Udacity: Data Analyst Nanodegree
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Project P1: Statistical Analysis of *The Stroop Effect*
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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.

Answers to Questions for Investigation:

1. Independent Variable: Congruency/Incongruency of the printed colors matching the printed color names.
   Dependent Variable: The time taken to read aloud each set of color names.

2. Statistical Hypotheses: (the assumptions made about the difference between population *means* that can be decided upon analyzing the difference between sample *means*)
   Null hypothesis: $H_{0:}\ \mu_{congruent\ -\ incongruent} = 0$
   Alternative hypothesis: $H_{A:}\ \mu_{congruent\ -\ incongruent} \neq 0$

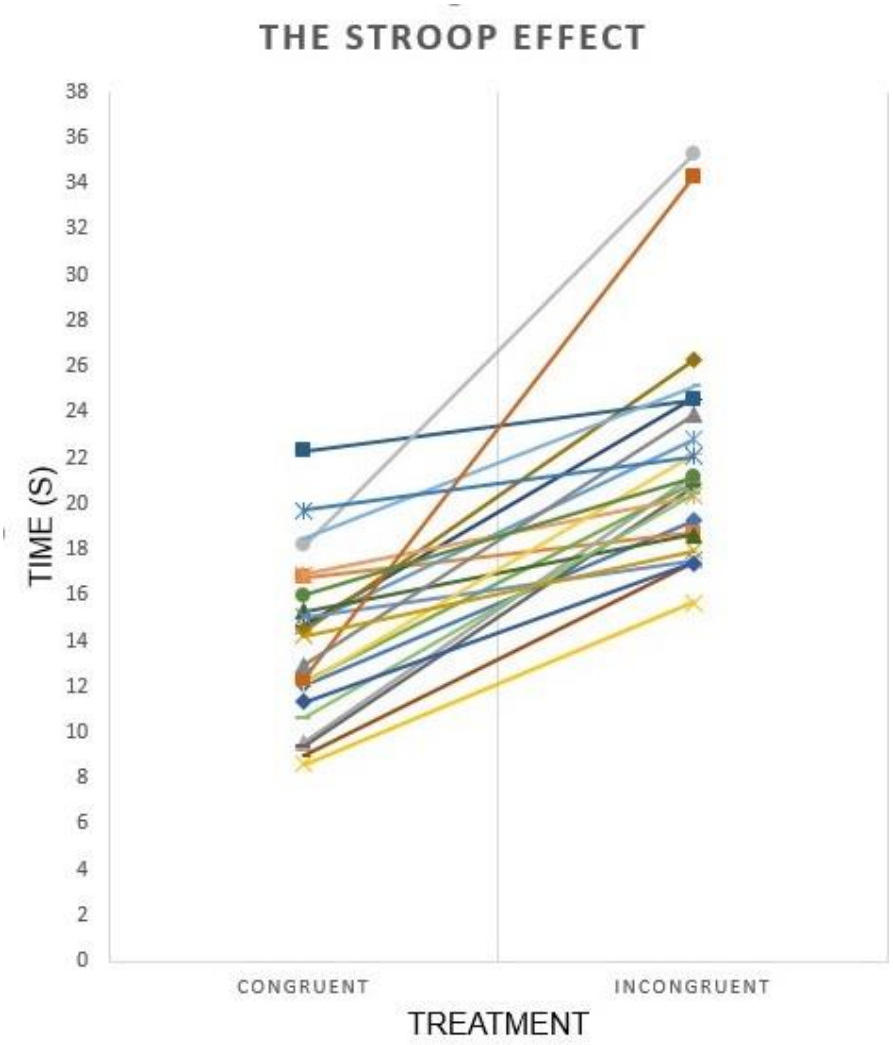
   The null hypothesis indicates that any differences in the time taken to read the *congruent* and *incongruent* sets of words is due to chance.

   Type of Test: I'm comparing paired samples from a population with unknown statistics ($\boldsymbol{\mu}_{population}$, $\boldsymbol{\sigma}_{population}$) for performing the tasks described above. This is almost the same as a pre- and post-test situation. Therefore, I will conduct a two-tailed, two sample t-test with paired samples. I chose a two-tailed test with confidence level at 95% ($\boldsymbol{\alpha = 0.05}$) because the criteria decision is more rigorous i.e. each tail's probability **p = .025** The rationale for applying the t-test vs. using a z-score is that $\boldsymbol{\sigma}_{population}$ is unknown and the sample size is small, n < 30.

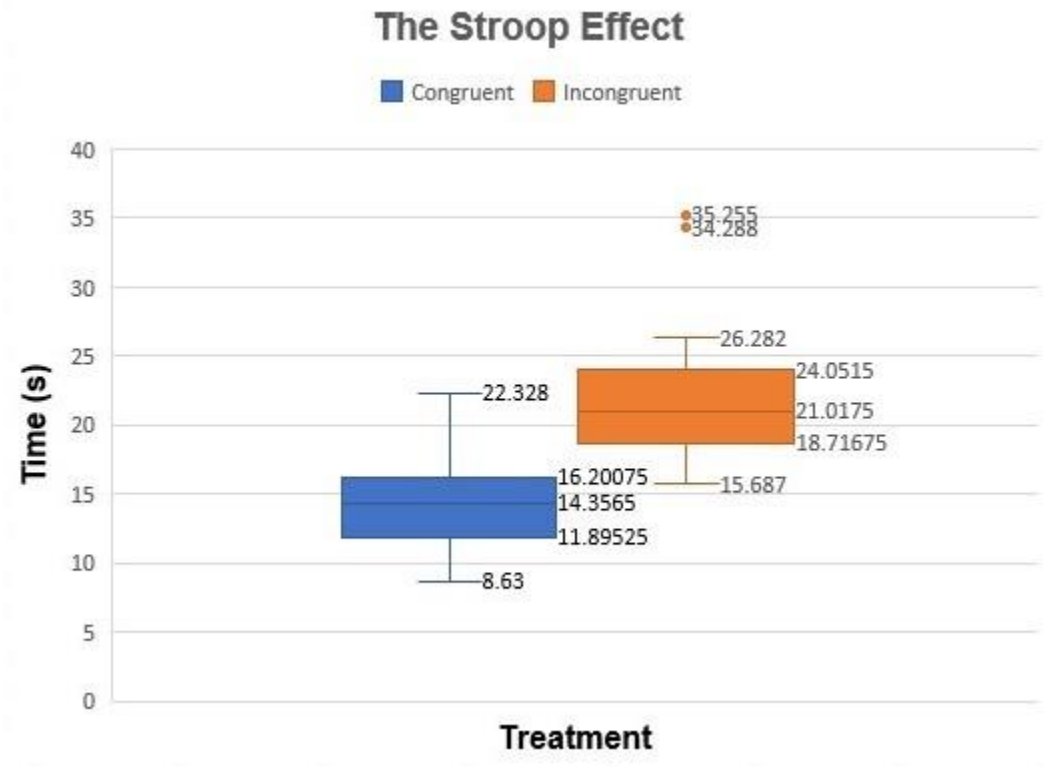
3. Descriptive Statistics
   Number of paired samples n = 24
   Means: $\bar{x}_{Congruent} = 14.05$; $\bar{x}_{Incongruent} = 22.02$; $\bar{x}_{Congruent\ –\ Incongruent} = 7.96$
   Std. deviations: $S_{Congruent} = 3.56$; $S_{Incongruent} = 4.80$; $S_{Congruent\ –\ Incongruent} = 4.86$

4. I've created two plots using Excel to visualize relationships between and among the paired sample data.
   Plot 1, is simply a series of line graphs connecting the paired points for each test taker. This chart illustrates that for almost every test taker the time required to read the *incongruent* set of words increased.
   Plot 2 is a side-by-side, box and whisker chart that shows the central tendency for the *congruent* reading times and a similar tendency for the *incongruent* reading times. Clearly there is a distinct difference in the *mean* times need to read the words between the *congruent* dataset and the *incongruent* dataset. Also, the *incongruent* dataset appears to be slightly more dispersed about the *mean*.

Plot 1.


THE STROOP EFFECT
TIME (S)
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
CONGRUENT
INCONGRUENT
TREATMENT

Plot 2.


The Stroop Effect
Congruent
Incongruent
Time (s)
40
35
30
25
20
15
10
5
0
35.255
34.288
26.282
24.0515
21.0175
18.71675
22.328
16.20075
14.3565
11.89525
15.687
8.63
Treatment

5. Std. error for $\bar{x}_{Congruent - Incongruent}$ $= (S_{Congruent - Incongruent})/\sqrt{n}$
$= - 4.86/\sqrt{24}$
$= - 0.992$

t-statistic $= (\bar{x}_{Congruent} - \bar{x}_{Incongruent})/$Std. error for $\bar{x}_{Congruent - Incongruent}$
$= 7.96/-0.992$
$= \mathbf{-8.02}$

For a two-tailed, paired sample, test at a confidence level of 95% (($\boldsymbol{\alpha = 0.05}$) with degrees of freedom **df** = n – 1 = **23** , from t-table $\mathbf{t_{critical}}$ = +/- **2.069**

Since t-statistic **-8.02** << - **2.069** ($t_{critical}$) I reject the null hypothesis.

Conclusion. My analysis confirms *The Stroop Effect*, namely that by making the printed color of each word congruent with its meaning enables most subjects to read the set of words faster.

Expectations. The results matched my expectations because after reading about *The Stroop Effect* it's clear that this is a thoroughly tested phenomenon.
However, when I did the test myself I recorded a slightly faster time reading the set of *incongruent* words. I suspect that by knowing about *The Stroop Effect* prior to taking the test I consciously '*tuned out*' the visual color cues.

6. My brief research about this phenomenon has informed me that people's brains tend to process words slightly faster than colors. When each word's color is *congruent* with its meaning there is no conflict in the brain, whereas when *incongruent* the slower color recognition slows down the task.

I think that any task requiring quick reaction time could be better served by instructions that are color coded. For example, a vehicle navigation system might work better if the turn instructions/arrows turns yellow ,  then red,  the closer the vehicle gets to the specific turning point.