

Stroop effect data analysis

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

Our independent variable is the congruence condition. The set of words being displayed is either congruent (color matches word), or not.

Our dependent variable is the time that it takes to finish the task.

2. What is an appropriate set of hypotheses for this task?

H_0 : Population mean time to finish the task will remain the same or decrease if colors are incongruent:

$$\mu_2 \leq \mu_1$$

H_a : Population mean time to finish the task will increase if colors are incongruent:

$$\mu_2 > \mu_1$$

What kind of statistical test do you expect to perform?

Dependent t-test for paired samples, one-tailed.

Justify your choices.

It is a t-test because we don't know the whole population metrics (μ , σ) and are only working with a sample of 24 values (< 30).

It is a paired dependent test because we're testing with the same subjects, only changing conditions.

It is a one-tailed test because we only want to verify if our subjects perform worse (time increases) with colors being incongruent.

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

Here are the mean, median and standard deviation for the dataset:

	Congruent	Incongruent
Mean	14.0511	22.0159
Standard deviation	3.5594	4.7971
Median	14.3565	21.0175

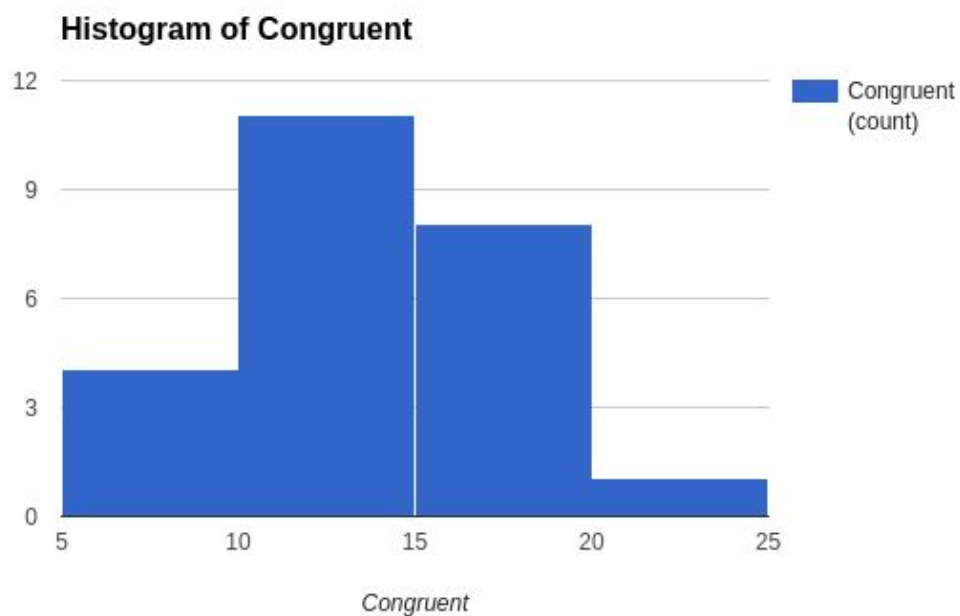
On average, participants took about 14 seconds to finish the congruent task, and about 21 seconds to finish the incongruent task, meaning their performance worsened by about 7 seconds. For now, this seems to go against our H_0 .

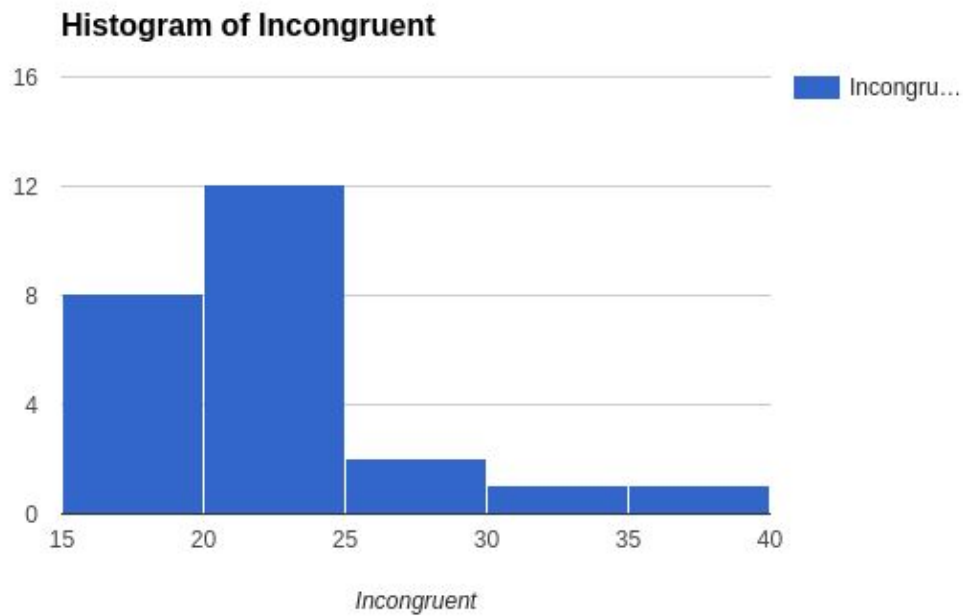
4. Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

The two histograms below show how much time most participants took finishing the congruent task and finishing the incongruent task.

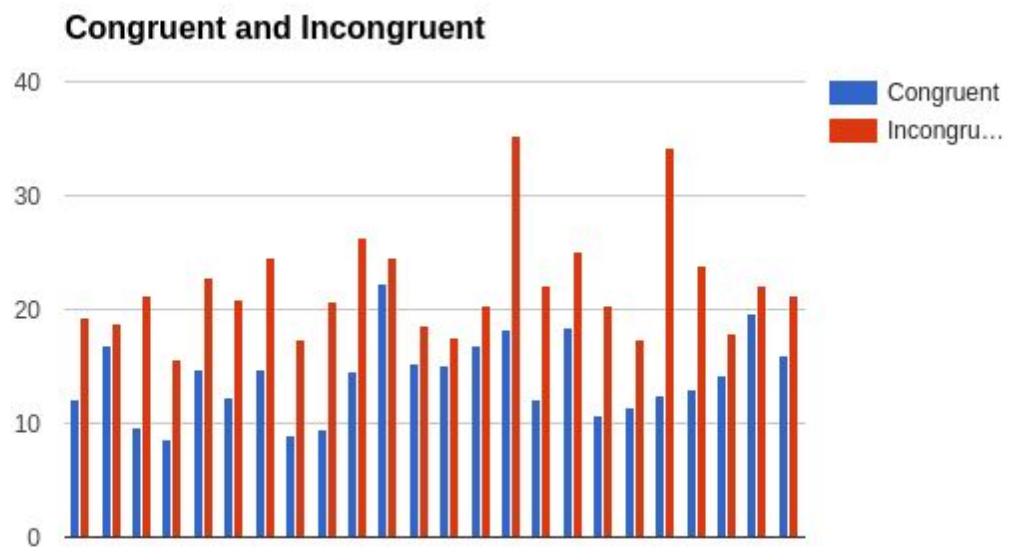
The first histogram (congruent task) shows that results are normally distributed and most people took from 10 to 15 seconds on this task.

The second histogram (incongruent task) shows that results are normally distributed, positively skewed, and most people took from 20 to 25 seconds on this task.





The bar chart below shows how congruent results relate to incongruent results. We can see that in all of our cases, incongruent timings are increased.



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?

Let's pick the confidence level α of 0.05. We have 23 degrees of freedom. Then, the T-statistic critical value will be 1.714. So if the T-score of our mean difference is greater than 1.714, it falls into the critical region and this would lead us to reject the H_0 .

$$\text{Std Dev } S = \text{SQRT}(\text{Total squared dev} / (N - 1)) = \text{SQRT}(544.3304 / 23) = 4.8648$$

$$\text{SE} = \text{Std Dev } S / \text{SQRT}(N) = 4.8648 / \text{SQRT}(24) = 0.9930$$

$$t = (\mu_{\text{of mean difference}} - 0) / (S / \text{SQRT}(N)) = 7.9648 / 0.9930 = 8.0207$$

	Mean diff	Squared dev	Std dev S	SE	t-statistic
	7.1990	0.5864	4.8648	0.9930	8.0207
	1.9500	36.1777			
	11.6500	13.5808			
	7.0570	0.8241			
	8.1340	0.0286			
	8.6400	0.4559			
	9.8800	3.6680			
	8.4070	0.1955			
	11.3610	11.5342			
	11.8020	14.7242			
	2.1960	33.2790			
	3.3460	21.3332			
	2.4370	30.5565			
	3.4010	20.8282			
	17.0550	82.6319			
	10.0280	4.2568			
	6.6440	1.7445			
	9.7900	3.3314			
	6.0810	3.5487			
	21.9190	194.7199			
	10.9500	8.9115			
	3.7270	17.9589			
	2.3480	31.5483			
	5.1530	7.9062			
Mean	7.9648				
Total		544.3304			

We can see that $8.0207 > 1.714$ (our critical value). So our mean difference falls within the critical region. The probability of obtaining a mean difference with t-statistic of 8.0207 is so low it's not in the T-table.

We have enough evidence to reject the H_0 and conclude that incongruent colors affect the Stroop test performance for the worse.

This result matches with what we expected to see.

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!

One theory is that the color recognition requires more time from the brain than simply reading the word. The other theory is that color recognition requires more attention or concentration from the reader. The third theory is that two different pathways are used by the brain for word reading and for color recognition, with reading path being more important and therefore "stronger".

Spreadsheet used for calculations:

<https://docs.google.com/spreadsheets/d/1ZmnOrcmUUzvCBg-z7NZEEdFsnPWs9LRjQpv3881F60JE/edit#gid=346495653>

Stroop effect in wikipedia:

https://en.wikipedia.org/wiki/Stroop_effect