Project 1: Test a Perceptual Phenomenon

In a Stroop effect experiment, participants are requested to look at a list of words. Each word is a color name and is displayed in a color which is congruent or incongruent with the color name. The participant's task is to speak out loud the color name of the displayed word.

The task has two conditions:

- a congruent-word condition: the color of displayed words match with the color-name the words saying
- an incongruent-word condition: the color of displayed words don't match with the color-name the words saying

In each case, we measure the time it takes a participant to name the color in equally-sized lists. Each participant will go through and record a time for each condition.

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

The independent variable is the printed word naming colors which the color and the printed word may or may not point to one color.

The dependent variable is the time (in second) a participant need to view all the words in the list and notice the color & word incongruence or congruence.

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

Hypotheses

I hypothesize that incongruently printed words don't have an effect on how long it takes someone to finish naming the color-name in a list of words. In other words, I use the null hypothesis in which the difference between each subject's congruent (μ_1) and incongruent (μ_2) tests will not be significant.

$$\mu_\Delta = \mu_2 - \mu_1$$
$$H_0: \mu_\Delta = 0$$

From the background information, the alternative hypothesis is that the difference between each subject's congruent and incongruent tests will be significant.

$$H_A: \mu_\Delta \neq 0$$

Kind of statistical test

I expect to perform a dependent t-test on the given data to determine if my null hypothesis should be accepted or rejected. Because a t-test allows me determine if the set of values in one sample (incongruence) is different enough from a random sample from a population (incongruence and congruence) to conclude that the incongruence is definitely making an impact on word color identifying time or not.

As stated in Wikipedia, "Paired samples t-tests typically consist of a sample of matched pairs of similar units, or one group of units that has been tested twice (a "repeated measures" t-test)." I decided to perform the dependent t-test for paired samples since the two samples are paired. Additionally, in order to use this test, the data needs to be normally distributed. Therefore, I expect to examine the data set to verify if it is normally distributed.

My personal Stroop times (added to the data set file):

Congruent: 21.238

Incongruent: 55.947

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

Measure of central tendency: Mean and Median
Measure of variability: standard deviation (std)

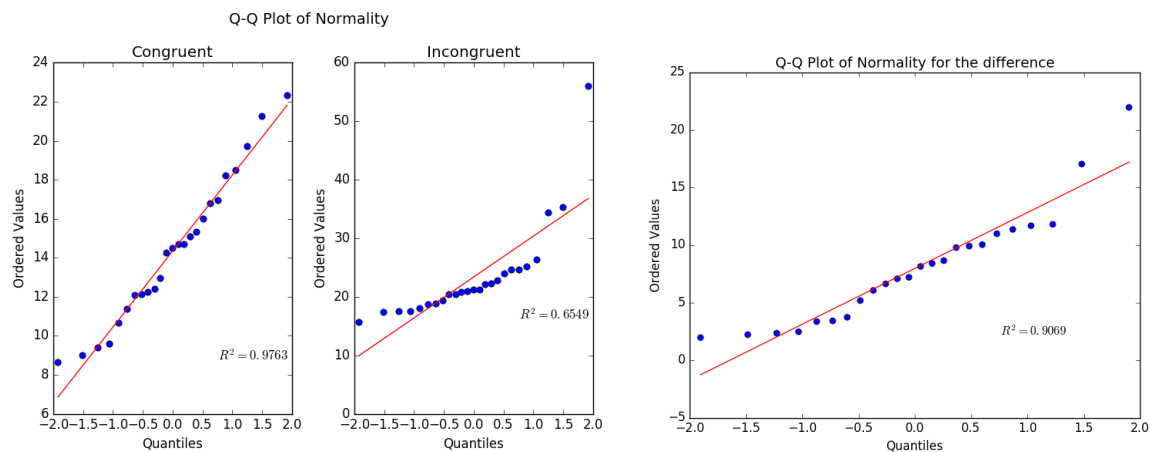|	**Congruent (μ_1)**	**Incongruent (μ_2)**	**Difference (μ_Δ)**
count	25	25	25
mean	14.3386	23.37316	9.03456
std	3.769244	8.252616	7.161742
min	8.63	15.687	1.95
1st 1/4	12.079	18.741	3.727
median	14.48	21.157	8.134
3rd 1/4	16.791	24.524	10.95
max	22.328	55.947	34.709

Since the median and mean are also relatively close in each sample, there is a possibility that this data set is normally distributed.

On the other hand, all statistical measures of central tendency such as mean, median, standard deviation between two samples are far different. Actually, Incongruent Test's numbers are much higher.

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.
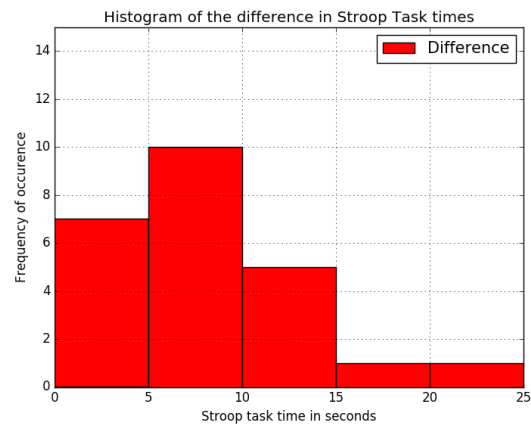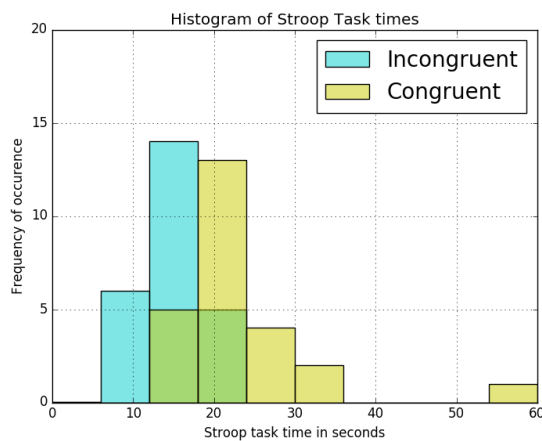
Note: green represents where the Congruent and Incongruent plots overlap

It can be seen in the above diagrams (both the Histogram and QQ plots), the sampling distributions of both samples and the difference appear normal. However, there are one outlier points at the upper end of the Incongruent data. These points are not highly influential. Without the outlier points, the means and median in each sample are very closely matched - reflecting normal distributions.

5. Perform the statistical test and report the results.

degrees of freedom: 24

tt statistic: 6.30751607288

p value: less than 0.0001 (1.60751712516e-06)

What is your confidence level and your critical statistic value?

My confidence level is 99% with a critical value of ± 2.78743581.

Do you reject the null hypothesis or fail to reject it?

I confidently reject the null hypothesis.

Come to a conclusion in terms of the experiment task.

It is easily concluded that in the incongruent task it takes longer time than it does in the congruent task.

Did the results match up with your expectations?

Yes, it did. After try the experimental site, my initial expectation is that the time to take incongruent tasks must be longer than it to take the congruent test.

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!

This effect is quite interesting showing that human's brain cannot work on multitasks at one time. In this experiment, a part of your mind is processing "reading the word" or to understand "what is it" of the word first, and then using a different part of the brain for processing the printed color of the word. The second part of the test requires a lot of concentration to complete – which accounts for the difference in the reaction times.

Another experiment, I can think of is that most of people can read "unorganized order" words or word letter mixing. For example, if you have the following phrase: "Pehadplhiila is the lergsat city in Pnvsynlaniea", you can read its meaning of ": "Philadelphia is the largest city in Pennsylvania". As you can see, the text is still readable yet disorganized, but it takes more time for us to read.

References:

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