Hypothesis Testing on a Stroop Effect

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.

Investigating Stroop Effect using sample data

1. **Dependent and Independent Variables**
   Dependent variable: time taken to identify ink color of word.
   Independent variable: words condition (congruent or incongruent)

2. **a. Appropriate set of hypothesis**
   Let μ_{co} be population mean time to identify the color of words with congruent condition and μ_{inc} be the population mean time to identify the color of words with incongruent condition.

   Our null hypothesis *(H_o)* is that the mean time to identify the ink color of congruent words condition is greater or equal to the mean time to identify the ink color of incongruent words condition.

   Alternative hypothesis would be the mean time to identify the ink color of congruent words condition is smaller than the mean time to identify the ink color of incongruent words condition.

   $H_o : \mu_{co} \geq \mu_{inc}$
   $H_A : \mu_{co} < \mu_{inc}$

   b. Statistical test to perform
   Below are some points telling the type of information we have and what we would like to know from the results
   - We don't know the population parameters so we can't perform z-test.
   - We can perform t-test as we have sample data available.
   - The samples for congruent and incongruent words timings are dependent because our subject (participants) is same. Each participant is asked to identify both congruent and incongruent words.
   - We are also concerned whether the mean timing for identifying congruent words are more or less than the mean timing for identifying incongruent words. So this would be a one directional test.

Considering all above points, a one directional t-test for dependent samples can be performed. With this test we are trying to determine whether we have enough evidence to prove that the recognition time for congruent words is less than the recognition time for incongruent words for entire population.
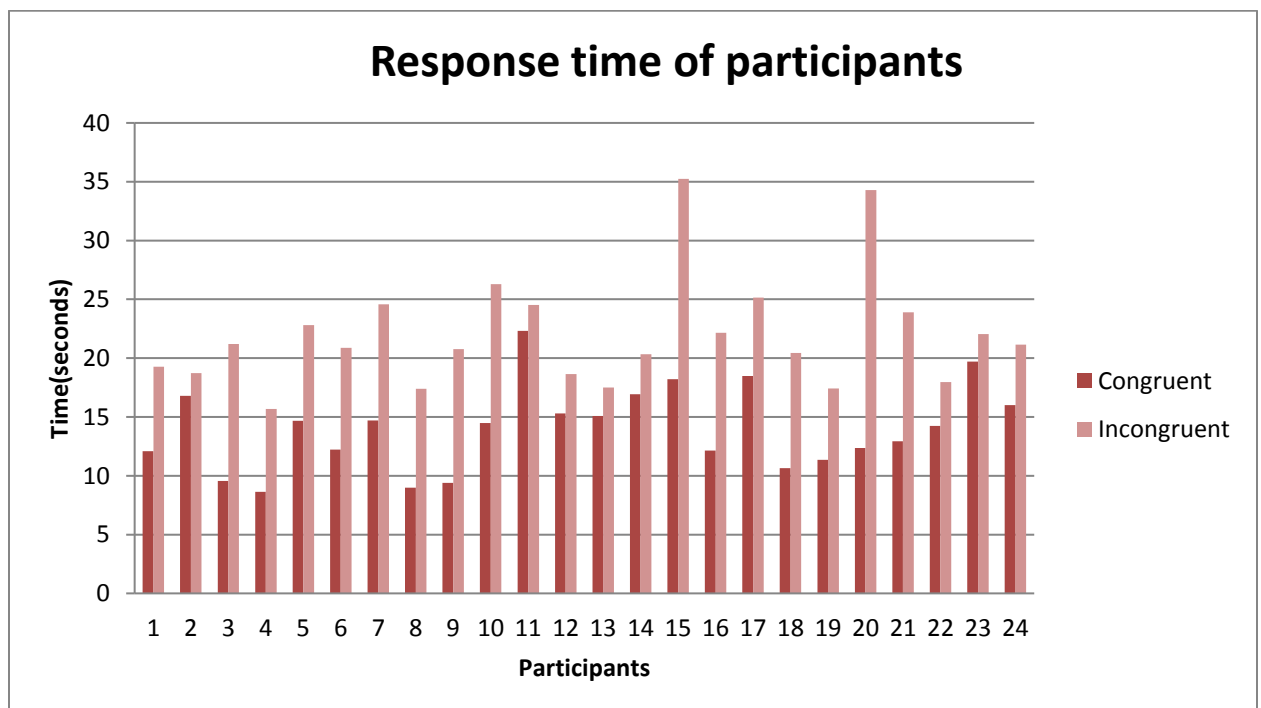
3. Descriptive statistics for the dataset

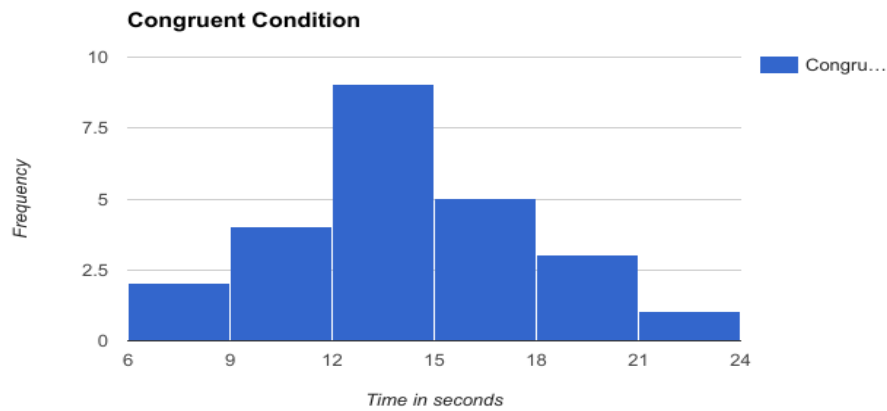| Statistic	Congruent	Incongruent
n	24	24
mean($\bar{x}$)	14.05	22.02
s	3.56	4.80
s^2	12.67	23.04

$$\bar{x}_{\text{co-inc}} = -7.96$$
$$s_{\text{co-inc}} = 4.86$$

4. Visualization for dataset

- Below plot shows the response time for each participant. Every participant has taken more time to identify the words with incongruent condition.
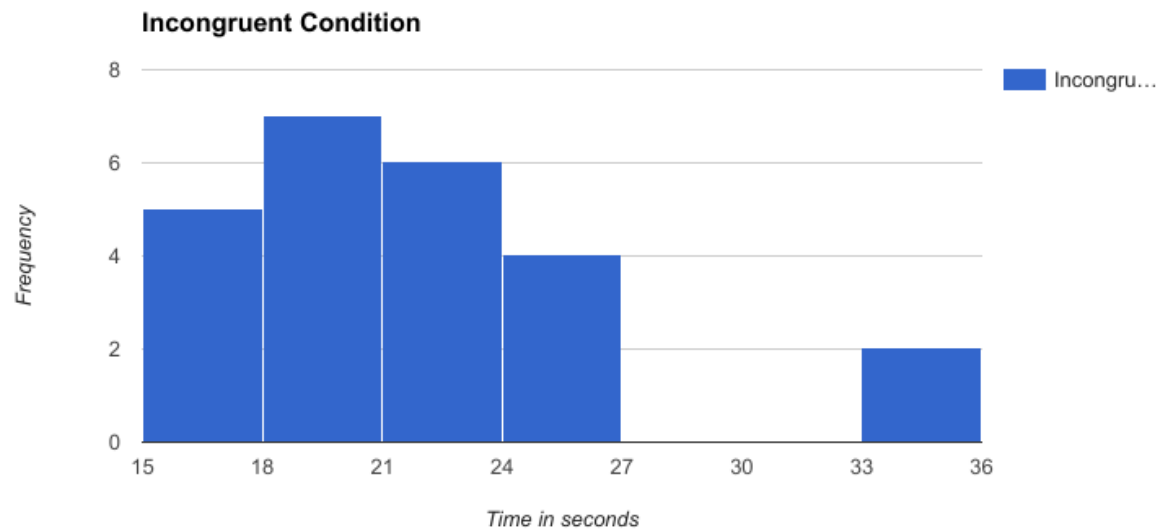
- Histogram for congruent data set

Congruent Condition

Most of the participants have taken 12-15 seconds in responding for congruent words condition. Mean of sample is also 14.05 seconds.

- Histogram for incongruent data set

Incongruent Condition

Most participants have taken 18-24 seconds in responding for incongruent words. Average of sample is 22.02.

5. **Statistical Test**
   Degrees of freedom = n-1 = 23
   Alpha level (α) = 0.05
   $t_{critical}$ = -1.714
   SE = 0.99
   t = -8.04

p-value < 0.0001
By conventional criteria, this difference is considered to be extremely statistically significant.

At 95% confidence interval tcritical-value in the negative direction is -1.714.

Calculated t-value for the sample dataset is -8.04. Our t-value lies within the critical region and hence we can reject our null hypothesis. This means it is very unlikely that the difference between the mean time for color recognition for congruent dataset and incongruent dataset have occurred by chance.

Based on our test we can say that it takes more time to recognize the words with incongruent condition. And hence our alternate hypothesis is true.

Results match up with my expectation as for me too it took more time to recognize color for incongruent dataset as compared to congruent dataset.

6. I think our brain is more trained on reading when presented with a text rather than focusing on which color it is written.