Statistical Analysis of Stroop Effect

**Introduction**

This project is aiming to analyze the Stroop effect [Stroop, 1935] data gathered from a research similar to the resource [Stroop-test] in the references. SAS/STAT package [SAS-9.4] is being used to produce the plots, the tables and implement the analysis. The analytical results, relevant findings and graphs are discussed in this report.

In an article form the web source [WiseGeek], the Stroop effect described as follows;

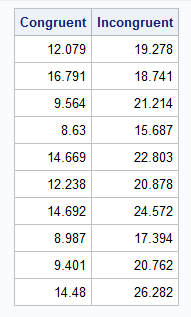
“The Stroop effect is a demonstration of the phenomenon that the brain's reaction time slows down when it has to deal with conflicting information. This slowed reaction time happens because of interference, or a processing delay caused by competing or incompatible functions in the brain”.

When caring out a Stoop test, the participants are given a set of words of colors names. In the congruent Stroop test, words of colors names are the same with the color itself. On the other hand, in the incongruent Stroop test, words of colors names and colors are different. Then the time to recognize the colors is collected.

**Data exploration**

The following table (Table 1) shows a sample of the records in the data set for the variables Congruent and Incongruent. The units of the records are time (in seconds) taken to complete the test based on the particular test criteria.

Table 1: A sample of the data in the Stroop test dataset (units: time in seconds)



The Figure 1 and Figure 2 show the histograms and density plots of data distribution of congruent and incongruent test results, respectively. The distribution of data of both plots shows fairly Gaussian like (see the density kernels) behaviors for bath variables. Based on the data in Figure 2, some individuals require relative large amount of time to complete the incongruent test.

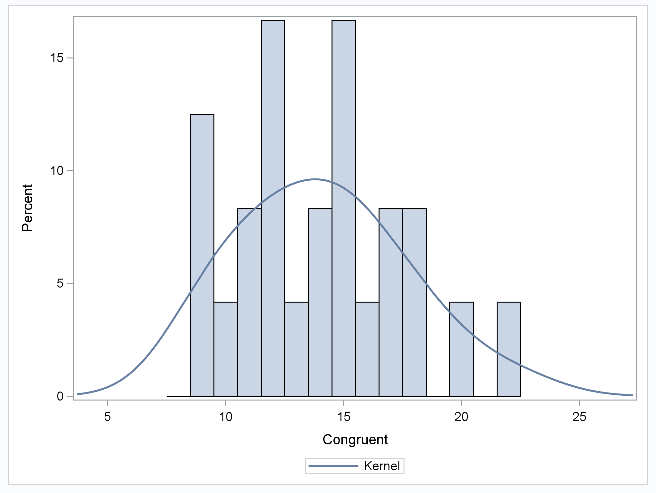


Figure 1: The data distribution of congruent test values.

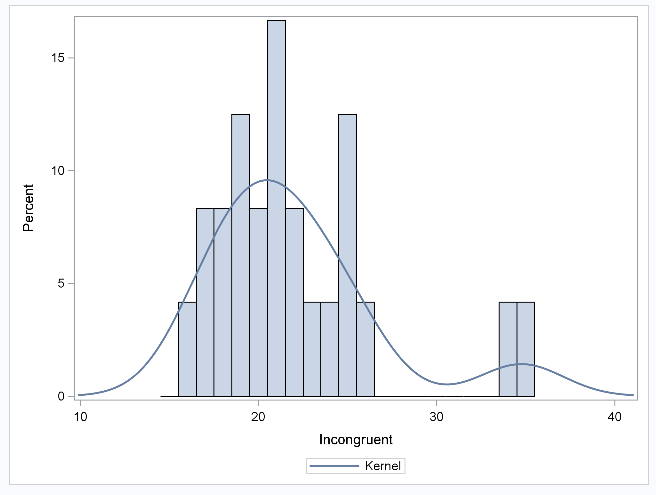
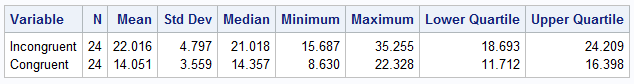


Figure 2: The data distribution of incongruent test values.

The Table 2 shows some summery statistics of the Stroop test dataset.

Table 2: The descriptive statistics of the Stroop test dataset



As shown in the Table 2, the Stroop test dataset contains 24 records for different individuals. Based on the data in Table 2, all the measured and calculated values for incongruent Stroop are greater than the corresponding values of congruent test values. The ranges (max - min) of data for incongruent and congruent tests values are 19.568 and 13.698 seconds, respectively.

Figure 3 shows the boxplots (basic statistics as graphical fashion) of one directional data distribution for the variables congruent and incongruent. In Figure 3, the differences between statistical parameters (mean, median, Q1, Q3, min and max) can be clearly seen for the two variables. In addition, there are some potential outliers visible for the variable incongruent (Figure 3).

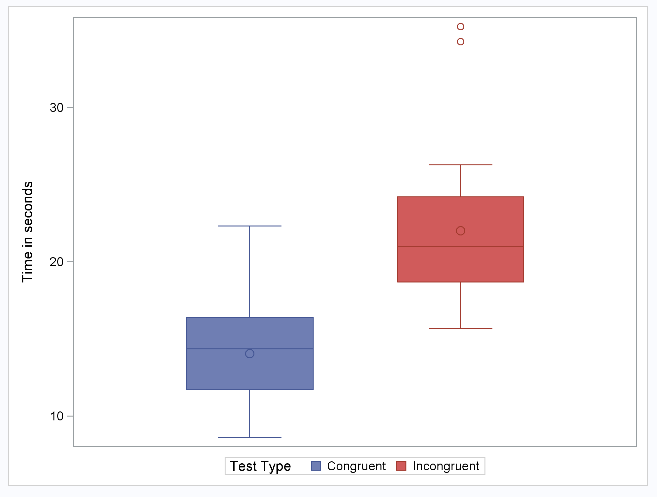


Figure 3: One-dimensional distribution of data for the variables congruent and incongruent

**Statistical test setup**

The values of incongruent and congruent tests are independent each other, because, the test criteria are different for the tests. The individual personal wise factors effect on congruent test can be affect to the incongruent test. Therefore, for this analysis, the **independent variable** is *congruent test value* and **dependent variable** is *incongruent test value* for the particular person tested.

Since the incongruent test values (Table 1 and Table 2) are greater than the corresponding congruent test values, the incongruent test values can be significantly greater than the congruent values. However, there are some overlapping of the data between the two variable can be seen. Therefore, to verify the data in the two variables are significantly different or not, two-way t-test can be carried out for the means of the variables.

For this purpose the null hypothesis (H0) is; there is no significant different between two means.

i.e., µ *(congruent)* = µ *(incongruent)*

Therefore, the alternative hypothesis (H1) is;

µ *(congruent)* < µ *(incongruent),*

where, µ *(congruent)* and µ *(incongruent)* are means of congruent and incongruent test results, respectively.

**Two sample t-test results**

The SAS t-test procedure was set to check the null hypothesis and compare the t-values at the lower level of 95% confidence level. The calculated results are discussed below.

The upper 95% confidence intervals are 12.548 and 19.990, and the lower 95% confidence intervals are 2.766 and 3.728 (Table 3) for the variables congruent an incongruent, respectively.

The t-values for both Pooled and Satterthwaite methods are -6.53. The P-values for both methods are less than 0.0001 (Table 4).

Table 3: 95% confidence levels for means of the variables congruent and incongruent

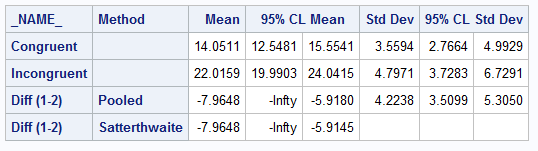
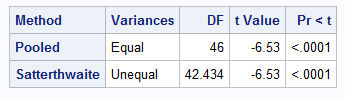


Table 4: T-test results



Since the p-value is less than 0.05, null hypothesis is rejected. Therefore, alternative hypothesis (µ *(congruent)* < µ *(incongruent)*) can be accepted. In other words, the mean of the variable congruent is significantly smaller than that of incongruent variable.

**Remarks**

Since null hypothesis is rejected, the different between the test results were confirmed to be significantly different. That is, the congruent Stroop tasks take significantly less time than the incongruent test tasks.

**References:**

Stroop-test: https://faculty.washington.edu/chudler/java/timesc.html

SAS-9.4: [www.sas.com/en\_us/software/sas9.html](http://www.sas.com/en_us/software/sas9.html)

WiseGeek: www.wisegeek.org/what-is-the-stroop-effect.htm

The Stroop test original paper: Stroop, J. Ridley. "Studies of interference in serial verbal reactions." *Journal of experimental psychology* 18.6 (1935): 643.

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