

Test a Perceptual Phenomenon - Stroop Effect

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.

Investigation

1. Independent variable. Dependent variable

Independent variable - Congruent and incongruent words... Colored words

Dependent variable - Time taken to name the ink colors... Reaction time

2. Hypotheses for this task? Kind of statistical test. Reason for choices.

H_0 — No difference in reaction time when congruent words changed to incongruent words

$$\mu_C = \mu_I$$

H_A — Significant difference in reaction time when congruent words changed to incongruent words

$$\mu_C \neq \mu_I$$

μ_C = Population Mean, from which congruent word test sample is derived

μ_I = Population Mean, from which incongruent word test sample is derived

Why this hypothesis?

When incongruent words used then the reaction time may increase or decrease from when the words are congruent. Hence the hypothesis tests for two tailed test, and not for any specific direction.

We need a t test – because we do not know the population mean, nor the population standard deviation.

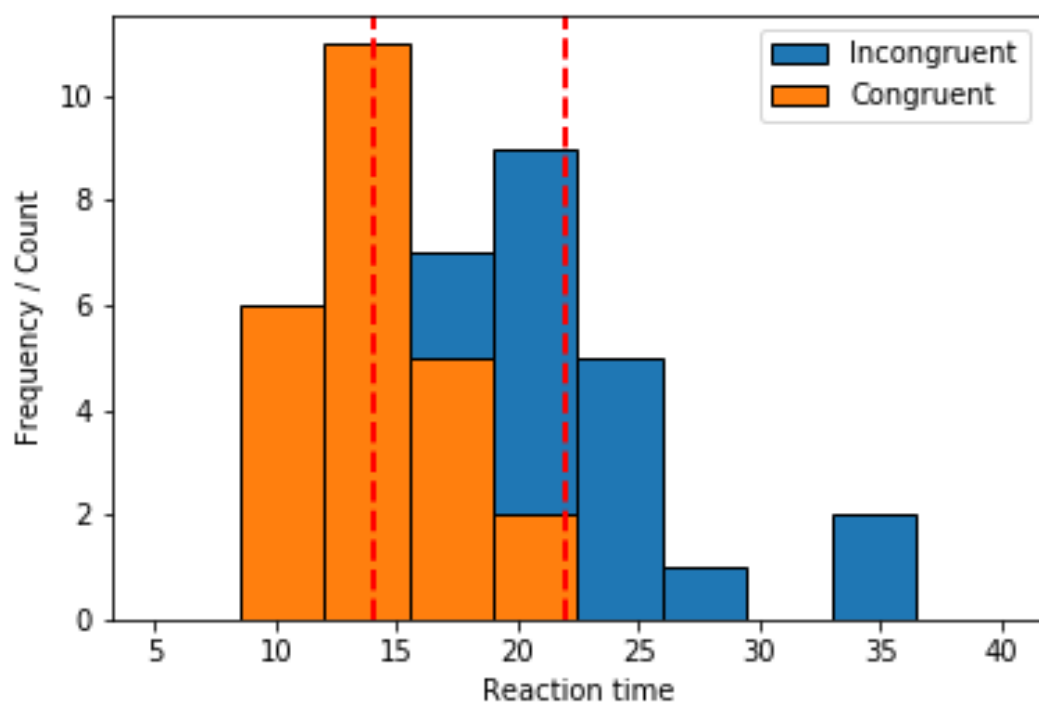
We need paired sample t-test, because the sample data is generated for the same persons for congruent words, and for incongruent words. In other words paired t-test compares one set of measurements with a second set of measurement for the same sample. It is used to compare “before” and “after” scores in experiments to determine whether significant change has occurred.

3. Some descriptive statistics regarding this dataset. Includes measure of central tendency and measure of variability.

<i>Congruent</i>		<i>Incongruent</i>	
Mean	14.051125	Mean	22.01591667
Standard Error	0.726550901	Standard Error	0.979195185
Median	14.3565	Median	21.0175
Standard Deviation	3.559357958	Standard Deviation	4.797057122
Sample Variance	12.66902907	Sample Variance	23.01175704
Count	24	Count	24

Note: Above data generated using Excel using Analysis Toolpack, option Descriptive Statistics

4. Visualizations that show the distribution of the sample data. What observed about the plot or plots.



Above visualization shows overlapping Histograms of Congruent sample data and Incongruent sample data. The red dash line shows the mean of the sample data. We can see that there is significant difference in the two groups, also that the two groups have different ranges - with incongruent group have much longer reaction time.

5. Statistical test results. Confidence level and critical statistic value. Reject the null hypothesis or fail to reject it? Conclusion in terms of the experiment task.

t-Test: Paired Two Sample for Means		
	<i>Congruent</i>	<i>Incongruent</i>
Mean	14.051125	22.01591667
Variance	12.66902907	23.01175704
Observations	24	24
Hypothesized Mean Difference	0	
df	23	
t Stat	-8.020706944	
P(T<=t) two-tail	4.103E-08	
t Critical two-tail	2.06865761	

Note: Above data generated using Excel using Analysis Toolpack, option t-test paired

Test Result

$$t(23) = -8.021, p \approx 0, \text{ two tailed}$$

$$t - \text{critical} = \pm 2.069$$

Confidence interval on the mean difference
95% CI = (-10.019477, -5.910323)

The two-tailed P value is less than 0.0001
This difference is extremely statistically significant
Hence, we reject the null hypothesis.

Based on confidence interval, we are 95% confident that the difference between congruent and incongruent group means difference is between -10.019477 and -5.910323

The results of the test match my expectations.

Resources Used

- Installed jupyter and used matplotlib in it to generate the visualization
- Using Excel for Statistical Analysis
https://ire.org//media/uploads/car2013_tipsheets/excel_stats_nicar2013.pdf
- Stroop effect
https://en.wikipedia.org/wiki/Stroop_effect
- Which type of test to use
<http://support.minitab.com/en-us/minitab/17/topic-library/basic-statistics-and-graphs/hypothesis-tests/tests-of-means/types-of-t-tests/>
- Understanding t-Tests: 1-sample, 2-sample, and Paired t-Tests | Minitab
<http://blog.minitab.com/blog/adventures-in-statistics-2/understanding-t-tests%3A-1-sample%2C-2-sample%2C-and-paired-t-tests>

Code for Visualization

```
from matplotlib import pyplot as plt
import pandas as pd

data = pd.read_csv('stroopdata-csvutf8.csv')

congruent = data.Congruent
incongruent = data.Incongruent

plt.hist(incongruent, range=(5,40), edgecolor='black')
plt.hist(congruent, range=(5,40), edgecolor='black')

plt.legend(['Incongruent', 'Congruent'])
plt.ylabel('Frequency / Count')
plt.xlabel('Reaction time')

plt.axvline(congruent.mean(), color='red', linestyle='dashed', linewidth=2)
plt.axvline(incongruent.mean(), color='red', linestyle='dashed', linewidth=2)

plt.show()
plt.savefig('stroop-hist-overlaid')
```