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?

Answer:

From Wikipedia link, in mathematical modeling, statistical modeling and experimental sciences, the values of dependent variables depend on the values of independent variables. The dependent variables represent the output or outcome whose variation is being studied. The independent variables represent inputs or causes, i.e., potential reasons for variation or, in the experimental setting, the variable controlled by the experimenter.

That being said, what is not going to depend on the individual's capacity to focus and read the words correctly is **whether the font name and color were similar or different**. This will be a fact and will not depend on anything. So**, this will be our independent variable**. And therefore the other thing remaining to be observed, which **is the time taken to correctly read the color of the word will be our dependent variable.**

- Help from the post at the following link: **https://www.thestudentroom.co.uk/showthread.php?t=301293**

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

Answer:

As is clear from this link, "the hypothesis should therefore give us an idea of how the font name and color matching/not will affect the reaction time". And so, our hypothesis is going to depend on the reaction time taken to read the color name of the word correctly.

*All in all, the **null hypothesis** will say that, there is no difference between congruent and incongruent means in the population **or** **the time taken for congruent set will be less than or equal to the time taken for the incongruent set.** Note that the hypothesis makes reference to the population and not the samples*

So, converting this to mathematical notation, this is how we'll go:

Suppose,
$\mu_{congruent} = \mu_c$ = mean time spent by participants on congruent test
$\mu_{incongruent} = \mu_i$ = mean time spent by participants on incongruent test

So, the ***alternative hypothesis*** will be say that ***the time taken for incongruent set will be greater than the time taken for the congruent set.***

Therefore,

Null hypothesis, $H_0 = \mu_c - \mu_i >= 0$
Alternative hypothesis, $H_a = \mu_c - \mu_i < 0$

From the following link https://www.linkedin.com/pulse/z-test-vs-t-test-arunmozhi-ilango/, T-test is best applied, at least in theory, if you have a limited sample size ($n < 30$) as long as the variables are approximately normally distributed and the variation of scores in the two groups is not reliably different. It is also great if you do not know the populations' standard deviation. If the standard deviation is known, then, it would be best to use another type of statistical test, the Z-test.

So, we'll be using t-test.

Also, from the following link https://erc.barnard.edu/spss/t_tests, a One-Sample T-Test compares a sample mean to a known population mean. An Independent Samples T-Test compares two sample means from different populations regarding the same variable. A Paired Samples T-Test compares two sample means from the same population regarding the same variable at two different times such as during a pre-test and post-test, or it compares two sample means from different populations whose members have been matched.

Also, from the following link https://www.quora.com/What-is-the-difference-between-one-sample-and-two-sample-t-test, a one sample t-test is used to compare the mean of a sample to a known value (often 0, but not always).
A two sample t test is used to compare the means of two different samples.

Therefore since each participant completes each of the conditions, we'll b performing a ***paired t-test.***

Now it's your chance to try out the Stroop task for yourself. Go to this link, which has a Java-based applet for performing the Stroop task. Record the times that you received on the task (you do not need to submit your times to the site.) Now, download this dataset which contains results from a number of participants in the task. Each row of the dataset contains the performance for one participant, with the first number their results on the congruent task and the second number their performance on the incongruent task.

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

Answer:

Link to the video of my Stroop Effect experiment:
https://drive.google.com/file/d/0B2kNov855nphS3k5bER1LU5OMm8/view?usp=sharing

Link to the spreadsheet where I did these calculations.

Measure of central tendency:

MeanOfCongruentData = 14.051125
MeanOfIncongruentData = 22.01591667

MedianOfCongruentData = 14.3565
MedianOfIncongruentData = 21.0175

ModeOfCongruentData = N/A
ModeOfIncongruentData = N/A

Measure of variability:

VarianceOfCongruentData, V_c = 12.14115286
VarianceOfInongruentData, V_i = 22.05293383

StandardDeviationOfCongruentData, $SD_c = \sqrt{(\Sigma(Xi-\dot{X})\hat{}2/\mathbf{n-1})}$ = 3.559357958
StandardDeviationOfIncongruentData, $SD_i = \sqrt{(\Sigma(Xi-\dot{X})\hat{}2/\mathbf{n-1})}$ = 4.797057122

Help from this link for variance and standard deviation.

And from this link, the interquartile range (IQR) is a measure of variability, based on dividing a data set into quartiles.

So, let's find the IQR.

As we know,
Q1 is the "middle" value in the first half of the rank-ordered data set.
Q2 is the median value in the set.
Q3 is the "middle" value in the second half of the rank-ordered data set.

Therefore, for Congruent data:

$Q1_c = 10.9915$
$Q2_c = 14.3565$
$Q3_c = 15.651$

And for Incongruent data:

$Q1_i = 18.302$
$Q2_i = 21.0175$
$Q3_i = 23.3485$

And, the interquartile range is equal to Q3 minus Q1.

Therefore, $IQR_c = Q3_c - Q1_c = 4.6595$

And $IQR_i = Q3_i - Q1_i = 5.0465$

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.

Answer:

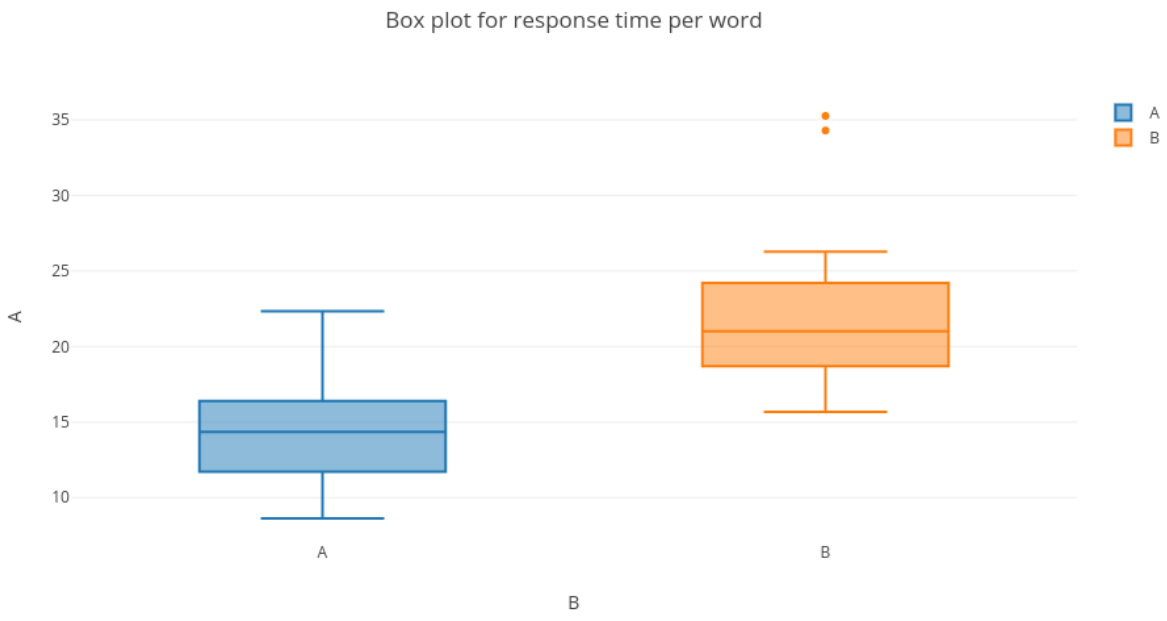

Fig: Box plot for response time in congruent set and incongruent set of words

The plot can be found at this link.

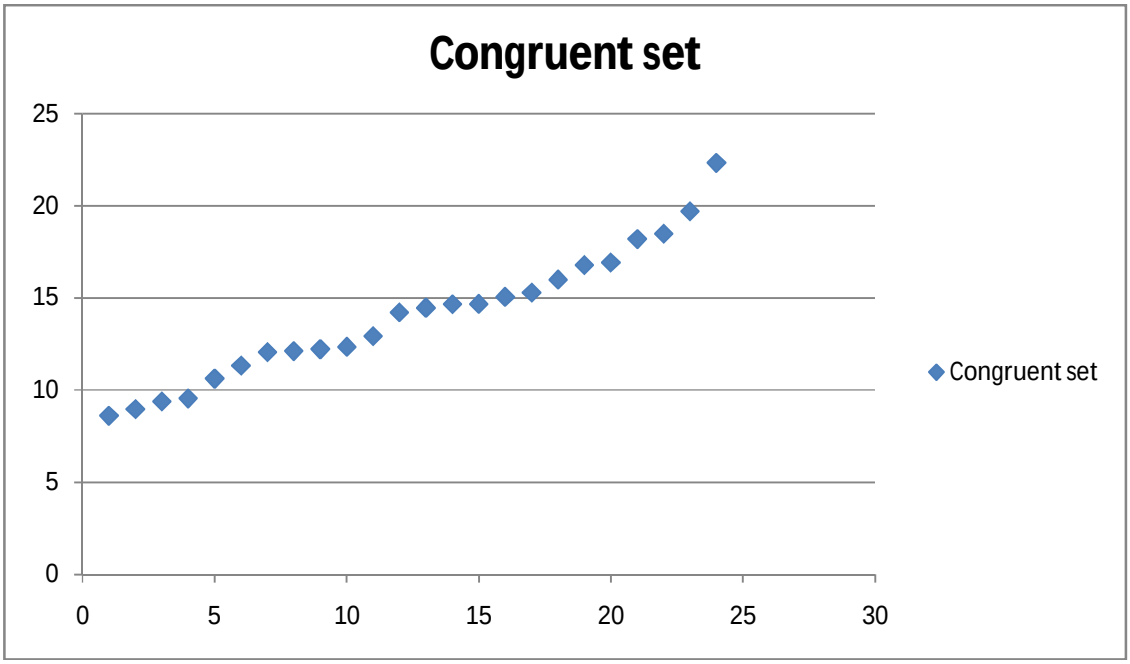

Fig. Scatter plot for time taken for the Congruent set of data, where time is along the y-axis and is in seconds and participants are along the x-axis.

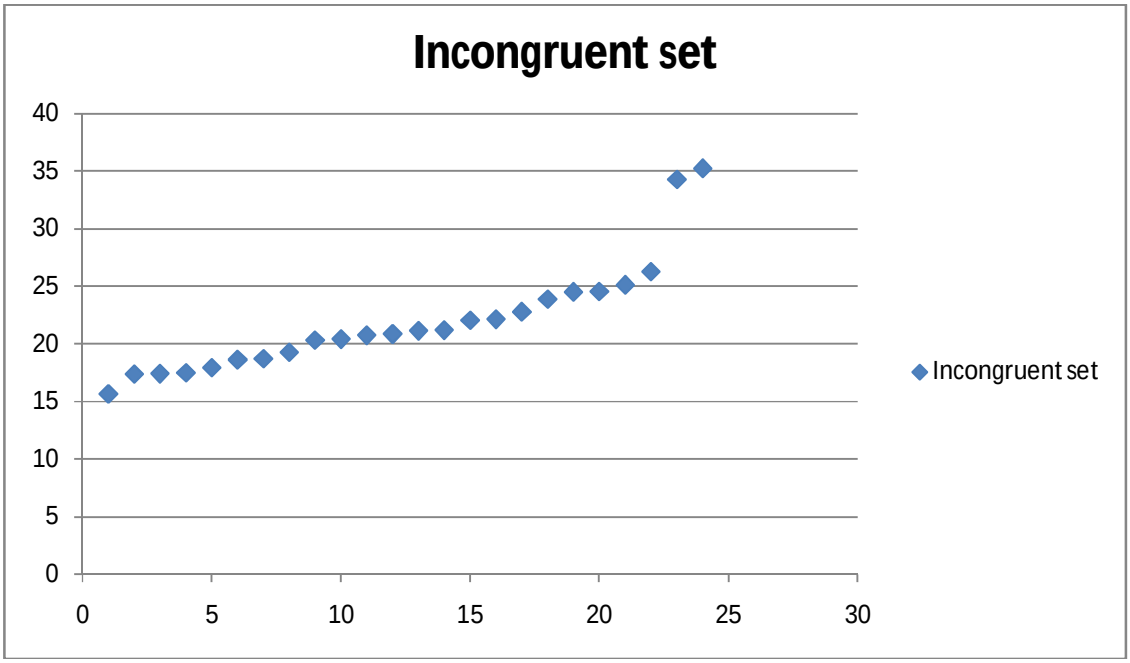

Fig. Scatter plot for time taken for the Incongruent set of data, where time is along the y-axis and is in seconds and participants are along the x-axis.

The time taken to correctly recognize the color of the congruent set is less than that of the time taken for the Incongruent set.

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?

Solution:

Considering my confidence level to be 99% or 0.99, the t-critical statistic at 23 degree of freedom (as total n = 24, so d.o.f = 24-1 = 23) shoule be: +-**2.500** and my t-statistic calculated by the formula,

t-statistic = Mean diff. of congruent and Incongruent data / Standard Error(S.E.)

And as my reviewer told in last review at this link,

To correctly calculate the s variable we must,

1 - Calculate the Differences (Congruent - Incongruent) of each test
2 - Calculate the squared deviations difference - ((Differences of Congruent and Incongruent)-Mean difference)^2
3 - Sum the squared deviations difference
4 - Divide it by the number of samples - 1 to achieve the Variance Difference.
5 - Square root the Variance Difference

Therefore, SD of Differences, s = 2.297946976
So, t-statistic, t `= (congruentMean - IncongruentMean)/(s/(math.sqrt(number_of_samples)))`

Or `t = -20.83654823`

Therefore, as t-statistic is not in the range of t-critical, **we reject the null hypothesis.**

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!

Answer:

This, I think is because of different ability of every person to interpret colors and/or words. Everyone has got different habit and so may be good at speaking, listening or reading while some may be better at interpreting shape, sizes and colors of objects. This is just how human brain acts and behave and is thus the expected behavior.