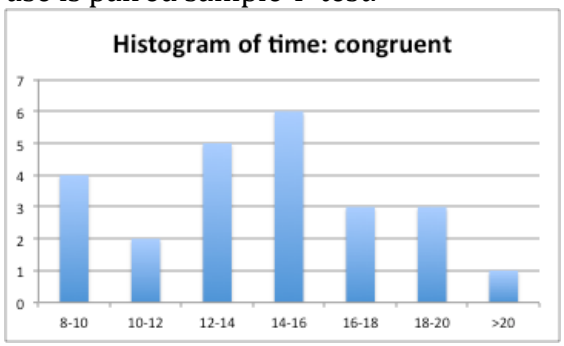
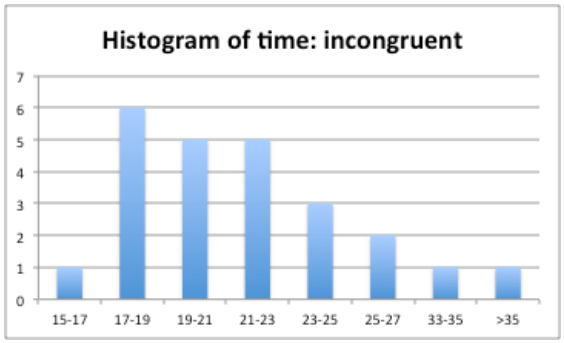
P1: Test a Perceptual Phenomenon

1. What is our independent variable? What is our dependent variable?
The condition of the word, congruent/incongruent is independent variable.
Time it takes to name the ink color in equally-sized lists is dependent variable.

2. What is an appropriate set of hypotheses for this task? What kind of statistical test do you expect to perform? Justify your choices.
Null hypotheses H0: the time it takes to name the ink color for congruent list (Tc) is the same as the time it takes to name the ink color for incongruent list (Ti). Tc=Ti.
Alternative hypotheses Ha: the time it takes to name the ink color for congruent list (Tc) is different from the time it takes to name the ink color for incongruent list (Ti). Tc!=Ti.
There are two groups of time, which are paired times of same participant for congruent and incongruent tasks. Those two populations are dependent and paired. Both of them are roughly normally distributed. So the appropriate statistic test to use is paired sample T-test.

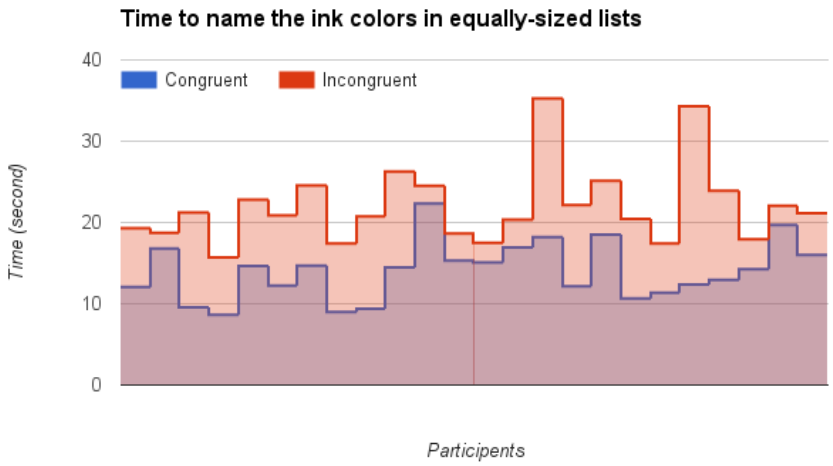




3. Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability.
Central tendency:
Mean Congruent = 14.05 Mean Incongruent = 22.02
Median Congruent = 14.36 Median Incongruent = 21.02

Variability:
Standard deviation Congruent = 3.56 Standard deviation Incongruent = 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.
The stepped area chart below shows the comparison of time used for congruent and incongruent tasks for each participant as a pair. As you can see, for each participant, the time used for incongruent tasks tend to be longer than time used for congruent tasks.



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?
μD = 7.9648
SD = 4.8648
n = 24
t-value = (μD/(SD/SQRT(n)) = 8.0207
p-value < 0.0001
At 95% confidence level (α=0.05), t-critical = 2.0686. The t-value is way larger than t-critical. So I can reject the null hypothesis H0. I can conclude that the time to name the ink color for congruent list is different from the time for incongruent list. The 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!
I think the reason for longer time to name incongruent list is due to the distraction of the meaning of the words itself from the color of the word is printed. Human brain need to distinguish the "meaning" perception and "color" perception when they are not consistent, which requires more time.
One similar task would be Spatial task. In one version of the spatial Stroop task, an up or down-pointing arrow appears randomly above or below a central point. Despite being asked to discriminate the direction of the arrow while ignoring its location, individuals typically make faster and more accurate responses to congruent stimuli (i.e., an down-pointing arrow located below the fixation sign) than to incongruent ones (i.e., a up-pointing arrow located below the fixation sign).

Reference
https://en.wikipedia.org/wiki/Stroop_effect