Stroop Data Analysis Project

1. What is our independent variable? What is our dependent variable?

Independent variable is the congruency of words along with their Color.

The time taken to read out all the colors used, forms the dependent variable, since this measurable item is dependent on the Congruent/Incongruent word being read by the students.

2. What is an appropriate set of hypotheses for this task? What kind of statistical test do you expect to perform? Justify your choices.

Following hypotheses can be deduced with the Stroop data samples:

• We can expect the mean time taken for reading the Congruent words to be the same as the time taken to read Incongruent words (Null Hypothesis) that is:

Ho: $\mu_I = \mu_C$ (where I = Incongruent, and C = Congruent)

Or we can represent in following mathematical statements:

H0: $\mu_i \leq \mu_c$ (μ_i - population mean of incongruent values, μ_c - population mean of congruent values)

H0: $\mu_c = \mu_i$

H0: $\mu_c - \mu_i = 0$

H0: $\mu_D = 0$

• Alternatively, we can say that the time taken for reading Congruent words is always lesser than the time taken to read Incongruent words, that is:

Ha: $\mu_I > \mu_C$

Ha: $\mu_i > \mu_c$ (μ_i - population mean of incongruent values, μ_c - population mean of congruent values)

Or we can represent in following mathematical statements:

Ha: $\mu_c \neq \mu_i$

Ha: $\mu_c - \mu_i \neq 0$

Ha: $\mu_D \neq 0$

Due to the availability of smaller sample set, the presence of outliners or bias in the test data can have an impact on the results. The sample mean and standard deviation are known, but not

the population mean and standard deviation. This makes the *data ineligible for a Z-test* to be performed over the Stroop data.

A *two-tailed dependent paired t-distribution test* is an ideal candidate for this study, since the same sample is subjected to the Congruent and Incongruent word reading exercise. The dependent t-test is also designed to also look for "*changes*" between dependent sample means, which is the average word reading time, in this case.

Due to the smaller sample size available (less than 30) and can be used to study if the difference between the Congruent and Incongruent sample means is due to noise, or outliners in the sample data collected.

For statistical analysis, following can be calculated:

- The sample mean, or average time difference between reading the Congruent words, with the Incongruent words,
- The standard deviation of the data samples from the mean, and
- The deviation, or variance between the samples, and

3. Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability.

The mean and median will be calculated as part of central tendency, as they are the 2 most referred parameters in Statistical studies, while the variance and standard deviation will be computed as part of variability using **Bessel's Correction**:

1. Central tendency (values are rounded to 2 decimal points):

	Congruent data	InCongruent data
Mean	14.05	22.02
Median	14.36	21.02

2. Variability (values are rounded to 2 decimal points):

	Congruent data	InCongruent data
Variance	12.67	23.01
Standard Deviation	3.56	4.80

4. Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

It can be deducted that it has taken longer time for the student to read out the incongruent data, when compared to time taken to read out the respective congruent words.

From the data, it has taken an average of 14.05 sec for the Congruent words to be read, while it took 22.01 sec on average to read the Incongruent words.

Adding more population samples would possibly make it convenient to fit the data into a normalized curve and look for deviations from the mean reading times.

Distribution of Congruent and Incongruent Reading Times and their Respective Delta
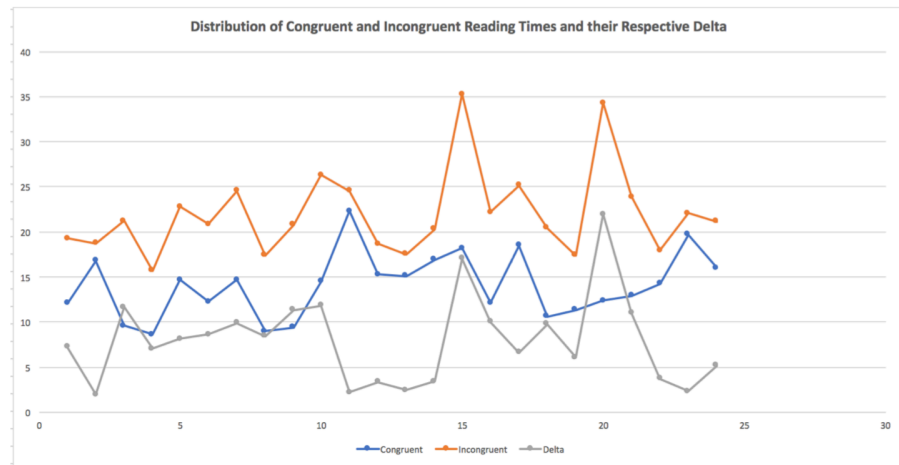
5. Now, perform the statistical test and report your results. What is your confidence level and your critical statistic value? Do you reject the null hypothesis or fail to reject it? Come to a conclusion in terms of the experiment task. Did the results match up with your expectations?

For statistical study, the difference in the Congruent and Incongruent reading time for each sample (ie. student) will be used, as the study will be focused on measuring how much longer did it take for a particular sample to complete reading both the types of visual words. A smaller difference indicates the student ranks very high in terms of identifying the words correctly. Accordingly, following is the data generated:

Congruent	Incongruent	Delta
12.079	19.278	-7.199
16.791	18.741	-1.95
9.564	21.214	-11.65
8.63	15.687	-7.057
14.669	22.803	-8.134
12.238	20.878	-8.64
14.692	24.572	-9.88
8.987	17.394	-8.407
9.401	20.762	-11.361
14.48	26.282	-11.802
22.328	24.524	-2.196
15.298	18.644	-3.346

15.073	17.51	-2.437
16.929	20.33	-3.401
18.2	35.255	-17.055
12.13	22.158	-10.028
18.495	25.139	-6.644
10.639	20.429	-9.79
11.344	17.425	-6.081
12.369	34.288	-21.919
12.944	23.894	-10.95
14.233	17.96	-3.727
19.71	22.058	-2.348
16.004	21.157	-5.153

Using the data from the "Delta" column above:

Mean = -7.964 sec

Standard deviation = 4.76

where: **N** = 24, **dF** = 23

Standard Error = 0.993 **t** = 8.0207
p-Value = 0.0001

95% CI for the difference in mean between the samples = (-10.019, -5.910)

INFERENCE: Given the very small p value above (0.0001), we can reject the Null Hypothesis (H_0), and give credence to the alternate Hypothesis (H_a), and deduce that it always takes longer time to read Incongruent words, than to read Congruent words, in agreement with the sample data collected for the analysis

6. What do you think is responsible for the effects observed? Can you think of an alternative or similar task that would result in a similar effect? Some research about the problem will be helpful for thinking about these two questions!

The Null Hypothesis is rejected because the experimental data proves that the time taken for reading Incongruent words is always higher than the time taken to read Congruent words.

Increasing the sample count can help bring down the p value, but it would still be less than 5%, which again goes on to reject the null hypothesis.

References

1. https://faculty.washington.edu/chudler/java/timesc.html
2. https://en.wikipedia.org/wiki/Bessel%27s_correction
3. https://statistics.laerd.com/statistical-guides/hypothesis-testing-3.php
4. https://study.com/academy/lesson/z-test-t-test-similarities-differences.html