

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

1. What is our independent variable? What is our dependent variable?

The independent variable is the word and color combination in the tests.

The Test score(s) is the dependent variable as it is the difference in score between Congruent and Incongruent test which is the measurement needed to analyse the Stroop task.

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

I will test the null hypothesis **H₀**: $\mu_C = \mu_I$, where μ_C is the congruent population mean and μ_I is the incongruent population mean. Where I will assess whether or not the sample means from the sample data holds enough evidence showing them to be statistically and significantly different, and we furthermore from this can infer that same holds true for the two populations and populations means. The alternative hypothesis therefore is **H_a**: $\mu_C \neq \mu_I$

This will practically be done via a Matched Pair samples t-test on the Mean of the difference μ_d between the Congruent and Incongruent paired scores. The choice of t-test over z-test is due to the generally accepted parameters:

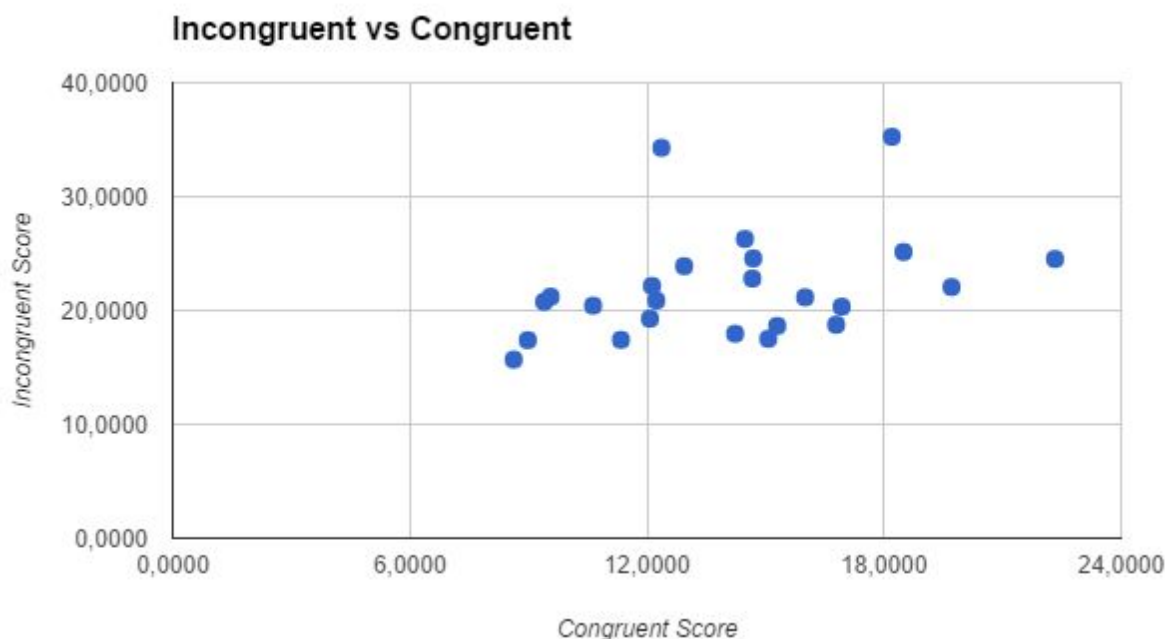
1. The sample size is less than 30.
2. The population standard deviation is not known.

The null hypothesis will be tested using a two tailed t-test with an alpha level of 0.05

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

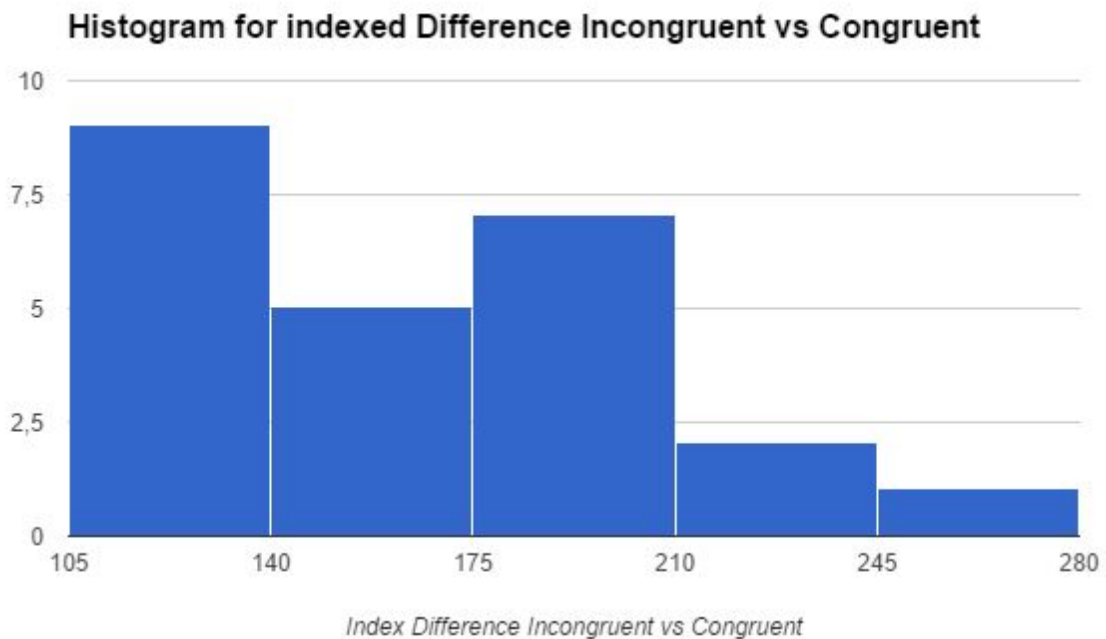
Descriptive Statistics	n	Mean Score	Median	Standard deviation
Congruent	24	14,0511	14,3565	3,5594
Incongruent	24	22,0159	21,0175	4,7971
Difference	24	7,9648	7,6665	4,8648

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.



From the scatterplot we can see that there is a positive relationship between the tests. This is backed up by a calculated Covariance of $\text{cov} = 5.76$. The strength of the relationship between paired differences however does not seem particularly strong which is evident from the calculated Correlation of $r = 0.35$.

So while a higher congruent score will also in general terms predict a higher incongruent score, the congruent score is a poor predictor of actually how high.



This Histogram of index of Incongruent score vs Congruent has 2 interesting take aways:

1. Lowest Index index is 105, i.e every single Incongruent score is higher than its paired congruent score.
2. 15 of 24 scores 62,5% of indexes are above index 140

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?

Statistical test on the Mean of differences (d_{μ}) between Incongruent and Congruent scores			Comments
Test Statistic	8,0207		
P value	0,0001		Two tailed p value less than 0,0001
t-critical values at alpha level 0.05	-2,06866	2,06866	23 degrees of Freedom at p value of 0,025
95% confidence interval	5,8664	10,0632	

The **test Statistic** calculated as $d\mu / (d\sigma / \sqrt{n}) = 8,02$ which puts the test statistics >8 standard errors to the right of the H0 hypothesis of **H0: $\mu_C = \mu_I$**

The p value calculated from the test statistic with 23 degrees of freedom is less than 0.0001, this p value is therefore significantly lower than the right tail t-critical value at alpha level 0.05 = 2.06866.

Result of test statistic and p-value as well range in the 95% confidence interval are all showing significant statistical evidence that the null hypothesis **H0: $\mu_C = \mu_I$** can be rejected. **$d\mu$ is both significantly different and significantly higher than 0.** This is not a surprising result, a simple visual check of the descriptive statistics shows a mean of differences which is >50% of the congruent score and the above charts are both showing a clear picture that incongruent score is higher than congruent score.

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!

In my very non-scientific opinion this effect is due to our brains being used to either processing color as something being presented as is, or as word with that same color or in a neutral color for example in black writing. When we experience a mix of the two, the color recognition and processing as well as reading habits, are being confused and the brain needs a fraction more time to distinguish between the 2 and complete the task.

It could be interesting to do the same test, where the participants are grouped in ages and do a statistical test whether or not the mean difference would increase as age increases, i.e. would more years of habit result in higher difference between congruent and incongruent.

Further examples of this, could be to read sentences which are written in styles different from the usual left to right, for example each word written downwards instead of on a straight line. Or that you should say the number of times a number is written instead of the actual number, for example for this string "one one one one" you should say 4.

Sources:

For calculating P value the www.graphpad.com calculator has been used

For answering question 6 inspiration and examples have been found at wikipedia.org as well as faculty.washington.edu