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?

The independent variable is the list of words the participants of the Stroop task are presented with, with each word displayed in a color of ink. Since the task has two conditions, the independent variable also has two conditions. When the task is in the congruent words condition, the words being displayed are color words whose names match the colors in which they are printed. When the task is in the incongruent words condition, the words being displayed are color words whose names do not match the colors in which they are printed.

The dependent variable in both cases is the time it takes to name the ink colors in the 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.

We compare the results of two tasks executed by a group of participants. What I want to do is to determine if the difference in the time it takes to name the ink colors in both cases did not occur by chance, but is something that can be attributed to the whole population. This leads to the following hypotheses:

H0: $\mu C = \mu I$,the population mean of the congruent condition is equal to the population mean of the incongruent condition, where μC is the congruent condition mean and μI is the incongruent condition mean.

Ha: $\mu C \neq \mu I$,the population mean of the congruent condition is not equal to the population mean of the incongruent condition, where μC is the congruent condition mean and μI is the incongruent condition mean.

H0 (null hypothesis) assumes that the population means of the two conditions are not significantly different.

Ha (alternative hypothesis) assumes that the population means of the two conditions are significantly different.

We only have samples and we don't know the population parameters μ and σ. Therefore we must work with a t-distribution and a t-test. The t-test is a repeated measures design since every participant participates in both tasks. This also means that any carry over effects are not taken into account.

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

The sample mean of the congruent task is 14.05.
The sample mean of the incongruent task is 22.02.
The sample mean of the difference between the two tasks is -7.96.
The standard deviation of the congruent task is 3.56 (used Bessel's correction)
The standard deviation of the incongruent task is 4.80 (used Bessel's correction)
The standard deviation of the difference is 4.86

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.
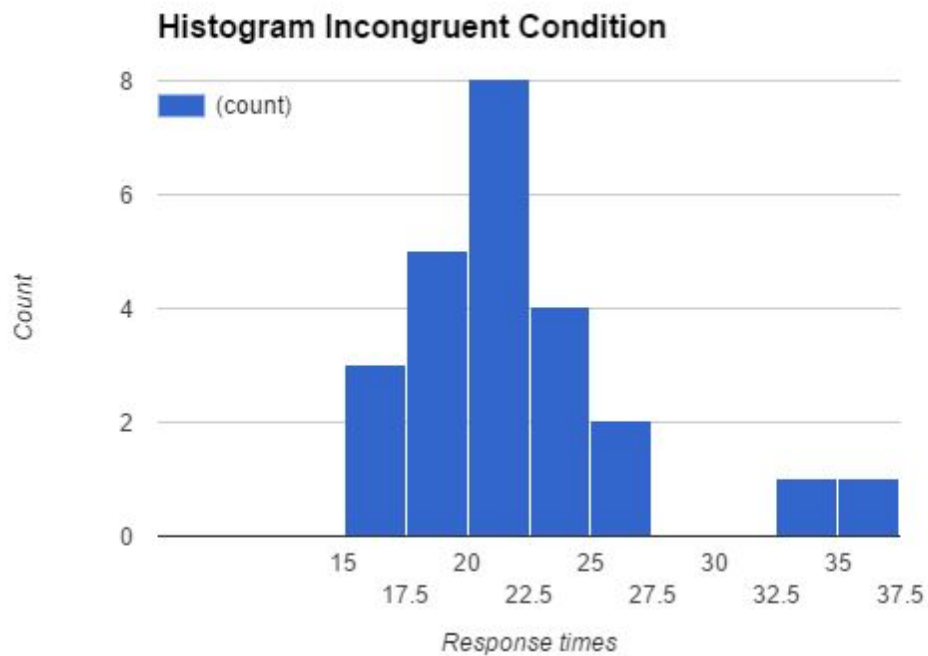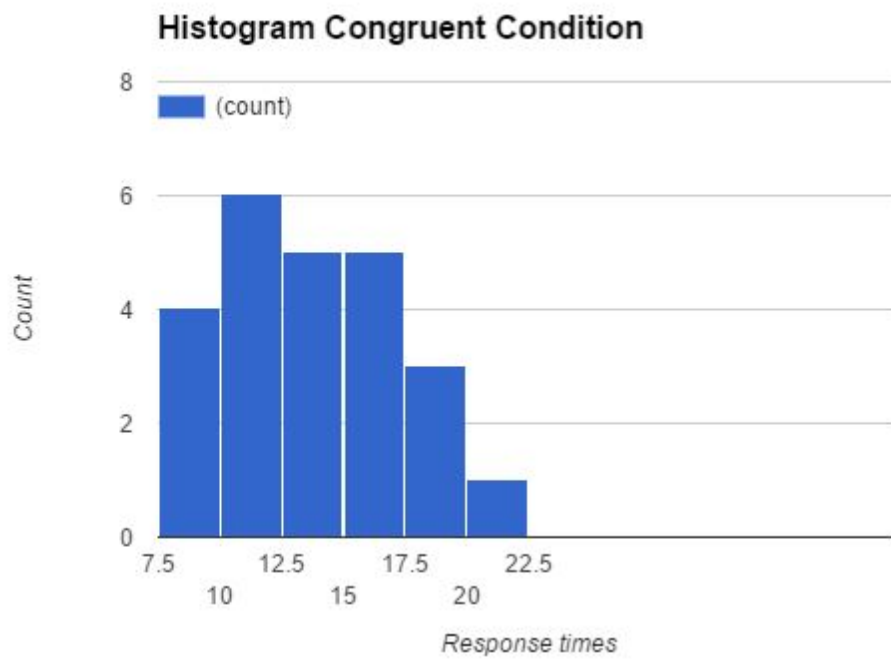
There is a visible difference between the conditions in terms of both central tendency as spread. The congruent condition has on average lower response times and a smaller spread.

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?

As confidence level I use α = 0.05.
It is a two-tailed test.
Df = 23.
T-critical = ± 2.069
As part of question 3 I already calculated the standard deviation of the difference between the two conditions: 4.86
As part of question 3 I also calculated the sample means: 14.05 and 22.02.
The t-statistic is the difference between the sample means of two conditions divided by the division of standard deviation of the difference with the root of the sample size:
(14.05-22.02)/(4.86/sqrt(24))= -8.02
The two-tailed P value is less than 0.0001. (used graphpad)
The t-statistic lies beyond the t-critical value. Therefore I reject the null hypothesis.
This is in line with my expectation based on the Stroop tasks I did myself.
To summarize, the probability that the significant difference in time between the two conditions is due to chance, is extremely small. We can therefore expect to see significant differences every time we repeat the Stroop tasks.

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!

According to the wiki page on the Stroop effect, there are multiple theories that explain the Stroop effect, but all theories have in common that a conflict in the processing of relevant and irrelevant information causes delays in processing.The most common explanation is the automaticity theory: "It suggests that since recognizing colors is not an "automatic process" there is hesitancy to respond; whereas, the brain automatically understands the meaning of words as a result of habitual reading." (taken from wikipedia)

An alternative task that would result in a simular effect would be any task where the written information and the displayed information are not aligned. For example showing arrows with a direction mentioned in the arrows in words where an arrow pointing to the right contains the text up. Or (taken from wikipedia) combining basic emotions via emoticons with words.

Used sites:

http://www.graphpad.com/quickcalcs/ To calculate the p-value

To answer question 6