

Project 1: Test a Perceptual Phenomenon - Stroop Task

Submitted by: Bharteesh Kulkarni

Course: Udacity Data Analyst Nanodegree

Date: 09/07/2015

Introduction

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.

Q1: What is our independent variable? What is our dependent variable?

A: Independent variable in this experiment is the Congruency/Incongruency of color words and their printed colors (whether word name and color of font was same or different). Dependent variable is the amount of time taken to name the ink color in which the words are displayed.

Q2: What is an appropriate set of hypotheses for this task? What kind of statistical test do you expect to perform? Justify your choices.

A: For this experiment, **Inferential Statistics** should be used to make generalizations about the entire population from which the random samples are drawn. In other words, Inferential Statistics makes inferences about populations using sample data.

The sample dataset for this experiment contains the results from 24 participants and we will use Inferential Statistics to perform Hypothesis Testing and make inferences about the entire population using this sample data.

Hypothesis Testing:

Following set of hypotheses would be needed:

- Null Hypothesis (H_0 : There is no difference in the time taken to read congruent and incongruent words)
- Alternate Hypothesis (H_a : Time taken to read congruent words is less than time taken to read incongruent words)

tail-type: For this task, **1-tailed test** would be appropriate as the alternate hypothesis is defined in a particular direction (negative), which means, if we have a directional hypothesis we conduct a 1-tailed test.

t-test vs z-test:

Since the sample size is less than 30 and population standard deviation is unknown, a **t-test** will be appropriate for this experiment.⁵

Since the experiment is conducted on the same group of participants twice (one for congruency and the other for incongruency), **paired sample t-test** would be appropriate to compare two population means as the two samples are correlated.

Q3. Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability.

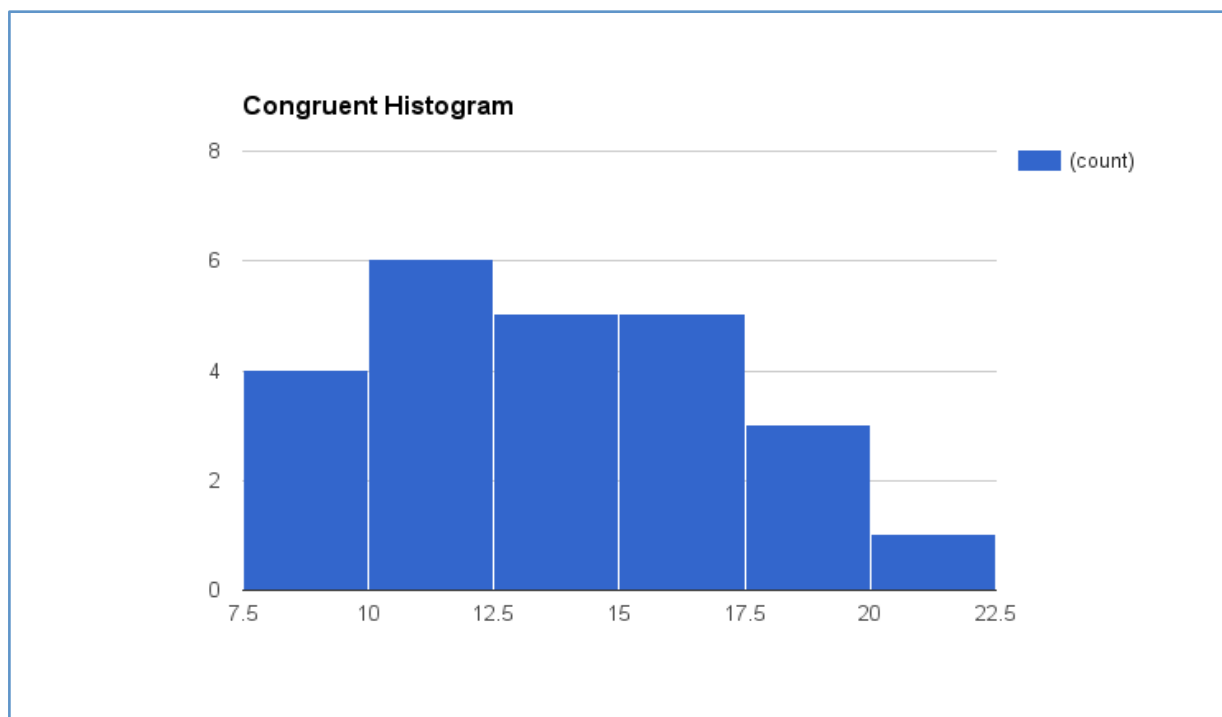
A: Measure of central tendency: Mean values for congruent and incongruent performances are shown below:

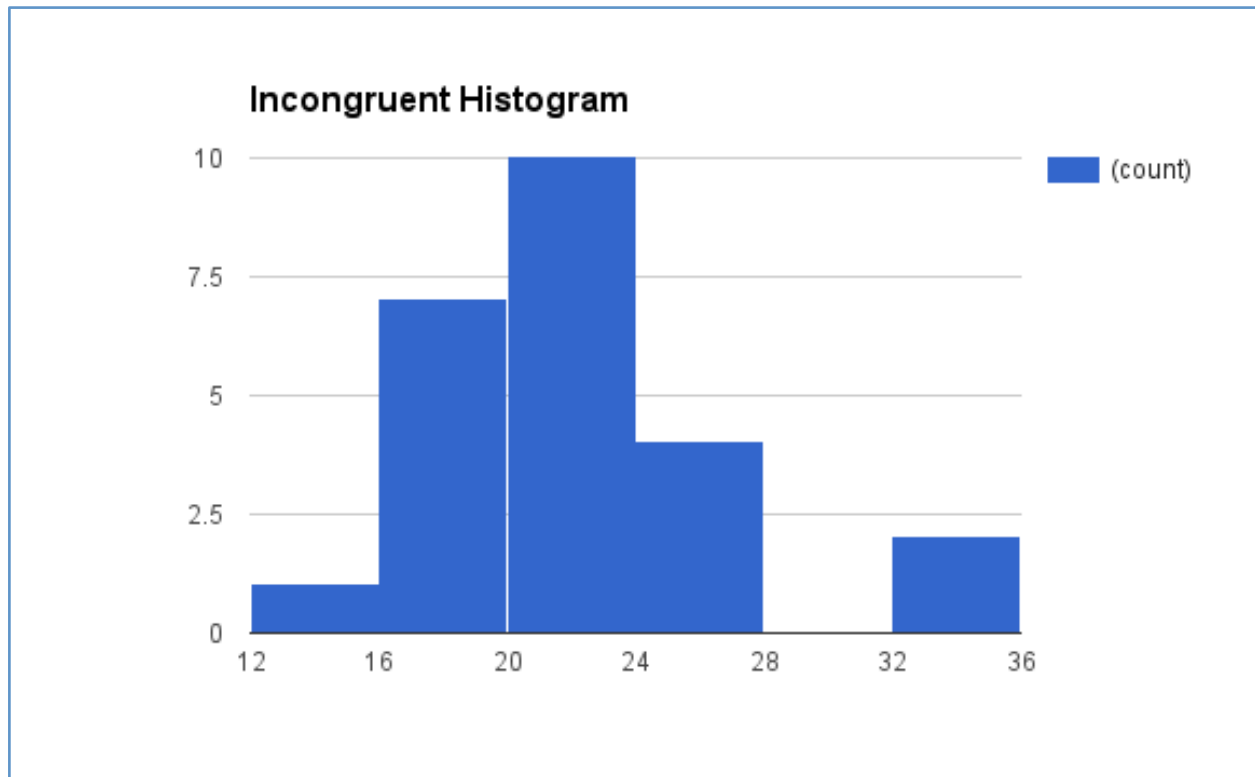
$$\mu_{\text{congruent}} (\mu_a) = 14.051, \mu_{\text{incongruent}} (\mu_b) = 22.015$$

Measure of variability: Sample Standard deviation for congruent and incongruent performances are shown below:

$$\sigma_{\text{congruent}} (\sigma_a) = 3.56, \sigma_{\text{incongruent}} (\sigma_b) = 4.80$$

Q4: 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.





Observation about Histograms:

Most of the participants took less than 20 seconds to read congruent words. However, to read incongruent words, most of the participants took over 20 seconds.

Q5. 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?

First, mean difference (d) is calculated:

$$d = \mu_a - \mu_b = -7.964$$

Standard deviation of the differences:

$$S_d = 4.865$$

Standard error of the mean difference:

$$SE(d) = S_d / \sqrt{n} = 0.993$$

t-critical value from t-table with 23 df and α value of 0.05 = 1.714

t-statistic:

$$T = d / SE(d) = -8.02$$

Degrees of freedom (df) = $n - 1 = 23$

Confidence level (α) = 0.05

1-tailed p-value < 0.0001 (calculated from www.graphpad.com with 23 df)

As the p-value is significantly less than the t-critical value, we reject the Null Hypothesis

Conclusion: Since the difference of Means is a negative number, it can be concluded from this experiment that the average time taken by participants to read Congruent words is less than the average time taken to read Incongruent words.

References

1. https://en.wikipedia.org/wiki/Stroop_effect
2. <http://stattrek.com/hypothesis-test/hypothesis-testing.aspx>
3. http://www.ats.ucla.edu/stat/mult_pkg/faq/general/tail_tests.htm
4. http://afni.nimh.nih.gov/pub/dist/HOWTO/howto/ht05_group/html/background_ANOVA.html
5. <http://www.statisticshowto.com/when-to-use-a-t-score-vs-z-score/>