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:
    - task condition: congruent words (variable: 1) or incongruent words (variable: 2)
- Dependent variable: Time to name all the colors of the words (variable: t)

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

- Dependent t-test (one-sample), two-tailed test
- Hypothesis:
    - Null hypothesis: $\mu_{(congruent)} = \mu_{(incongruent)}$
    - Alternative hypothesis: $\mu_{(congruent)} \neq \mu_{(incongruent)}$
    - $\mu_{(congruent)}, \mu_{(incongruent)}$: time needed to complete the task (population mean)

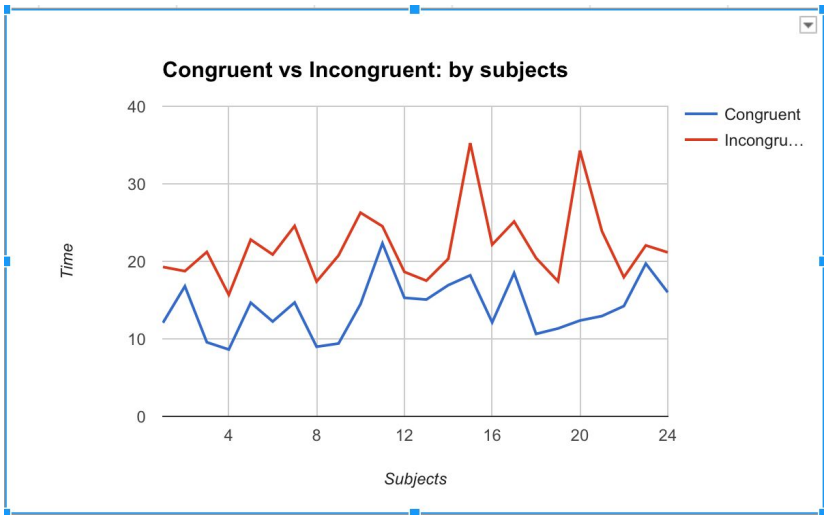
- Explanation:

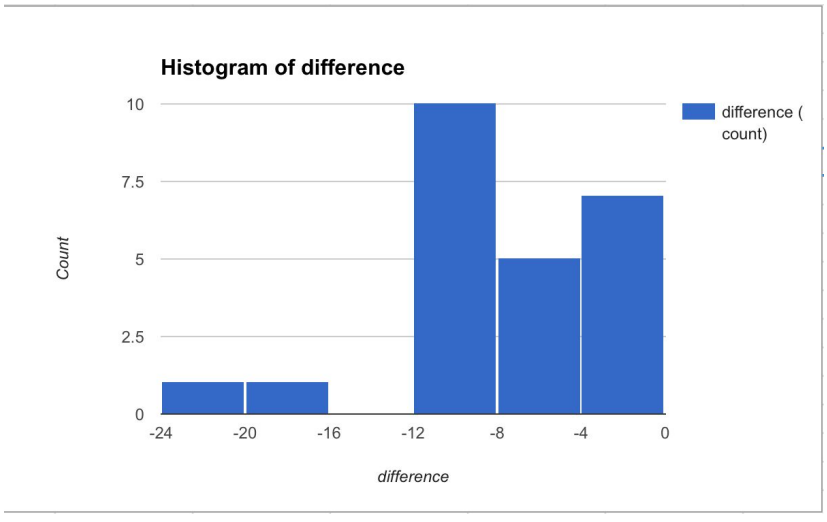
- Dependent t-test: The same participants took the task twice. So the sample is dependent and dependent t-test is needed.
- Hypothesis: By comparing the sample mean time of each conditions, we can estimate whether the population mean of each task completion time would show significant difference.
- Significance level: The significant level was set to two-tailed p value < 0.05 (no direction and more conservative).

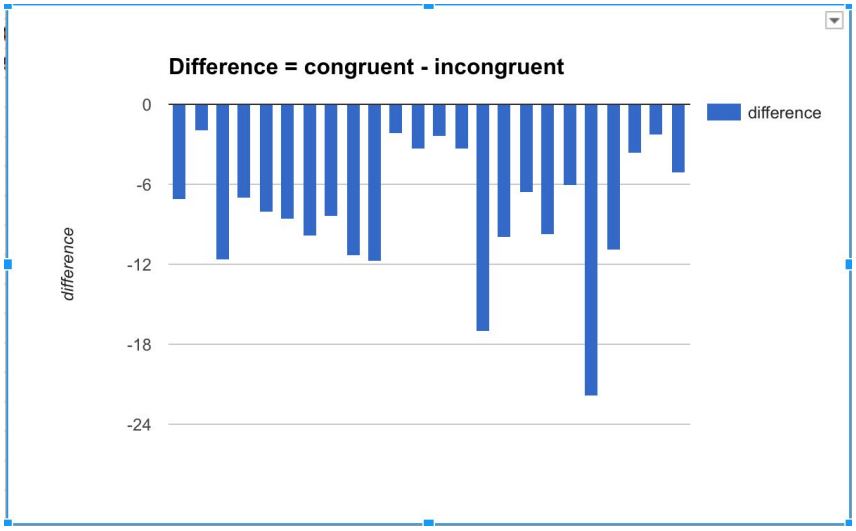
3. Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability.

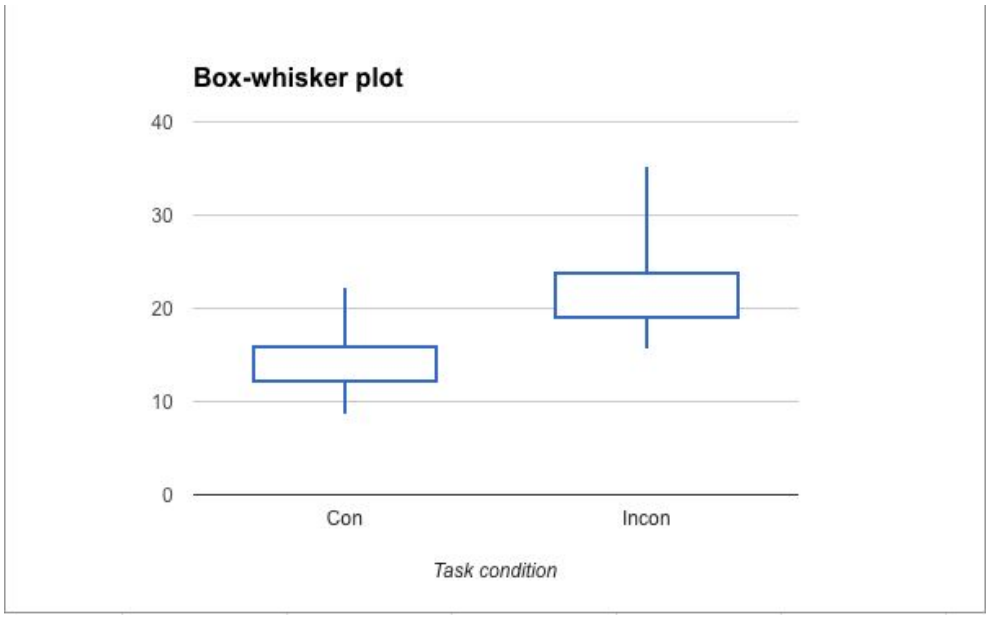
- Congruent task: mean time = 14.051, stdev = 3.559
- Incongruent task: mean time = 22.016, stdev = 4.797
- Difference (t1-t2): mean difference = -7.965, stdev = 4.865
- degree of freedom: n - 1 = 23

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.









- Description: The time of incongruent task seems to be longer than the time of congruent task. There are nobody who completed the incongruent task faster than congruent task. The histogram of difference is negatively skewed.
- Outliers: One participant showed Z-score over 2 (2.33) in congruent task. Two participant showed Z-score over 2.5 (2.76, 2.56) in incongruent task. These data can be seen as peaks on the first graph.

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?

- Mean of difference = -7.9648, standard deviation = 4.8648
- Standard error = 0.99303
- t value = -8.02071
- Critical statistic value = -2.069, +2.069 (at two-tailed $p < 0.05$)
- 95% confidence level: (-10.0194, -5.9102)
- Conclusion: The time of incongruent task shows significant difference from the time of congruent task. (The time of incongruent task is significantly larger than the time of congruent task. It takes more time to tell the color when the color and word doesn't match.)

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 brain has to inhibit (ignore) the content of the word and think about the color in the incongruent condition. So the information processing time is longer.
- Similar task: Tasks with conflicting(interfering) information would show similar results. For example, the stop signal task shows the arrow and asks what *side* - the location presented in the monitor (left or right) or the *direction* the arrow points to. The arrow could be on the "right side" and point to the "right direction" - congruent condition. Or the arrow could be on the "left side" and point to the "left direction" - incongruent condition. The subject has to press the right or left button as quickly as possible. But, when an auditory signal (= stop signal) is given, the subject has to stop and do not press any button. The timing of the stop signal varies. This task measures how well the subjects inhibit their response and how long it takes to successfully inhibit the response (reaction time). The reaction time is typically longer in the incongruent condition than the congruent condition. (Reference: http://www.cambridgecognition.com/tests/stop-signal-task-sst)