le

August 29, 2016

Hypothesis testing on the Stroop effect

What is the Stroop effect?

"The finding that naming the colors of color words (e.g. the words 'green', 'red', 'blue', etc.) is easier and quicker if the actual observed colors of the words match the colors that the words denote (e.g. the colors green, red, blue, etc., respectively) than if they do not match."[1]

Congruent	Incongruent
YELLOW BLUE ORANGE GREEN RED PURPLE	YELLOW BLUE ORANGE GREEN RED PURPLE

Variables

In this test, we want to know if the congruent and incongruent words affect participants' performance time.

Independent variable: congruent and incongruent words.
Dependent variable: the time it takes to perform a task.

Hypothesis

Null: The population mean difference between the congruent and incongruent task is not statistically significant.

$$H_0 : \mu_{Difference} = \mu_0$$

[1] Wikipedia: https://en.wikipedia.org/wiki/Stroop_effect#Original_experiment

Alternative: The population mean difference between the congruent and incongruent task is statistically significant.

$$H_a : \mu_{Difference} \neq \mu_0$$

Statistical Test

When working with this sample of twenty-four observations, we can use the Central Limit Theorem to assume that the distribution of the sample means approaches normality regardless of the shape of the population distribution. If we continue to take many random samples from the population to measure the mean and plot all the sample means, the distribution will have a bell curve shape.
Hence, we can use the dependent two tailed t-test to determine whether the average difference in performance time between the congruent and incongruent tasks are statistically significant for our population.

Dependent two-tailed t-test:

- *Dependent*: the same participants performed two different tasks.
- *T-test*: measure the mean difference between the congruent and incongruent tasks.

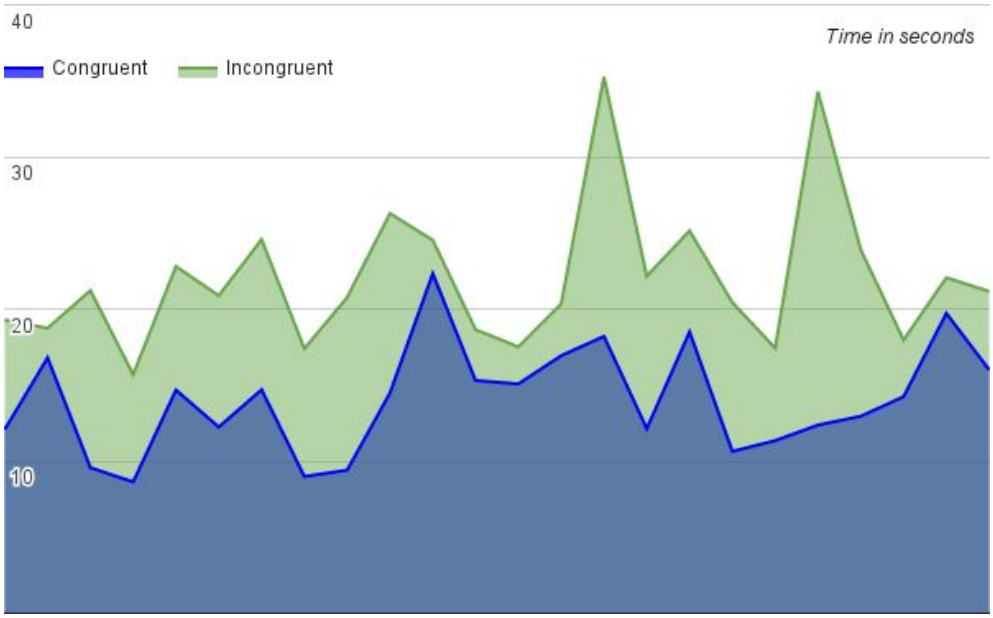
Personal Stroop effect results
Congruent: 12.604
Incongruent: 26.284

Basic Statistics

	Congruent	**Incongruent**	**Difference**
count	24.000000	24.000000	24.000000
mean	14.051125	22.015917	-7.964792
std	3.559358	4.797057	4.864827
min	8.630000	15.687000	-21.919000
25%	11.895250	18.716750	-10.258500
50%	14.356500	21.017500	-7.666500
75%	16.200750	24.051500	-3.645500

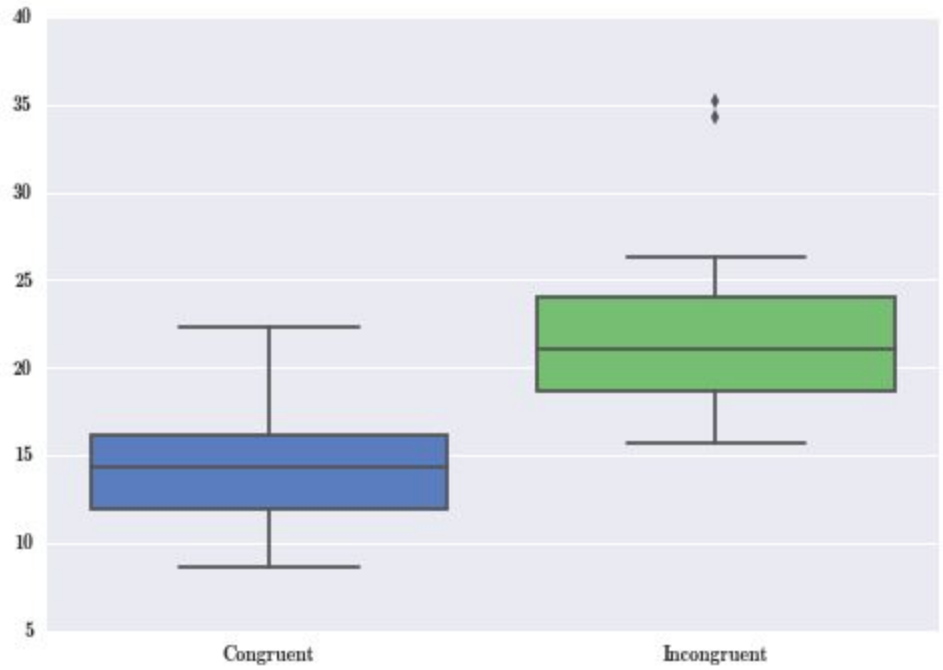
max	22.328000	35.255000	-1.950000

Congruent and Incongruent Area Plot



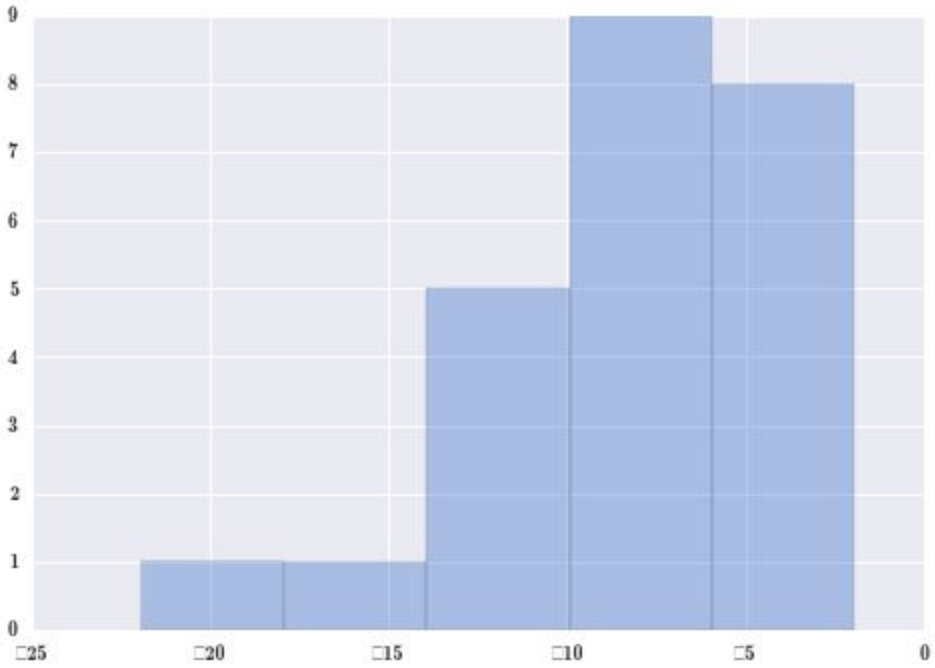
When we look at the time for all 24 participants, we can clearly see that most people complete the congruent task faster than the incongruent task.

Congruent and Incongruent Boxplot



The spread on the incongruent task is wider. Indicating that participants required more time to perform this task.

Histogram of Difference between Congruent and Incongruent



The distribution for the differences between the two sets of scores is negatively skewed. Showing that the participants have difficulties on the incongruent task.

Dependent two-tailed T - Test

Alpha = .05

T-Critical = -2.069 and +2.069

t(23) = -8.02, p < .0001, two-tailed

Confidence Interval on the mean difference at 95%, = (-8.96 to -6.97)

r^2 = .74

Conclusion

With a T-statistic of -8.02/+8.02 in the T-critical regions we get a p-value less than .0001 which is statistically significant. Therefore we reject the null hypothesis. Naming the colors with matching color words is easier than naming the colors with non matching color words.

When we apply the stroop effect, participants can perform 7 to 9 seconds faster on the congruent task but they would take 7 to 9 seconds longer on the incongruent task. For our sample of 24, 74% of the difference in performance time is due to the stroop effect.

Reference

https://en.wikipedia.org/wiki/Stroop_effect#Original_experiment

http://www.graphpad.com/quickcalcs/pValue2/

https://www.wolframalpha.com/

https://www.stat.tamu.edu/~lzhou/stat302/T-Table.pdf

https://stanford.edu/~mwaskom/software/seaborn/tutorial/distributions.html

http://support.minitab.com/en-us/minitab/17/topic-library/basic-statistics-and-graphs/hypothesis-tests/tests-of-means/why-use-paired-t/

http://www2.psychology.uiowa.edu/faculty/mordkoff/GradStats/part%201/I.07%20normal.pdf