# Project 1: Test a Perceptual Phenomenon

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?

Independent variable:

two task conditions: a congruent words condition, and an incongruent words condition.

Dependent variable:

the time it takes to name the ink colors in equally-sized lists

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

Null hypothesis: it takes equal time or shorter time to name the ink color under the incongruent words condition than the congruent words condition. ($H_0$: $u <= u_0$)

Alternative hypothesis: it takes longer time to name the ink color under the incongruent words condition than the congruent words condition. ($H_A$: $u > u_0$)

u: mean time to name the ink color under incongruent words condition

u0: mean time to name the ink color under congruent words condition

*This is a positive one-tail t-test for dependent mean under two conditions.* [1]

The population mean and standard deviation is unknown, the same sample is presented with both conditions.

- Interval or ratio scale of measurement

- Samples or sets of data used to produce the difference scores are linked in the population through repeated measurement and matching
- Random sampling from a defined population
- Scores are normally distributed in the population; difference scores are normally distributed

## 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 of Congruent and Incongruent is 14.051 and 22.016.

The median of Congruent and Incongruent is 14.357 and 21.018.

The sample standard deviation of Congruent and Incongruent is 3.559 and 4.797.
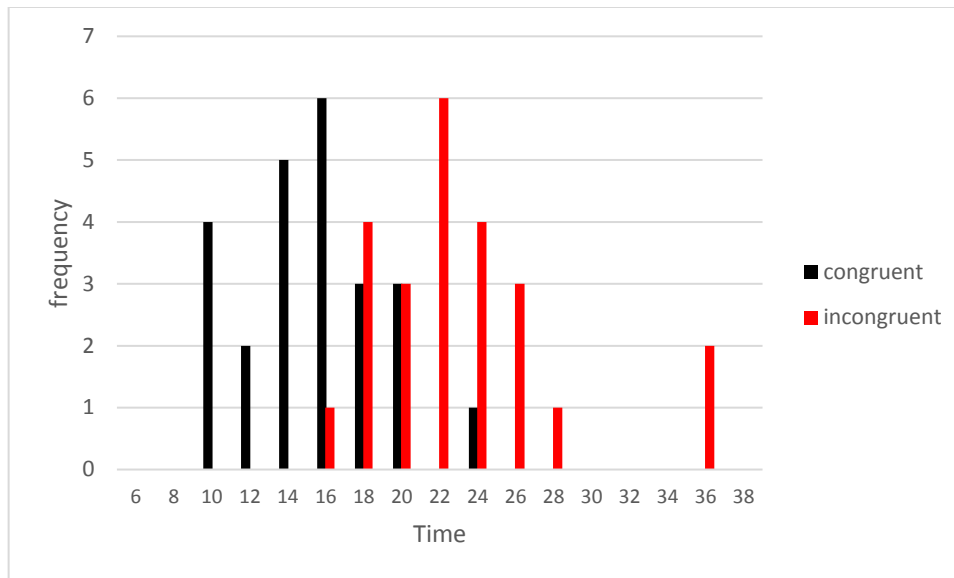
n=24, degree of freedom is 23.

The mean of the difference between conditions is 7.965.

The sample standard deviation of the difference between conditions is 4.865.

## 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.
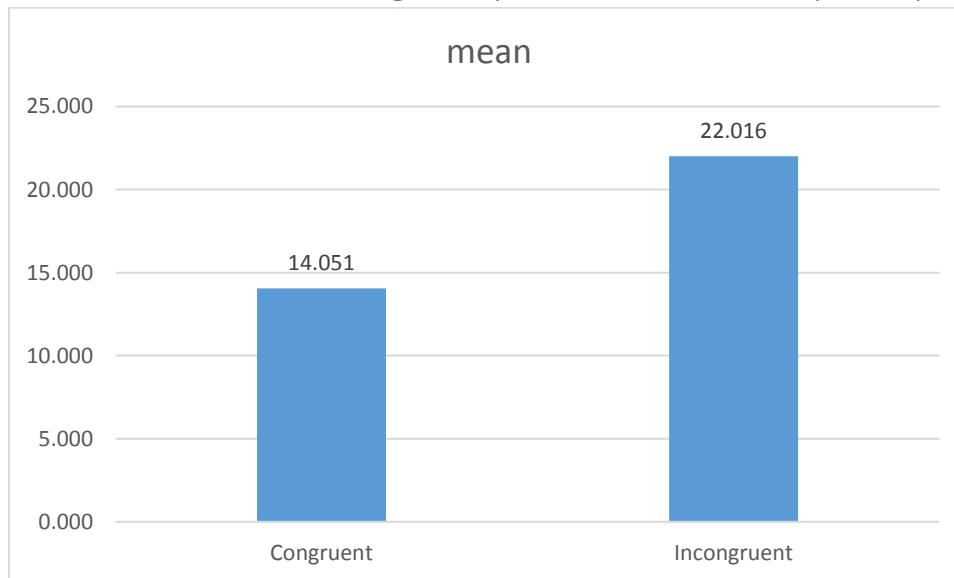


On average, it takes longer to name the ink color in the incongruent group than the congruent group.

The histogram distribution of two conditions shows incongruent tends to have longer time.

## 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?

Use one tail t-test with alpha value $\alpha = 0.001$, confidence level 99.9% and critical t value (n=24 samples, df=23) is 3.485.

Given the mean of the difference between conditions is 7.965, and the sample standard deviation of the difference between conditions is 4.865.

SEM=Sd/sqrt(n) = 4.865/sqrt(24) = 0.993

t-score = mean/SEM = 7.965/0.993 = 8.02 > critical t value, p < 0.001

Reject the null hypothesis.

Conclusion: it takes longer time to name the ink color under the incongruent words condition than the congruent words condition.

This result is same as my expectation.

## 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!

We tend to first perceive the content of the text when we see the word, rather than perceive the color of the text. This could be due to different processing speed, attention priority, automaticity of

information [2]. When the text and the color do not match, it takes longer time to process the competing information.

Similar tasks [2]: Numerical Stroop. Congruent: digits with bigger value are presented with bigger size; incongruent: digits with bigger size are presented with smaller size. Measure the time it takes to name the digit with bigger size.

**Reference**

[1] http://www.psychology.emory.edu/clinical/bliwise/Tutorials/TOM/meanstests/assump.htm

[2] https://en.wikipedia.org/wiki/Stroop_effect#Neuroanatomy