Project 2: Test a Perceptual Phenomenon

A1: The independent variable is the condition of the task, i.e., a congruent/incongruent words condition. The dependent variable is the time it takes for the participants to complete the task.

A2: The Null Hypothesis is that the time to complete the congruent and incongruent word set will be the same. The Alternative Hypothesis is that they will be different. This can be represented symbolically as follows:

$$H_0: \mu_c = \mu_i$$
$$H_A: \mu_c \neq \mu_i$$

Where H_0 is the null hypotheses, μ_c is the mean congruent time for the population, μ_i is the mean incongruent time for the population, and H_A is the alternative hypothesis.

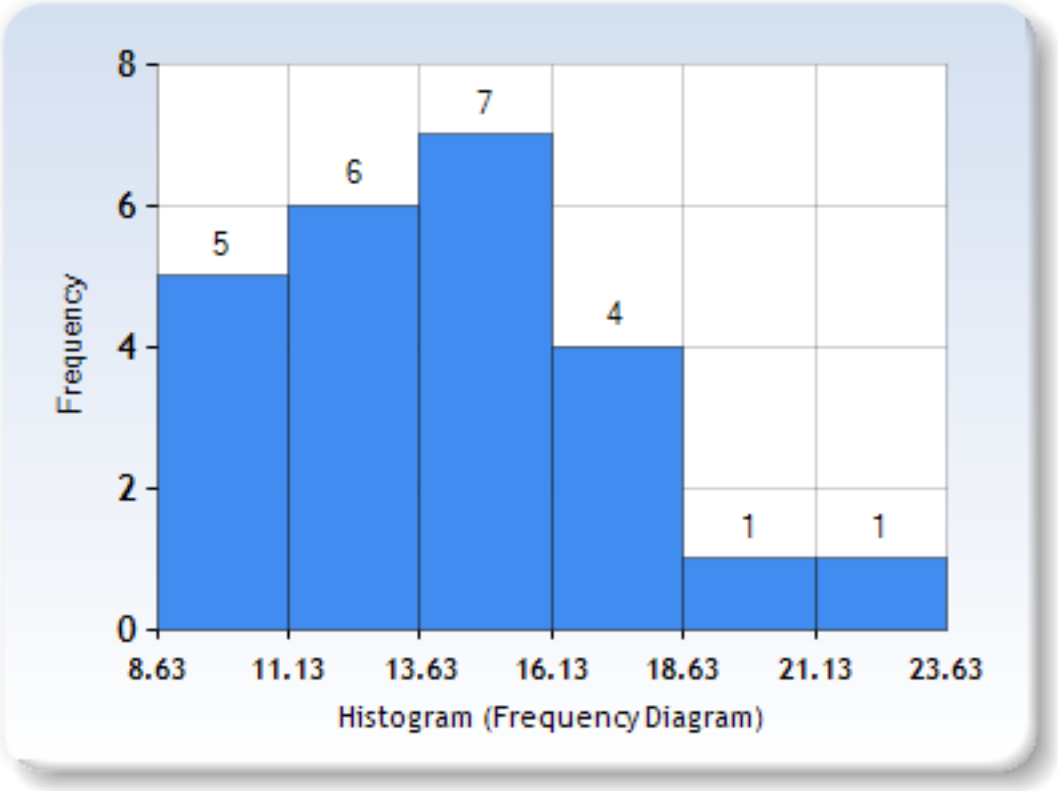
In this case, we would expect to perform a two-tailed dependent t-test. It will be two-tailed as we are unsure about whether participants' times will be faster or slower as a result of going through a congruent or incongruent word set. A t-test was selected as we do not know the population parameters and would like to compare the two samples to each other. And since the samples are related to each other, it is a dependent t-test.

A3: Descriptive Statistics:

	Congruent	Incongruent	Difference
Mean (s)	14.05	22.02	-7.96
Standard Deviation (s)	3.56	4.80	4.86

A4: Illustrations of the sample data [1]

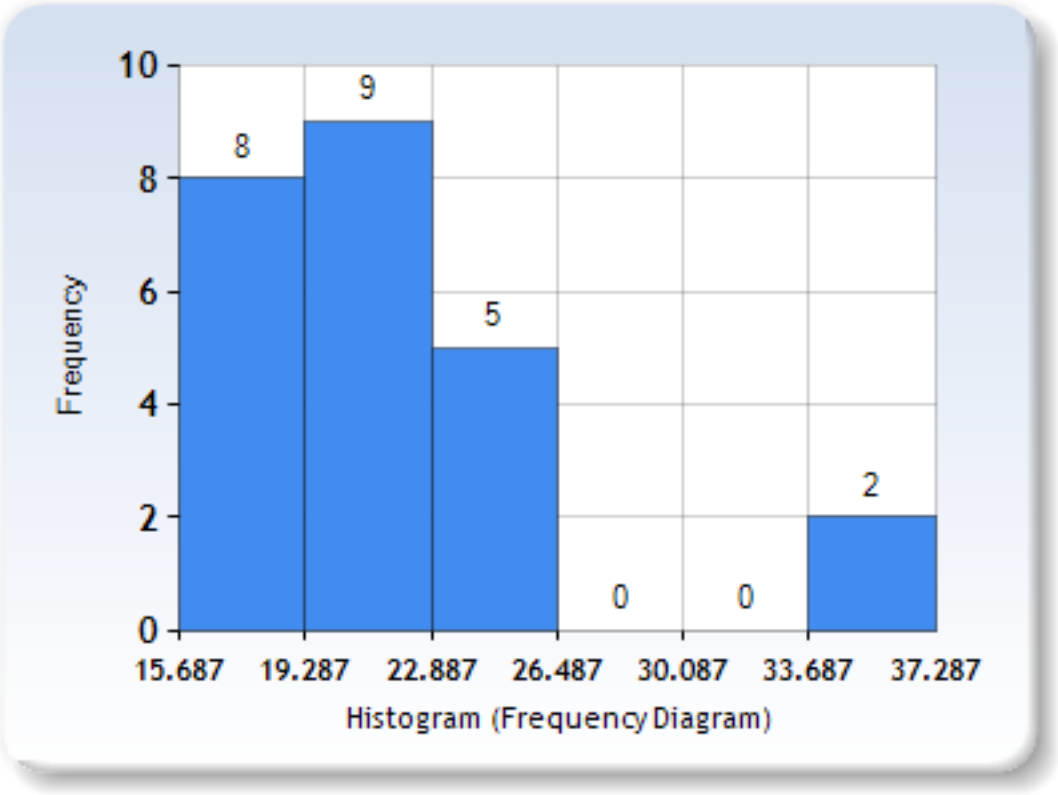
Congruent Sample



The 24 samples were divided into 6 bins and plotted as shown above. The bin ranges and frequencies are also shown in the table below.

Frequency Table	
Class	*Count*
8.63-11.129	5
11.13-13.629	6
13.63-16.129	7
16.13-18.629	4
18.63-21.129	1
21.13-23.629	1

Incongruent Sample



The 24 samples were divided into 6 bins and plotted as shown above. The bin ranges and frequencies are also shown in the table below.

Frequency Table	
Class	*Count*
15.687-19.286	8
19.287-22.886	9
22.887-26.486	5
26.487-30.086	0
30.087-33.686	0
33.687-37.286	2

When comparing the two histograms one can see that the range of the congruent and incongruent samples vary. The congruent sample's range is 8.63 – 23.63, whereas the incongruent sample's range is 15.69 – 37.29. The bin with the largest number of subjects for the congruent sample is 13.63 – 16.13, and for the incongruent sample it is 19.29 – 22.89. At first glance it looks as though the incongruent sample has slower times than the congruent sample.

A5: Statistical Test

In order to analyze the data, a two-tailed dependent t-test will be performed at a confidence interval of 95%. For a sample size of 24, with 23 degrees of freedom, this results in $t_{critical}$ = +/-2.069

In order to compare the two situations, the difference in the time between the congruent and incongruent situations is calculated for each subject. This is then used to calculate the mean and the standard deviation.

Mean Difference = -7.96
Standard Deviation = 4.84

This results in a t-statistic of -8.021, and a corresponding p value of less than 0.0001. When compared to the t-critical value, the calculated t-statistic is beyond the $t_{critical}$ value. As a result we reject the null. [2]

This result is in line with the initial observations. It took statistically significantly less time to complete the word set for a congruent sample versus an incongruent sample.

A6: A reason for the difference in times could be attributed to the additional computation required for one's brain to correctly distinguish between a word's meaning and it's colour when the two are out of sync. Alternatively, when the two are in sync, the brain can rely on the first interpretation it sees, the colour of the word. As a result, it does not have to register both the colour and the meaning and then distinguish the correct answer.

One might expect to see a similar result when participants are asked to identify the direction of an arrow (N, S, E, W) when the arrow is placed in a congruent location with respect to the center of the screen, versus when the arrow is located at incongruent locations. So an incongruent example might look like an arrow pointing east, but in the west location with respect to the screen. [3]
For a link to the calculations, please see the following Google Sheet:
https://docs.google.com/spreadsheets/d/1ih5hU71qi2pF20bFwX4qv8449jPyNHkeVL85rFPCia8/edit?usp=sharing

Resources:
[1] http://www.socscistatistics.com/descriptive/histograms/
[2] http://www.graphpad.com/quickcalcs/pValue1/
[3] https://en.wikipedia.org/wiki/Stroop_effect#Variations