

Statistics: The Science of Decisions

Project Instructions

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.

Questions For Investigation

As a general note, be sure to keep a record of any resources that you use or refer to in the creation of your project. You will need to report your sources as part of the project submission.

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

A : Independent Variables - Congruent data, since it's not dependent on any other factor

Dependent variables - InCongruent data, since many factors may affect it like time etc.

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

A : H_0 - Time taken by participant to answer congruent word is equal to the time taken by participant to answer incongruent word, i.e, stroop effect does not have effect on the time taken to answer the word.

H_A - Time taken by participant to answer congruent word is either less than or greater than or not equal to the time taken by participant to answer incongruent word, i.e, stroop effect does have an effect on the time taken to answer the word.

$$H_0: \mu_1 = \mu_2$$

$$H_A: \mu_1 < \mu_2$$

$$H_A: \mu_1 > \mu_2$$

$$H_A: \mu_1 \neq \mu_2$$

where μ_1 = mean time taken to answer congruent word, μ_2 = mean time taken to answer incongruent word

Assuming $\alpha = 0.05$

We will be performing **dependent** (since only one sample is tested twice or same set of people are involved in the test), **paired** (since tests are performed at different time intervals) **t Tests** for this scenario.

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

A: These are the observations for the dataset given:

1. Congruent : Minimum - 8.63, Maximum - 22.328
2. Incongruent : Minimum - 15.687, Maximum - 35.255

Central Tendency : a **central tendency** (or **measure of central tendency**) is a central or typical value for a probability distribution. Measures of central tendency are:

1. Mean
2. Median
3. Mode, etc.

Mean : The sum of all measurements divided by the number of observations in the data set. Mean for the data provided in the data set is :

$$\bar{X} = \frac{\sum x}{n}$$

$$x_1 = 14.051125$$

$$x_2 = 22.01591667$$

Measure of variability

Variance : **variance** is the average squared deviation from the sample mean, as defined by the following formula:

$$s^2 = \sum (x_i - \bar{x})^2 / (n - 1)$$

where s^2 is the sample variance, \bar{x} is the sample mean, x_i is the i th element from the sample, and n is the number of elements in the sample

Variance for the data provided in the dataset is :

Variance (X) - 12.66902907

Variance (Y) - 23.01175704

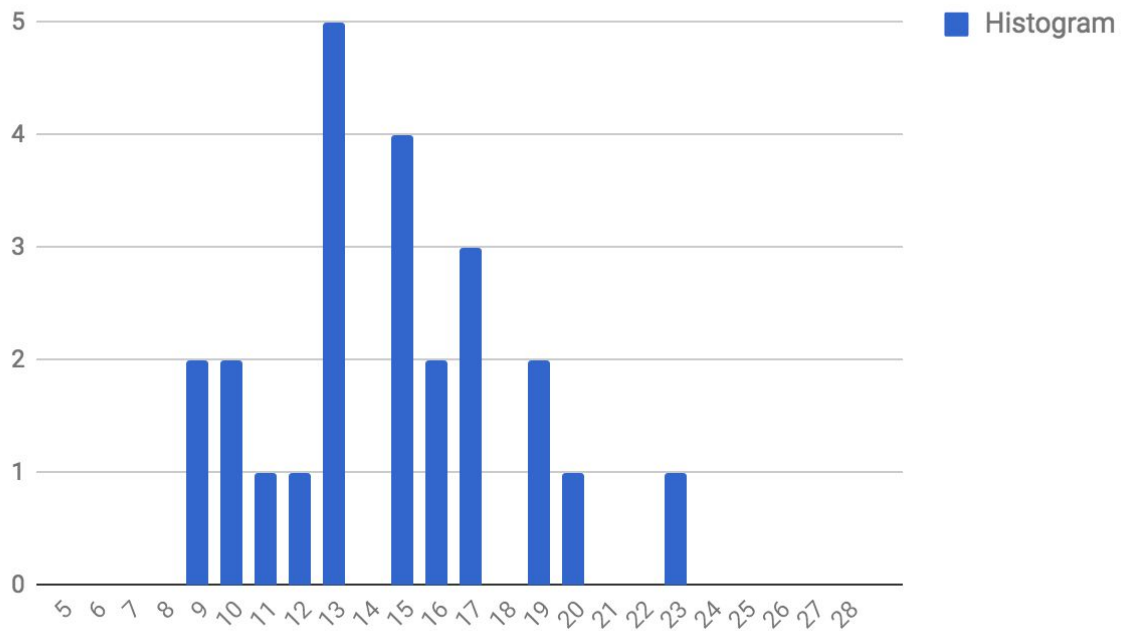
Standard Deviation : The standard deviation is a measure of the spread of scores within a set of data, calculated by the following formula:

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n - 1}}$$

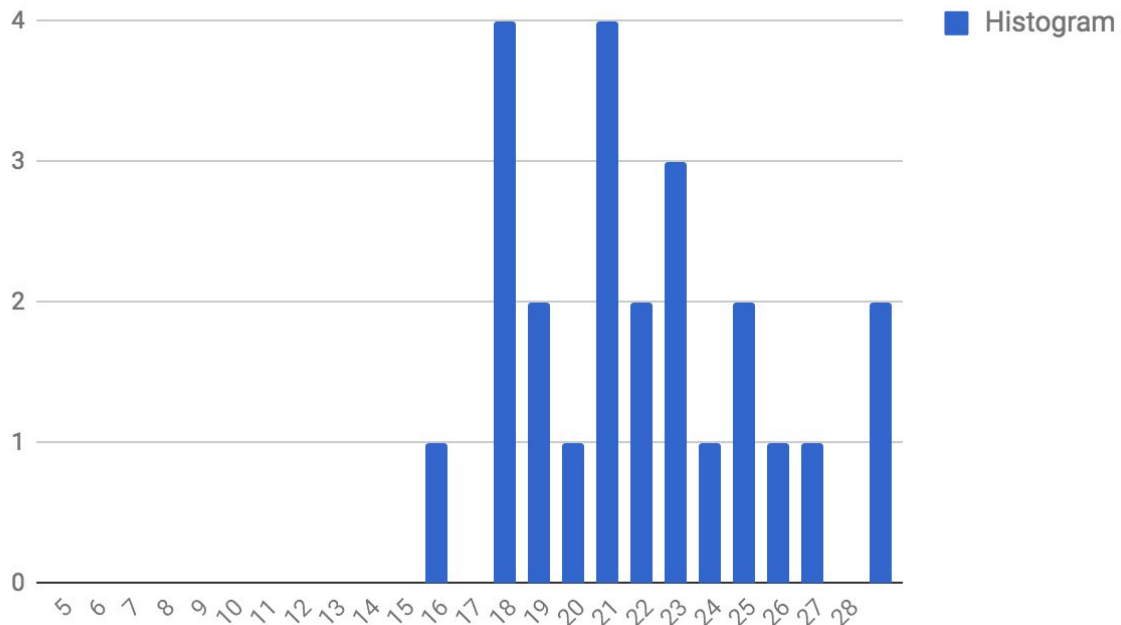
SD (X) - 3.559357958
SD (Y) - 4.797057122

**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.**

Congruent Words



Incongruent Words



As observed from the histogram, incongruent words take more time as the graph is more towards the right side as compared to the congruent words plot.

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?

A : So, the statistical test we are going to perform is 2 tailed t test with the following parameters

$\alpha = 0.05$, significance level

$n_1 = 24$, sample 1 size

$n_2 = 24$, sample 2 size

$\bar{x}_1 = 14.051125$, mean sample size 1

$\bar{x}_2 = 22.01591667$, mean sample size 2

Mean(d) = 7.964791667

Confidence Interval : The uncertainty is denoted by the confidence level. And the range of the confidence interval is defined by the following equation.

Confidence interval = sample statistic \pm Margin of error

Margin of error = Critical value * Standard deviation of statistic

To calculate M.O.E,

$t_{\text{critical}} = 2.009$, $\alpha = 0.025$ (two-tailed test), $df = (n_1 + n_2 - 2) = 46 \approx 50$ (estimating to closest value in the t table)

S.E. = 0.5884685972
M.O.E = $t_{\text{critical}} \times \text{S.E.} = 1.182233412$
T(statistic) = 13.53477773
C.I. = 6.782558255, 9.147025078

$$T = \frac{\bar{d}}{SE(d)}$$

Since, t statistic value does not lie in the confidence interval (95% region), so we can infer that **we reject the null hypothesis** and hence, Stroop test does have an effect on the time taken by a person to answer the colour correctly. Also, p-value is less than 0.00001.

Conclusion

We performed a test and assumed that it doesn't affect the time taken to name the colour. Since it has a significant difference, so we infer that the time taken to answer a congruent word is significantly less than the time taken to answer an incongruent word

No, the results doesn't match with our expectations.

6. Optional: 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!

A : As per wiki, when the name of a color (e.g., "blue", "green", or "red") is printed in a color that is not denoted by the name (e.g., the word "red" printed in blue ink instead of red ink), naming the color of the word takes longer and is more prone to errors than when the color of the ink matches the name of the color. So, our brain visualises by seeing the colour and pictures it accordingly and expects the colour name to be same as the ink colour.

Alternatives to Stroop Test :

Stress-induced eating: an alternative method for inducing ego-threatening stress

This study was designed to assess the effectiveness of a modified Stroop test as a method of inducing ego-threatening stress in dieters. Twenty females completed a Stroop task and watched a fearful film, and then consumed ice cream, *ad libitum*, under the guise of a tasting-test. It was predicted that the Stroop task would trigger greater consumption of ice cream than a fearful film, and that this effect would be more pronounced for binge-eaters than non-binge-eaters. More ice cream was consumed following the Stroop task, however both binge-eaters and non-binge-eaters consumed more ice cream after the Stroop task than the film-task. This data suggests that the ego-threatening Stroop test has potential as a standardized method for use in studies of stress-induced eating.

References :

<http://www.benlcollins.com/spreadsheets/histograms-normal-distribution/>

https://en.wikipedia.org/wiki/Stroop_effect

<http://www.sciencedirect.com/science/article/pii/S0195666300903878>