

## **PROJECT 2: Test a Perceptual Phenomenon**

### **ABSTRACT**

This project aims to understand the Stroop's effect with the help of various aspects of differential statistics, and the different visualisations.

### **BACKGROUND INFORMATION**

Stroop's effect is a phenomenon that was discovered in the 1900's. It's one of the famous and widely used tests in psychology. It aims at understanding the reaction of a person reading the word in two different scenarios.

Scenario 1: Congruent condition

Congruent condition refers to the condition when the colour name of word is same as the color.

Eg: BLUE

RED	YELLOW	BLUE	GREEN	BLACK
PINK	ORANGE	BROWN	GRAY	PURPLE
GREEN	GRAY	BLACK	BLUE	YELLOW
GRAY	BROWN	PINK	ORANGE	BLUE
YELLOW	RED	GREEN	BLACK	GRAY
BLACK	BROWN	PURPLE	ORANGE	PINK
PURPLE	BLACK	YELLOW	RED	GREEN
ORANGE	PINK	BROWN	GRAY	PURPLE

Figure 1: Representing CONGRUENT condition

Scenario 2: Incongruent condition

Incongruent condition refers to the condition when the colour name of word is different than the colour.

Eg: PINK

RED	YELLOW	BLUE	GREEN	BLACK
PINK	ORANGE	BROWN	GRAY	PURPLE
GREEN	GRAY	BLACK	BLUE	YELLOW
GRAY	BROWN	PINK	ORANGE	BLUE
YELLOW	RED	GREEN	BLACK	GRAY
BLACK	BROWN	PURPLE	ORANGE	PINK
PURPLE	BLACK	YELLOW	RED	GREEN
ORANGE	PINK	BROWN	GRAY	PURPLE

Figure 2 Representing INCONGRUENT condition

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

Independent variable: The two different conditions for the word:

- 1) Congruent condition
- 2) Incongruent condition

Dependent variable: Response time of a person in seconds.

**Question 2a. Establish hypotheses:** What is an appropriate set of hypotheses for this task?

Null Hypothesis:

The null hypothesis states that there is no relationship between the two measured phenomena. In this case, the null hypothesis is that the time taken to identify the colour of words in congruent condition and the time taken to identify the words in incongruent condition is same.

Let  $\mu_{\text{incongruent}}$  be the population mean of the incongruent values and

$\mu_{\text{congruent}}$  be the population mean of the congruent values

Mathematically,

$$H_0:- \mu_{\text{incongruent}} = \mu_{\text{congruent}}$$

Alternate Hypothesis:



In the alternate hypothesis, it states there is a relationship in the two measured phenomena. In this scenario, the alternate hypothesis is that the time taken to identify the word in incongruent condition is greater than time taken in case of congruent condition.

$$H_A:- \mu_{\text{incongruent}} > \mu_{\text{congruent}}$$

**Question 2b. Establish a statistical test:** What kind of statistical test do you expect to perform? Justify your choices.

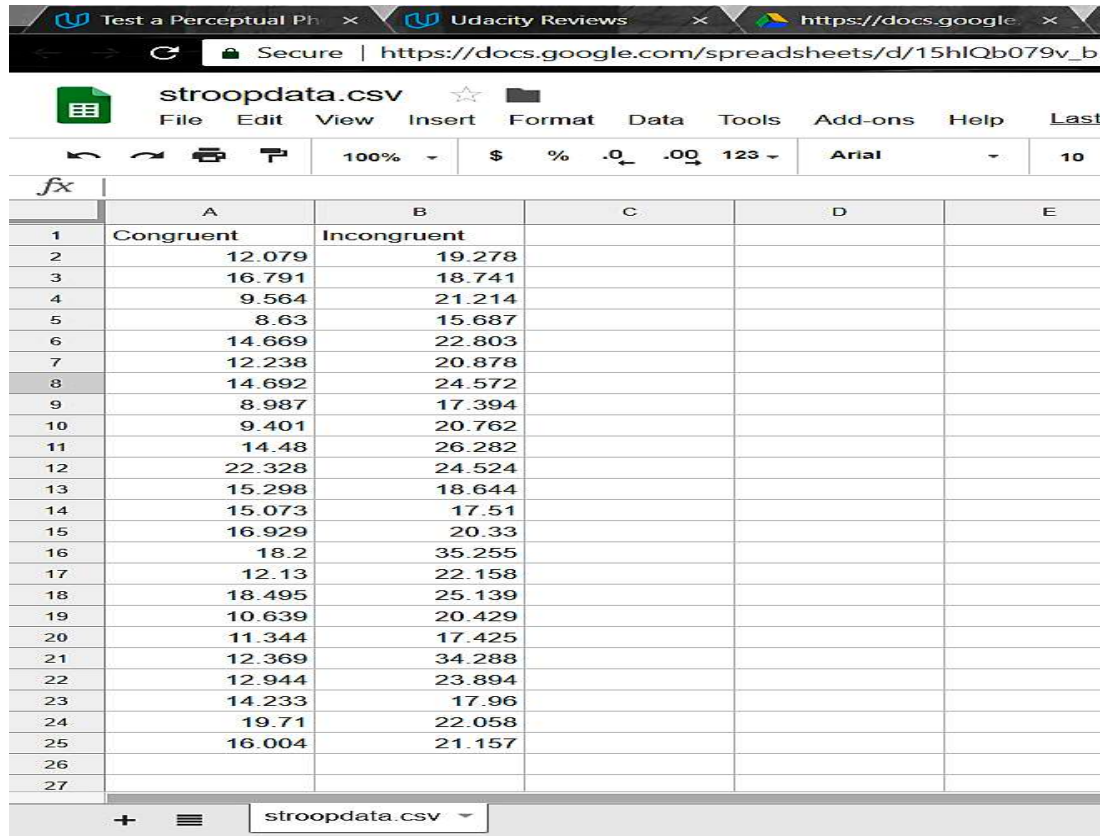
**Assumptions for the statistical test:**

In this project, the paired t-test will be used keeping the following factors in mind:

-  The sample set consists of less than 30 values.
-  Since the data is for sample, population parameters would not be able to be calculated.

**Question 3: Report descriptive statistics: Include at least one measure of central tendency and at least one measure of variability.**

The Sample data we have is:



	A	B	C	D	E
1	Congruent	Incongruent			
2	12.079	19.278			
3	16.791	18.741			
4	9.564	21.214			
5	8.63	15.687			
6	14.669	22.803			
7	12.238	20.878			
8	14.692	24.572			
9	8.987	17.394			
10	9.401	20.762			
11	14.48	26.282			
12	22.328	24.524			
13	15.298	18.644			
14	15.073	17.51			
15	16.929	20.33			
16	18.2	35.255			
17	12.13	22.158			
18	18.495	25.139			
19	10.639	20.429			
20	11.344	17.425			
21	12.369	34.288			
22	12.944	23.894			
23	14.233	17.96			
24	19.71	22.058			
25	16.004	21.157			
26					
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➤ Measure of Central Tendency:

- Mean

Using the AVERAGE function, the mean in both the scenarios is calculated as:

$$\bar{x}_{\text{congruent}} = 14.05$$

$$\bar{x}_{\text{incongruent}} = 22.02$$

- Median

Using the MEDIAN function, the median in both the scenarios is calculated as:

$$\text{Median}_{\text{congruent}} = 14.3565$$

$$\text{Median}_{\text{incongruent}} = 21.0175$$

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stroopdata.csv

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	A	B	C	D
1	Congruent	Incongruent	CONGRUENT	INCONGRUENT
2	12.079	19.278		
3	16.791	18.741		
4	9.564	21.214	mean	mean
5	8.63	15.687	14.051125	22.01591667
6	14.669	22.803		
7	12.238	20.878	median	median
8	14.692	24.572	14.3565	21.0175
9	8.987	17.394		
10	9.401	20.762		
11	14.48	26.282		
12	22.328	24.524		
13	15.298	18.644		
14	15.073	17.51		
15	16.929	20.33		
16	18.2	35.255		
17	12.13	22.158		
18	18.495	25.139		
19	10.639	20.429		
20	11.344	17.425		
21	12.369	34.288		
22	12.944	23.894		
23	14.233	17.96		
24	19.71	22.058		
25	16.004	21.157		
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➤ Measure of Central Variability

Now, the standard deviation of the difference between congruent and incongruent will be calculated.

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	A	B	C	D	E
1	Congruent	Incongruent	Difference	Mean_of_diff	
2	12.079	19.278	-7.199	-7.964791667	
3	16.791	18.741	-1.95		
4	9.564	21.214	-11.65		
5	8.63	15.687	-7.057		
6	14.669	22.803	-8.134		
7	12.238	20.878	-8.64		
8	14.692	24.572	-9.88		
9	8.987	17.394	-8.407		
10	9.401	20.762	-11.361		
11	14.48	26.282	-11.802		
12	22.328	24.524	-2.196		
13	15.298	18.644	-3.346		
14	15.073	17.51	-2.437		
15	16.929	20.33	-3.401		
16	18.2	35.255	-17.055		
17	12.13	22.158	-10.028		
18	18.495	25.139	-6.644		
19	10.639	20.429	-9.79		
20	11.344	17.425	-6.081		
21	12.369	34.288	-21.919		
22	12.944	23.894	-10.95		
23	14.233	17.96	-3.727		
24	19.71	22.058	-2.348		
25	16.004	21.157	-5.153		
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1. The difference of the congruent and incongruent is firstly calculated. Further, the mean of differences is calculated as well.
2. Then the deviation of the differences from the mean difference is calculated. Along with that, square of deviations is also calculated.

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	A	B	C	D	E	F
1	Congruent	Incongruent	Difference	Mean_of_diff	Deviation from mean difference	Squared Deviations
2	12.079	19.278	-7.199	-7.964791667	0.765791667	0.5864368772
3	16.791	18.741	-1.95		6.014791667	36.1777188
4	9.564	21.214	-11.65		-3.685208333	13.58076046
5	8.63	15.687	-7.057		0.907791667	0.8240857107
6	14.669	22.803	-8.134		-0.169208333	0.02863145996
7	12.238	20.878	-8.64		-0.675208333	0.455906293
8	14.692	24.572	-9.88		-1.915208333	3.668022959
9	8.987	17.394	-8.407		-0.442208333	0.1955482098
10	9.401	20.762	-11.361		-3.396208333	11.53423104
11	14.48	26.282	-11.802		-3.837208333	14.72416779
12	22.328	24.524	-2.196		5.768791667	33.2789573
13	15.298	18.644	-3.346		4.618791667	21.33323646
14	15.073	17.51	-2.437		5.527791667	30.55648071
15	16.929	20.33	-3.401		4.563791667	20.82819438
16	18.2	35.255	-17.055		-9.090208333	82.63188754
17	12.13	22.158	-10.028		-2.063208333	4.256828625
18	18.495	25.139	-6.644		1.320791667	1.744490628
19	10.639	20.429	-9.79		-1.825208333	3.331385459
20	11.344	17.425	-6.081		1.883791667	3.548671045
21	12.369	34.288	-21.919		-13.95420833	194.7199302
22	12.944	23.894	-10.95		-2.985208333	8.911468791
23	14.233	17.96	-3.727		4.237791667	17.95887821
24	19.71	22.058	-2.348		5.616791667	31.54834863
25	16.004	21.157	-5.153		2.811791667	7.906172379
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3. After squared deviations have been calculated, we then divide the sum of squared deviations by n-1 because it is the case of tailed test.

As a result, we have found the standard deviation of differences, which is the measure of variability.

$$S=4.85$$



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fx

	A	B	C	D	E	F	G
1	Congruent	Incongruent	Difference	Mean_of_diff	Deviation from mean difference	Squared Deviations	(Sum of Squared Deviations)/(n-1)
2	12.079	19.278	-7.199	-7.964791667	0.765791667	0.5864368772	23.66654087
3	16.791	18.741	-1.95		6.014791667	36.1777188	
4	9.564	21.214	-11.65		-3.685208333	13.58076046	Standard Deviation
5	8.63	15.687	-7.057		0.907791667	0.8240857107	4.86482691
6	14.669	22.803	-8.134		-0.169208333	0.02863145996	
7	12.238	20.878	-8.64		-0.675208333	0.455906293	
8	14.692	24.572	-9.88		-1.915208333	3.668022959	
9	8.987	17.394	-8.407		-0.442208333	0.1955482098	
10	9.401	20.762	-11.361		-3.396208333	11.53423104	
11	14.48	26.282	-11.802		-3.837208333	14.72416779	
12	22.328	24.524	-2.196		5.768791667	33.2789573	
13	15.298	18.644	-3.346		4.618791667	21.33323646	
14	15.073	17.51	-2.437		5.527791667	30.55648071	
15	16.929	20.33	-3.401		4.563791667	20.82819438	
16	18.2	35.255	-17.055		-9.090208333	82.63188754	
17	12.13	22.158	-10.028		-2.063208333	4.256828625	
18	18.495	25.139	-6.644		1.320791667	1.744490628	
19	10.639	20.429	-9.79		-1.825208333	3.331385459	
20	11.344	17.425	-6.081		1.883791667	3.548671045	
21	12.369	34.288	-21.919		-13.95420833	194.7199302	
22	12.944	23.894	-10.95		-2.985208333	8.911468791	
23	14.233	17.96	-3.727		4.237791667	17.95887821	
24	19.71	22.058	-2.348		5.616791667	31.54834863	
25	16.004	21.157	-5.153		2.811791667	7.906172379	
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#### Question 4: Plot the data:

Visualization: Using Google Spreadsheet

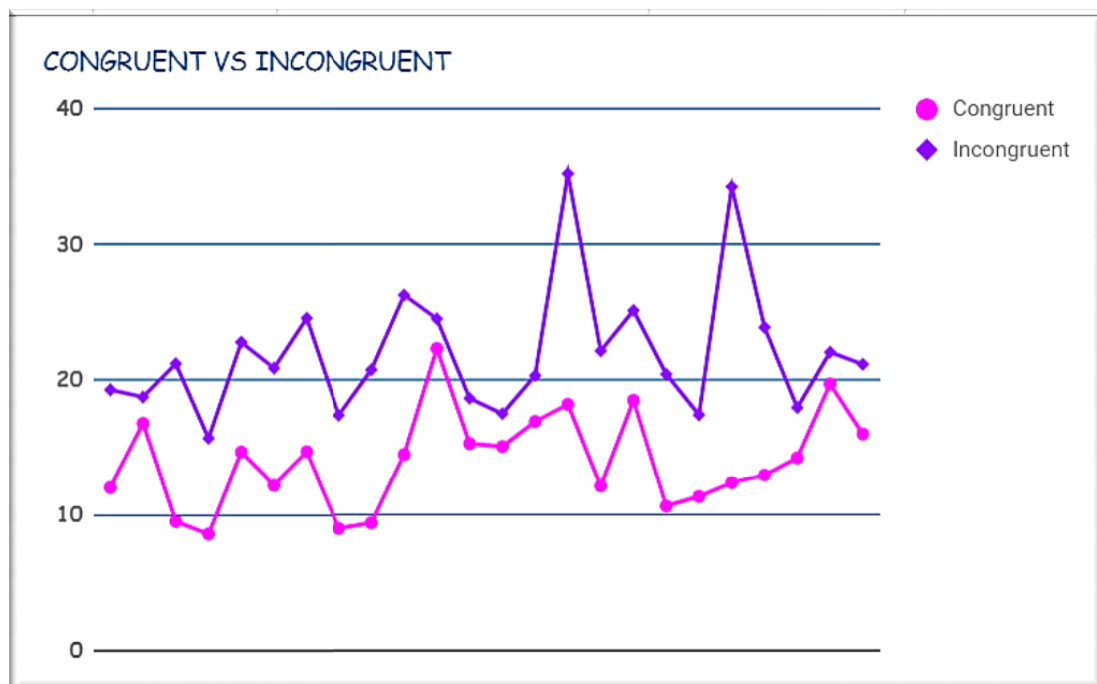


Figure 3: Line chart

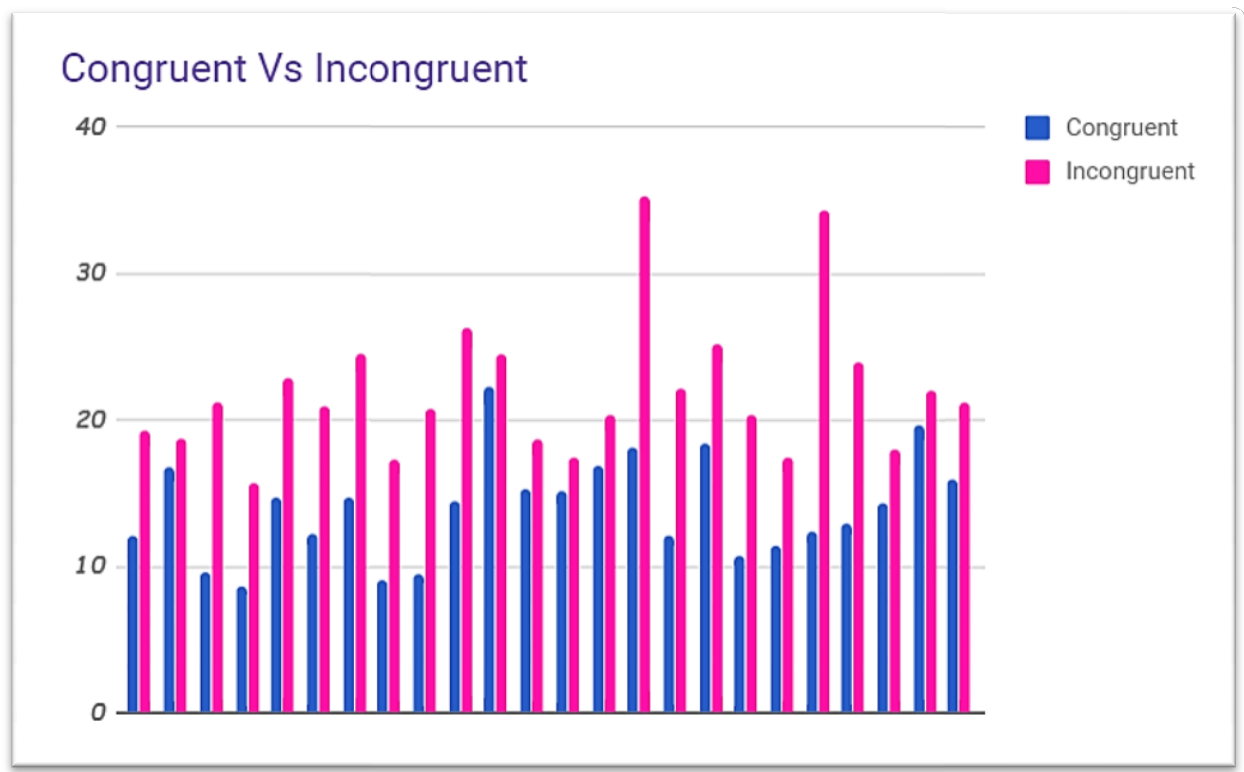


Figure 4: Bar graph

From analyzing the above plots, i.e. the line chart, and the bar graph, we can evidently note that the time taken by the person to read the words in incongruent condition is always higher than in the congruent condition.

### **Question 5. Perform the statistical test and interpret your results:**

To calculate the t-statistic:

We have the formula: 
$$T\text{-statistic} \rightarrow \frac{(x_{\text{congruent}} - x_{\text{incongruent}})}{s/\sqrt{n}}$$

where  $x_{\text{congruent}}$  and  $x_{\text{incongruent}}$  represent the mean of congruent and incongruent respectively.

Now, we know that  $(x_{\text{congruent}} - x_{\text{incongruent}})$  is basically the mean of differences: -7.96

$n=24$

$s$ =std.deviation of differences was found out to be: 4.865

Substituting these values in equation, we get:



T-statistic: -8.015

Now, since we have the T-statistic value, we can compare with the T-critical value to determine whether we should accept or reject the null hypothesis.

$n=24$

This implies that the df(i.e. degree of freedom  $\rightarrow n-1$ ) = 23.

Now, we are calculating this at 99% confidence level. Thus, the value for  $\alpha=0.01$ .

From the t-table, we can see that at 99% confidence level, the value is 2.50. In our observations, we found the t-statistic as -8.015, this leads us to reject the null hypothesis.

Thus, it's evident that the reaction time in case of incongruent conditions is much greater than that of the congruent conditions.

#### **Question 6: Digging deeper and extending the investigation :**

Alongside the stroop's effect, throughout the research, I found out about the different variations in the stroop's effect, which primarily are: Warped words, emotional, spatial, numerical, and reverse. In all, everything sums up in the psychological aspects of the human brain. It's all variant of the processing powers of the brain. An example that comes very handy is: if you conduct an experiment of reading normal text (i.e. this is me) vs. reversed text (i.e. em is siht), you can see the difference in the reaction/response time of the population.

Apart from stroop's experiment, there may be different experiments that account for the effect of colour on various events that take place.

## **BIBLIOGRAPHY**

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