Statistics: The Science of Decisions

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Background

The Stroop test is named after J. Ridley Stroop who discovered this test in 1930. In this test the participants are asked to identify the colored letters and the test is timed. This is called as congruent test. In the next the same participants are administered the same test where the letters and colors do not match. This is called as incongruent test. On an average the second test takes considerably more time than the first , this is based on my personal test score which had a significant difference (more than twice).

Using the sample data sets, we would like to determine if there is any significant statistical difference between the congruent and incongruent tests.

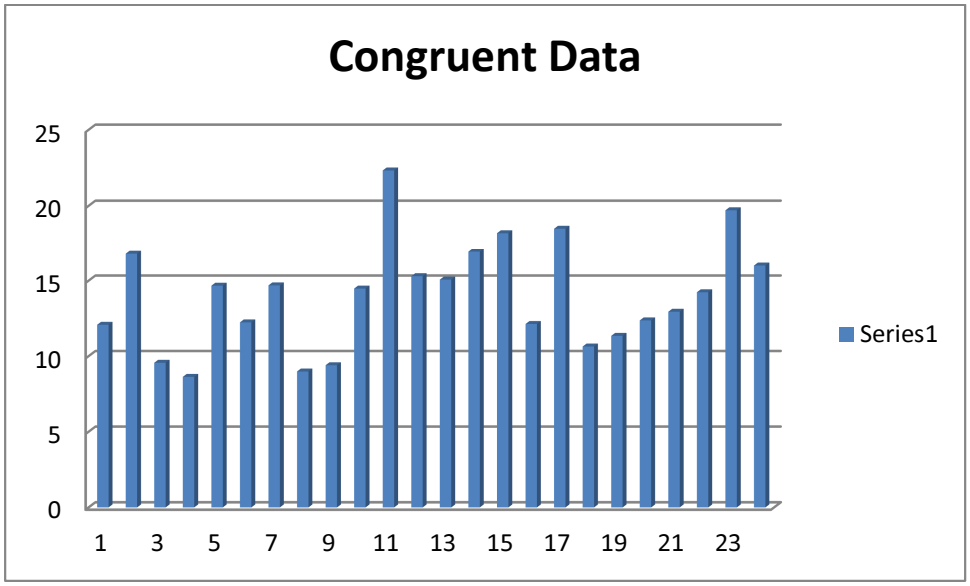
Sample Characteristics & Parameters

We have a set of time for congruent and incongruent datasets for a **sample size (N) of 24**.

Independent variable: The **words** are the independent variables

Dependent Variable: The dependent variable is the **time** taken by each participant to complete the test

Based on the sample data set, we can plot of the congruent data as follows.



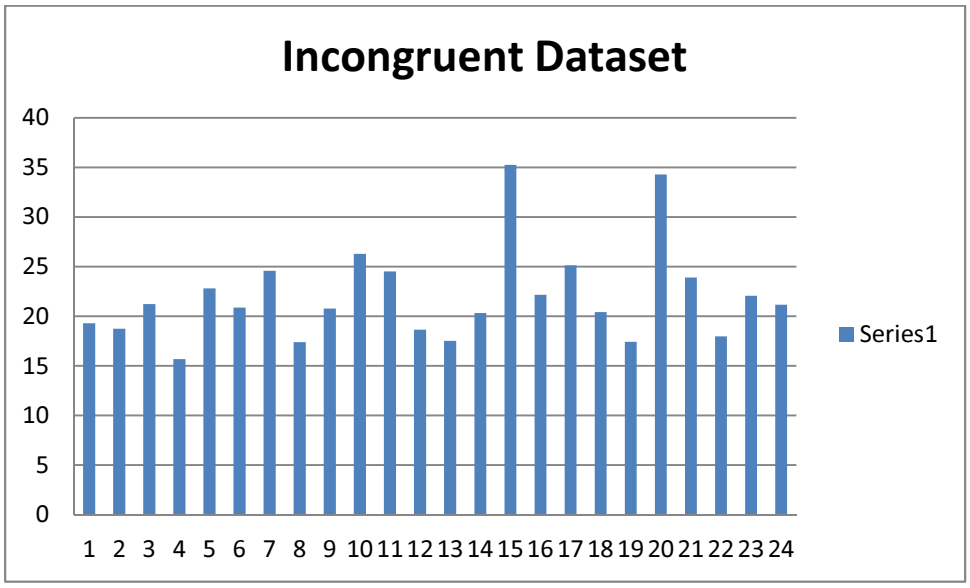
The dataset shows a more or less uniform distribution with the following Statistical parameters

Mean of the congruent sample, **Mc = 14.051 s**

Standard Deviation, Sc = 3.559

Variance, Vc = 12.669

For the incongruent data, the plot and details are as follows



The dataset again shows a uniform distribution with the following:

Mean , Mic = 22.0159

Standard Deviation, Sc = 4.797

Variance, Vc = 23.011

Statistical Study of the sample

In this case we don't have an estimate of the population parameters like population standard deviation, so z test is not a possibility. However, we would still like to understand the population behavior and the sample size is the same in both cases hence f test is not the right test for this case.

Based on the two sample data, we can perform a paired samples t test on the samples to study if the two scores are statistically different.

Based on the sample means, we would like to test if the population mean between congruent and incongruent samples is same or significantly different. This will help us further interpret and investigate the characteristics of the Stroop test

Ho: The population mean for the congruent test is same as the population mean for the incongruent test, **$\mu c = \mu ic$**

Ha: The population mean for the congruent test is statistically different from the population mean for the incongruent test, **µc != µic**.

Based on the nature of test, the two tailed test will be performed at the 0.05% level of significance or t critical value. The t critical value at 0.05% = +**- 2.069.**

The variance for the two samples, **Sp is 0.713**

Standard Error, **Se = 1.195**

The calculated value of t statistics based on the above is, **tstats = -6.532** (formula: mc-mic/Se)

R2 value: 0.481

The tstats is significantly lower than the tcritical value of +-2.064. The probability of this occurrence is much lower than **0.0001**.

The Standard deviation difference is a good measure of difference to validate this and confirm if the Standard deviation difference is different value.

Calculating the mean difference, corresponding standard deviation and t statistics is given below between the congruent and incongruent time for the sample is as follows.

Mean difference = **-7.964 s**

Standard deviation = 0.993

t statistics = mean/s.d/SQRT(N) = -8.02

The value of the t statistics also confirms the statistical significant difference between the standard deviation of the difference between the congruent and incongruent samples.

Based on the test, we can safely reject the null hypothesis and accept the alternate hypothesis.

Inference from the Statistical data

The t test clearly indicates a statistically significant difference in the mean values for the congruent and incongruent data. It can be safely assumed that the average time for congruent tests will be lower than the incongruent tests. The R2 value gives around 48% variance in the probability data.

There could be few probable causes for the variation as established by the psychologists:

- Selective attention, the brain just makes the assumption based on the colour association
- Stronger association due to the color (possibly processed in different parts of the brain)

- The act of reading individually makes the process slower

The current data set cannot provide any additional insights but clearly gives an interesting insight and potential for further controlled experiments.

It will be interesting to further experiment with the following possibilities:

1. Using shapes or forms instead of letters, this may eliminate the theory of reading the words individually
2. Changing colors to shapes/forms which can bring up possible different results.
3. Using non color words

There are many possibilities for data analysis for the test based on the mind's tendencies to form associations and selective attention.

Note on python program

The data from the python program shows minor variation than the excel calculations. This could be due to rounding errors. I have used excel values in this paper.

References

1. https://faculty.washington.edu/chudler/words.html#seffect – for Stroop test
2. https://stackoverflow.com/ - for help on python programming