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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?

The independent variable in this experiment is the test: for congruent words condition, and for incongruent words condition. The dependent variable here is the time required to name the color in each condition.

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

Ho: The time required to name the color in test with congruent condition is equal to the time required to name the color in test with incongruent condition.

Ha: The time required to name the color in test with incongruent condition is longer than the time required to name the color in test with congruent condition

In this experiment, we will deal with a hypothesis concerning mean using paired samples. We have here the result of the test of the individuals in each condition. So basically, we want to confirm in this experiment whether or not there is really significant difference in the time required to name the color in each condition.

In this problem, we will assume that the population data is approximately normally distributed. Also, the sample size we have is only 24 ($n < 30$) and the populations' standard deviation is unknown. Hence, we need to apply t-test. If the populations' standard deviation is known, then it is best to use another type of statistical test which is the z-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.

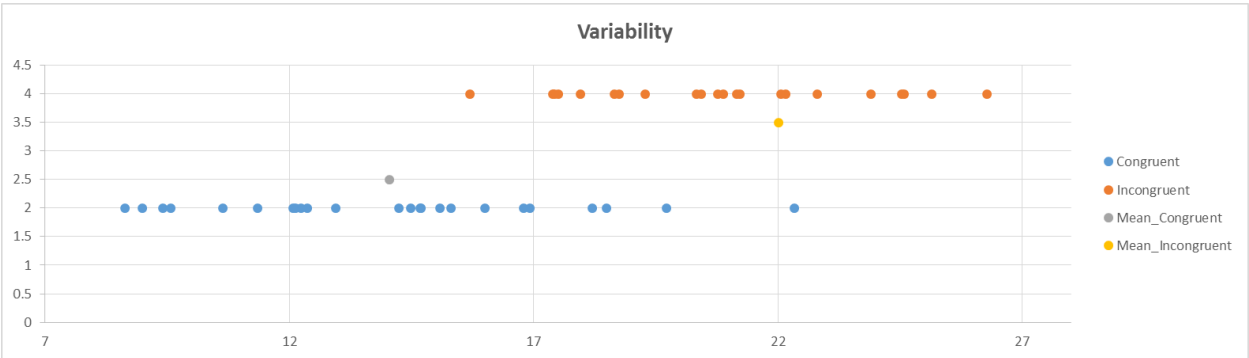
3. Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability.

MEASURE OF CENTRAL TENDENCY

	Congruent Conditon	Incongruent Condition
Mean	14.051	22.016
Median	14.357	21.018

Test with incongruent condition displays higher mean and median value.

MEASURE OF VARIABILITY



Based from the “variability chart”, we can see that test with incongruent condition has more variability in the data points. But we have to verify it further with other tests.

Range = Highest value – lowest value

	Congruent Conditon	Incongruent Condition
Max	22.328	35.255
Min	8.630	15.687
Range	13.698	19.568

From the “range table”, we can see indeed that test with incongruent condition has more variability as we have noticed in the variability chart. But let us have more test so we can overcome the sensitivity to extreme data values issue.

Interquartile Range – Quartile 3 – Quartile 1

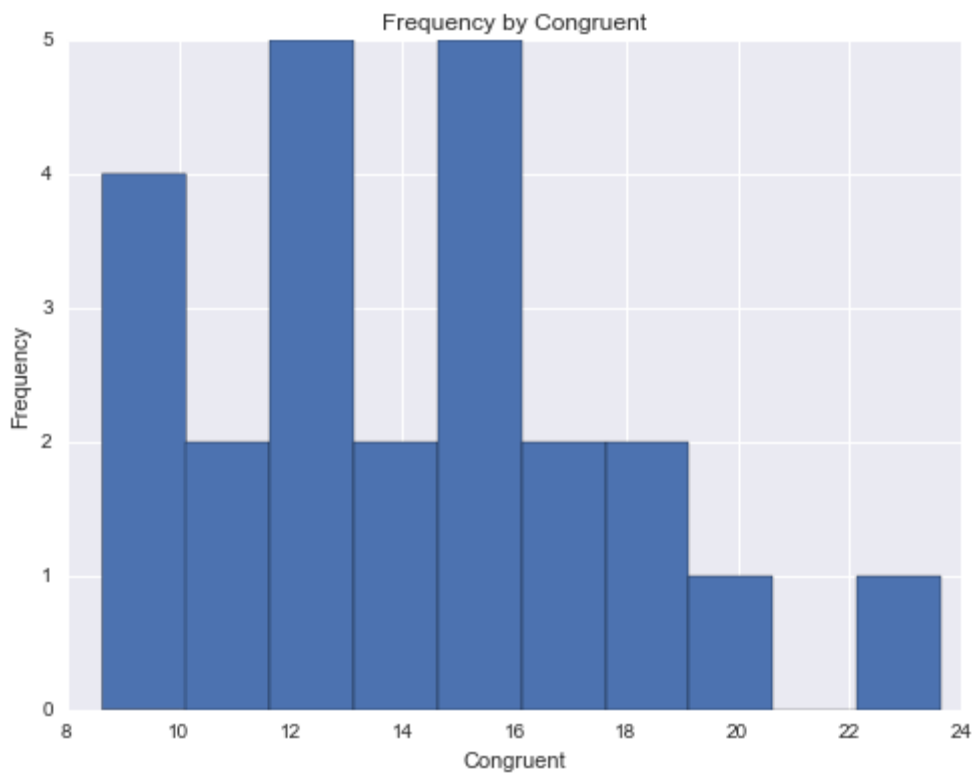
	Congruent Conditon	Incongruent Condition
Quartile 1	11.895	18.717
Quartile 3	16.201	24.052
Interquartile Range	4.306	5.335

Variance and Standard Deviation

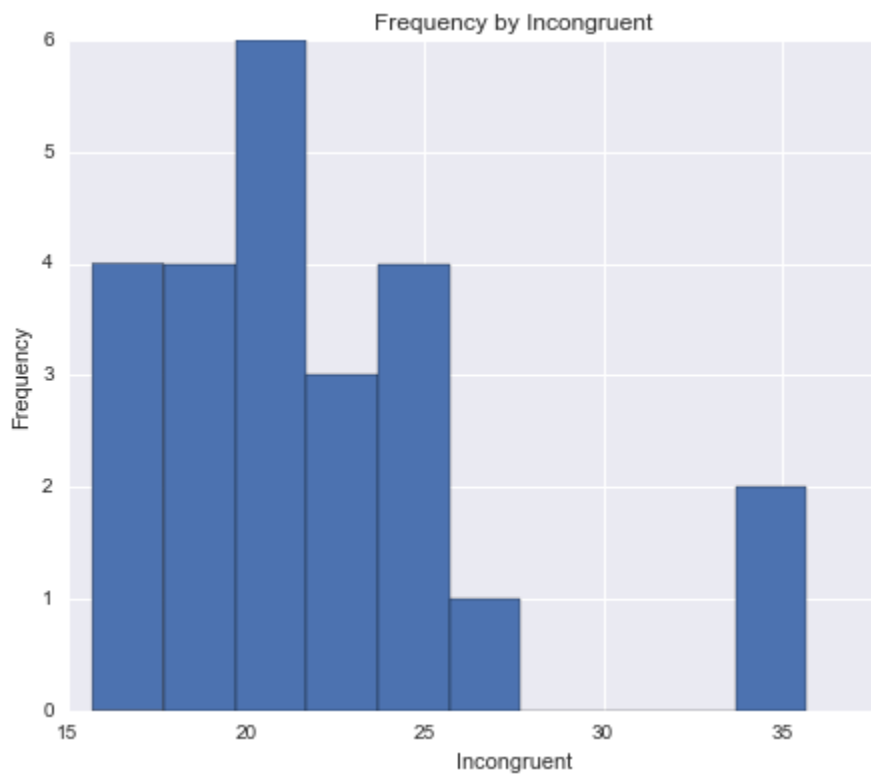
	Congruent Conditon	Incongruent Condition
Variance	12.669	23.012
Standard Deviation	3.559	4.797

So now, we can finally say that test with incongruent condition has more variability in the data points.

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.



This graph is skewed right. And the most of the time recorded for this group is between 12-13 and 15-16 seconds.



This graph is also skewed right. And we can see clearly that most of the time recorded for this group is between 20-22 seconds

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?

I will use significance level $\alpha = 5\%$.

Let μ_1 be the population mean of time required to name the color in test with congruent condition,
 μ_2 be the population mean of time required to name the color in test with incongruent condition, and
 $\mu_D = \mu_2 - \mu_1$.

Ho: $\mu_D = 0$
Ha: $\mu_D > 0$

t-Test: Paired Two Sample for Means		
	Congruent	Incongruent
Mean	22.01591667	14.051125
Variance	23.01175704	12.66902907
Observations	24	24
Pearson Correlation	0.351819527	
Hypothesized Mean Difference	0	
df	23	
t Stat	8.020706944	
P(T<=t) one-tail	2.0515E-08	
t Critical one-tail	1.713871528	

With p-value = 2.0515E-08 which is less than our $\alpha = 5\%$, we have to reject the null hypothesis. Therefore, with decent amount of evidence, we can now conclude that the time required to name the color in test with incongruent condition is longer than the time required to name the color in test with congruent condition.

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!

The result of the experiment is what we have expected. Obviously, your brain will need to perform more and needs to exert more effort in the test with incongruent condition.

Conducting an experiment on runners running on a flat ground/surface and running uphill will yield the same result. (I just thought of this one, result is pretty obvious 😊)