Test a Perceptual Phenomenon
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Background Information

Compute descriptive statistics and perform a statistical test on a data set based on a psychological phenomenon from experimental psychology called the Stroop Effect.

In a Stroop task, participants are presented with a list of words, with each word displayed in a colour of ink. The participant's task is to say out loud the colour 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 colour words whose names match the colours in which they are printed: for example RED, BLUE. In the incongruent words condition, the words displayed are colour words whose names do not match the colours in which they are printed: for example PURPLE, ORANGE. In each case, we measure the time it takes to name the ink colours in equally-sized lists. Each participant will go through and record a time from each condition.

The analysis is based on this dataset which contains results from a number of participants in the task.

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

    Independent variable:
    - The colour congruency condition in which ink colour and word differ

    Dependent variable:
    - Time to complete the congruent words condition (c)
    - Time to complete the Incongruent words (i)

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

    The set of hypotheses is:
    Null hypothesis, H0:
    There is no difference in the population means of response time under the congruent words condition and the incongruent words condition (H0: $\mu_c = \mu_i$).

    Alternative hypothesis, H1:
    Population mean of the response time under the incongruent words condition will be significantly larger than the response time under the congruent words condition (H1: $\mu_c < \mu_i$).

    This would be an one-tailed test, as a directional alternative hypothesis is used (the result is only interestingly if the time to read the incongruent words condition is larger than the incongruent word). As we don't know the population standard deviation is unknown and the sample size is less than 30, t-test should be applied. More specifically, dependant t-test for paired samples is deployed to compare if two samples are significantly different. Two samples are dependent because the participants took the test twice in two conditions.

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

The time to complete the congruent words condition is distributed with a mean of 14.05 seconds and a standard deviation of 3.56 seconds. The time to complete the incongruent words has a mean of 22.02 seconds and a standard deviation of 4.8 seconds.

It shows the standard deviation of *The Incongruent words* is larger than the one of *The Congruent Words*, which shows the time to complete *The Incongruent words* is more varied among participants.

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.**

The visualization for *The Congruent Words* shows highest frequency to complete the test is within 14 - 16 seconds. The histogram is slightly skewed to the left, and some unusual high number was observed in the fastest timeframe of 8 -10 seconds.

Congruent words (bin size: 2 sec)
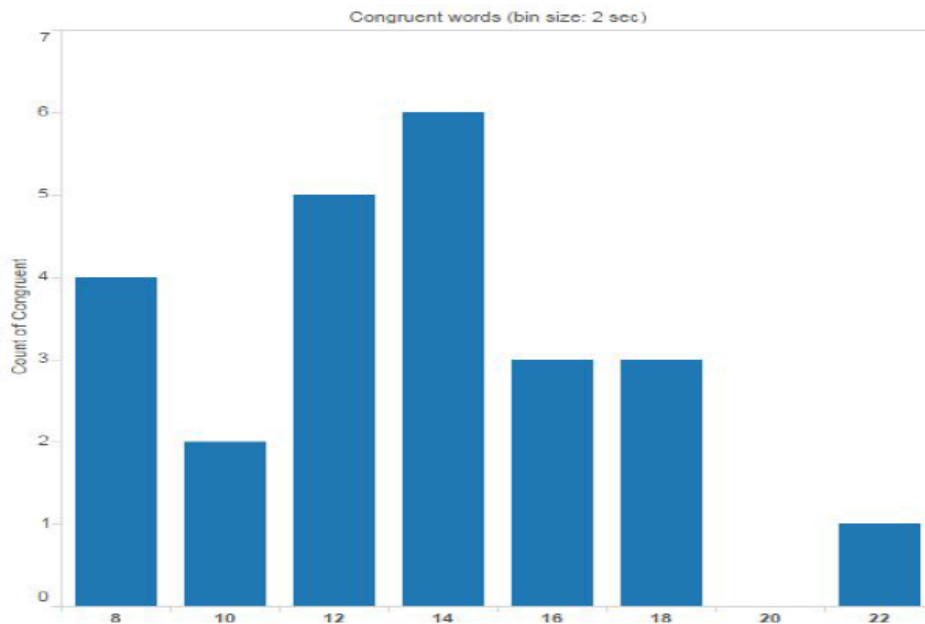
The typical time to complete *The Incongruent Words* was about 20 - 22 seconds. For this data set, the fastest time to complete *The Incongruent Words* was about 14 -16 seconds. There were two participants unusually took a long time of about 34 - 36 seconds to complete the test.

Incongruent words (bin size: 2 sec)
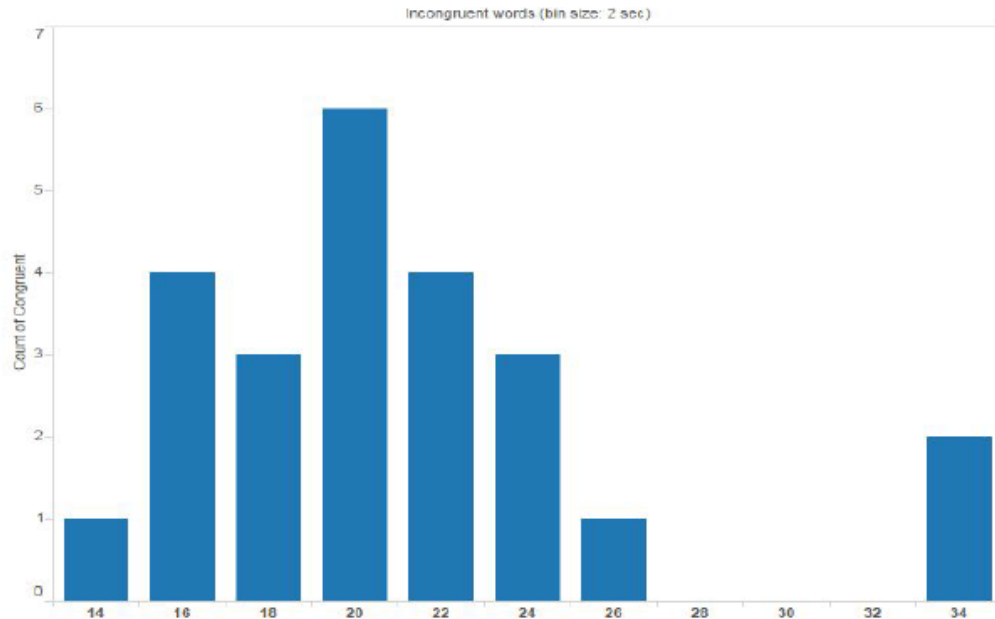
5. **Now, perform the statistical test and report your results. What is your confidence level and your critical statistic value? Do you reject the null hypothesis or fail to reject it? Come to a conclusion in terms of the experiment task. Did the results match up with your expectations?**

Degree of freedom: 23

Point estimate for $\mu c - \mu i$ = 14.05 - 22.02= -7.97
Standard deviation of differences =4.86

T-statistic= -8.02
For a confidence level of 95%, t-critical values are -1.714

The decision is to reject null hypothesis, as t value is way less than t critical value.
The conclusion is it takes less time to read the congruent words condition (i) than to read the incongruent words condition (c). The result definitely matched up with my expectation. In my own personal test, I took twice the amount of the time to complete the incongruent words condition.