P1: Test a Perceptual Phenomenon - the Stroop effect

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

Our independent variable is a binary categorical variable: the condition of the words list, which can be congruent or incongruent - considering that the size of each list is held constant.

Our dependent variable is the total time in seconds taken to name out loud the colors of the words in the list.

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

An appropriate set of hypotheses for this task is composed of:

- a null hypothesis (H_0): there's no difference between the population time mean to say the colors in the congruent condition (μ_c) and the population time mean in the incongruent condition (μ_i): $\mu_c = \mu_i$;

- and an alternative hypothesis (H_1): the population time mean to say the colors in the congruent condition (μ_c) is different from the population time mean in the incongruent condition (μ_i): $\mu_c \neq \mu_i$.

The most appropriate statistical test for this study is a paired t-test, based on what's listed below:

- we want to compare the means of two dependent samples;
- we don't know the population's parameters, specially the population's standard deviation;
- the sample sizes are below 30;
- we assume the distribution of the sample means are normal distributions.

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

Measures	Congruent Condition	Incongruent Condition
Mean (sec)	14.05	22.02
Median (sec)	14.36	21.02
Variance (sec)	12.67	23.01
Sample Standard Deviation (sec)	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.
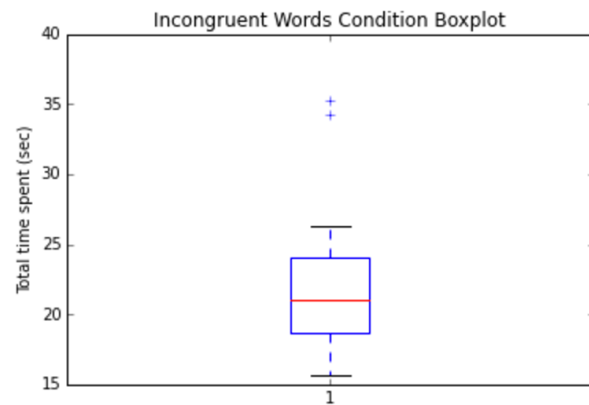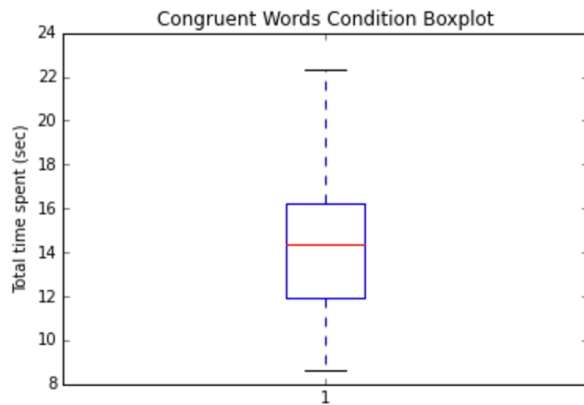
First, we have the box plots for the congruent and incongruent conditions. From them, we can notice that the results in the congruent condition have a broader distribution and present a lower mean. The congruent condition set has a more concentrated pattern and presents two outliers.
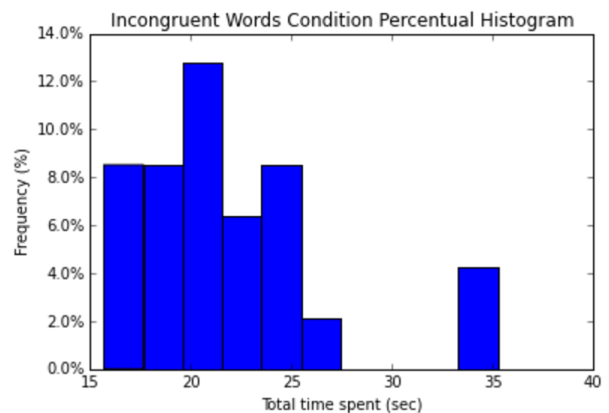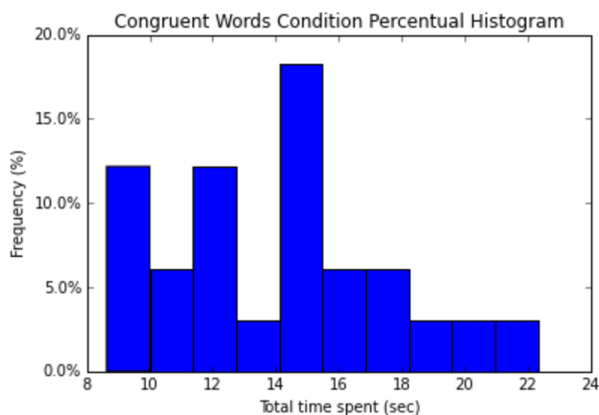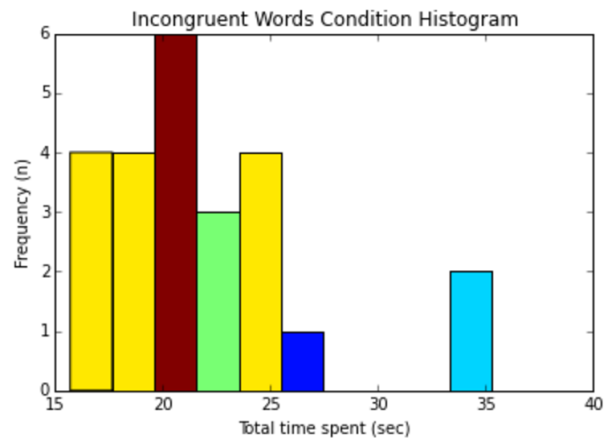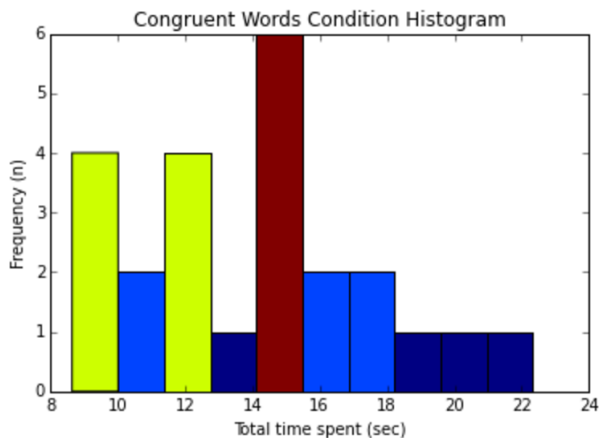
Next, we have 2 sets of histograms for both conditions, one expressing frequency in number of events and the other in percentual of total events. From them, we can also notice that the congruent condition set is more broadly distributed, with a greater number of less frequent observations. In the congruent condition, the most frequent time bin is between 14 and 16 seconds, while in the incongruent, the most frequent is between 21 and 22 seconds. Additionally, we can notice that both data sets are positively skewed.

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?**

I used a two-tailed t test with $\alpha = .05$, for which the t critical value is ± 2.07. The results are as follows:

$$t(23) = -8.02, p < .01, \text{two-tailed}, r^2 = .74$$

As $t > -2.07$, we can reject the null hypotheses for a confidence level of 95%. This means that the time mean in the congruent condition was significantly lower than the mean in the incongruent condition. In other words, we can conclude that it actually takes longer to say out loud the the color of the ink in the incongruent condition. And these results match up with my 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!**

The effects might be due to the fact that we tend to read the words when we have to say the colors out loud, so saying the colors as they are written feels more fluid to our brain and therefore it takes less time. When we have to focus on the actual color of the words, we have to fight against our tendency to read them, and as it takes more focus and effort to be done, it takes longer.

Another task that would probably result in a similar effect would be having to discriminate the direction of an arrow when it appears pointing upwards or downwards randomly above or below a reference point. We would tend to report the relative position of the arrow instead of its pointing direction.