Stroop Effect – Test a Perceptual Phenomenon

Abstract

Stroop effect refers to demonstration of interference in reaction time of the task. In this experiment, we compare the two samples gathered using congruent words condition and incongruent words condition. The test shows there is a significant difference in the reaction time of the people in the two cases.

Introduction

Stroop effect refers to demonstration of interference in reaction time of the task. The test consists of two phases:

1. Congruent Words Condition
   Reading the color of the ink with which the words are written, given that the color of the words and the word itself are same (fig. 1).

fig. 1

2. Incongruent Words Condition
   Reading the color of the ink with which the words are written, given that the color of the ink of the words and the word itself are different (fig. 2).

fig. 2

In both the cases, the time duration of the person to read all the words in equally sized lists is measured.

Investigation

Independent Variable – Ink color congruency to word name. In other words, is the test on Congruent Words or Incongruent Words.

Dependent Variable – Reaction time of the person.

Hypothesis –

H_o – There is no significant difference in the reaction time of the two tests

($\mu_{congruent} = \mu_{incongruent}$ **or** $\mu_{difference} = 0$) at **alpha level** of **0.5**

H_A – There is a significant difference in the reaction time of the two tests

($\mu_{congruent} \neq \mu_{incongruent}$ **or** $\mu_{difference} \neq 0$) at **alpha level** of **0.5**

Where,

$\mu_{congruent}$ = Population Mean from which Congruent Words test sample is derived

$\mu_{incongruent}$ = Population Mean from which Incongruent Words test sample is derived

$\mu_{difference}$ = Difference in the population Mean of the two samples.

Why these hypothesis?

A valid choice of hypothesis is the one, which tries to validate the existence of Stroop Effect. Stroop Effect's finding [1] suggests that the semantic facilitation displayed in case of congruent words, disappears in the case of incongruent words. Hence, there must be a difference in the central tendencies of the population from which the sample is derived. Here, we try to find, is this difference significant enough to be considered. Since, we cannot take into consideration all the objects in the world (population), we need to work with the samples at hand and use the method of hypothesis and statistical testing to infer the result.

Test Proposed – Two tailed dependent sample T-test (Subject Design – Two Conditions).

Why the two tailed dependent sample T-test?

The selection of T-test is due to the fact that, we are comparing reaction time of a sample from same population in two different conditions and hence coming to a conclusion about the population.

Also, considering the skewness of the data and presence of outliers (as shown in fig. 3 and fig. 4), use of t-test ensures the robustness even if the data is not normally distributed. This ensures the violation of assumptions without any significant errors being introduced.

Descriptive Statistics on Datasets –

Run stroop_effect_test.py[2][3][4][5], to verify the results.

Congruency	Mean(time)	Median(time)	Standard Deviation(time)
Congruent	14.0511	14.3565	3.55936
Incongruent	22.0159	21.0175	4.79706

Visualize –

Run stroop_effect_test.py, to verify the results.

The boxplot clearly displays significant difference in the median of the Reaction time of the two samples. It also indicates presence of a longer range of time difference in case of incongruent test sample as compared to congruent test sample (fig. 3).

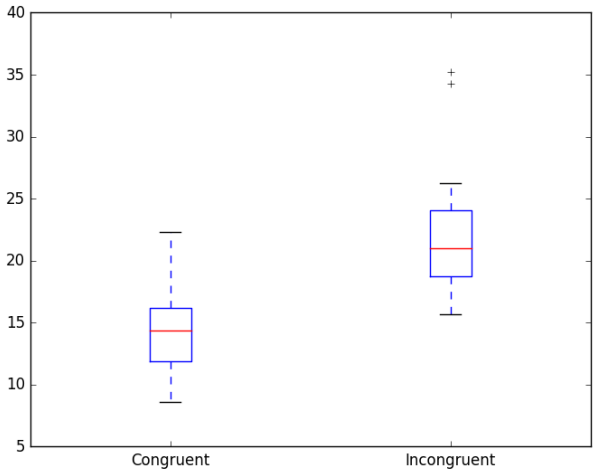

fig. 3

The histogram shows that there is a significant difference in median and mean of the two datasets. It is also evident from the plot that, there are certain outliers in both datasets. The blue dashed line represent the mean of the congruent dataset, and the cyan dashed line represent the mean of the incongruent dataset (fig. 4).

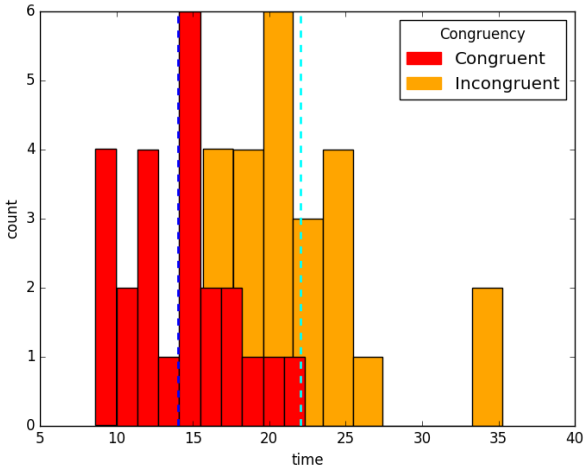

fig. 4

Test Result –

Run stroop_effect_test.py, to verify the results.

$$t(23) = -8.021, p = 0.00, two - tailed$$

$$t - critical = \pm 2.069$$

$$Confidence\ interval\ on\ the\ mean\ difference; 95\%\ CI = (-13.48, -2.45)$$

Since, **p-value is much less than, 0.025 for two tailed test**, hence, we **Reject the Null Hypothesis H_o**.

Therefore, there is a significant difference in the in the reaction time in the two conditions.

Possible Cause of Effect Observed

Considering that color detection is related to pattern detection, i.e., color is mapped to word "Yellow", this might take longer to process as compared to reading a 3 to 6 letter word as in the test. Also, since in the case of congruent words test, the mapping is directly visible in both reading and pattern recognition context. Hence, it might speed up the process of color recognition causing a significant difference in reaction time between the two tests.

Example of a Similar Test

An example of a test similar to Stroop Effect, can be Numerical Stroop Effect [6]. This test takes into consideration the magnitude as well as size (5 5) of the number. Reaction time while comparing digits in congruent trials (7 vs 3) is much faster than comparing digits in incongruent trials (3 vs 7).

Bibliography

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

[2] https://matplotlib.org/

[3] http://pandas.pydata.org/

[4] https://www.scipy.org/

[5] http://www.numpy.org/

[6] https://en.wikipedia.org/wiki/Stroop_effect#Numerical