P1 PROJECT: STATISTICS

STROOP EFFECT ANALYSIS

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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.

1. Independent and dependent variables

- The **independent variable** is the condition participants are subject to, either congruent or incongruent words condition.
- The **dependent variable** is the measure of reaction time to perform a task due to interference. In a Stroop test, the operational definition is the measure of time each participant takes to name the ink colors in equally-sized lists.

2. Hypotheses set and appropriate statistical tests.

The **null hypothesis (H0)** is that it takes the same time, on average, to accomplish both congruent and incongruent words condition tasks.

To **reject the null hypothesis (H1)**, the time it takes to perform the tasks must me significantly different, on average.

Although we expect the span of time to perform the incongruent test to be, on average, higher than the time it takes to perform the congruent task, we can't accept H0 if we find the average time of the incongruent test to be lower than the time of the congruent test. For this reason, it's correct to perform a **two-tailed test**.

$$H0: \mu_x = \mu_y$$

$$H1: \mu_x \neq \mu_y$$

Where:
μ = Population mean
x = Congruent test
y = Incongruent test

As we are using a small sample (24 individuals) and the population standard deviation is unknown, it's necessary to use Student's t test instead of a Z statistical test, verifying two different conditions on the same subject sample.

Statistical test: One sample t test, two-tailed.

$$t = \frac{\bar{D} - \mu_D}{SE}$$

Where:

$$\bar{D} = (\bar{X} - \bar{Y})$$

$$d_i = (x_i - y_i)$$

$$\mu_D = (\mu_x - \mu_y)$$

$$n = sample\ size$$

$$df(degrees\ of\ freedom) = n - 1$$

$$S\ (Sample\ standard\ deviation) = \sqrt{\frac{\sum_{i=1}^{n}(d_i - \bar{D})^2}{df}}$$

$$SE\ (Standard\ error) = \frac{S}{\sqrt{n}}$$

Assumptions:

$\alpha - level = 5\%$

$Confidence\ level = 95\%$

The sample was randomly selected from a defined population.

The characteristic is normally distributed in the population.

Interval scale of measurement.

Correlation measure #1: Cohen's d. Measures the absolute effect size in multiples of standard deviations.

$$d = \frac{\overline{D} - \mu_D}{S}$$

Correlation measure #2: Coefficient of determination (r^2). Measures the relative strength of the relationship, in a scale from 0 (nonexistent) to 1 (perfect relationship).

$$r^2 = \frac{t^2}{t^2 + df}$$

3. Descriptive statistics

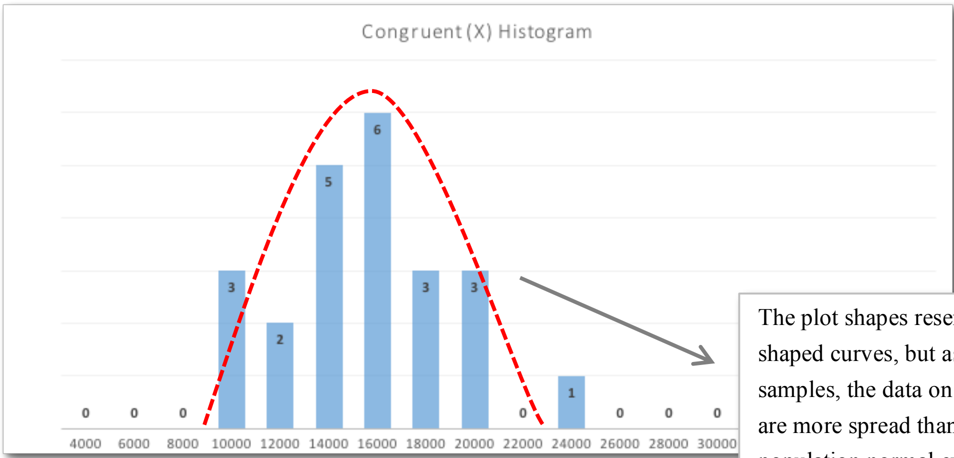
3.1 Measures of central tendency

	Congruent (x)	Incongruent (y)	Difference (y – x)
Mean	14,051	22,016	7,965
Median	14,357	21,018	7,667
Mode	n/a	n/a	n/a

3.2 Measures of dispersion

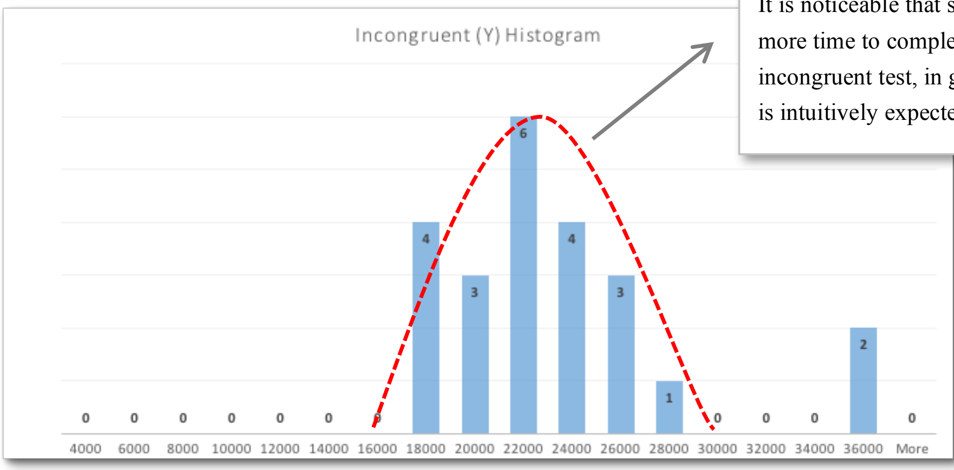
	Congruent (x)	Incongruent (y)	Difference (y – x)
Range	13,698	19,568	19,969
Interquartile Range (IQR)	4,306	5,335	6,613
Standard Deviation (S)	3,559	4,797	4,865
Standard Error (SE)	727	979	993

4. Data Plot

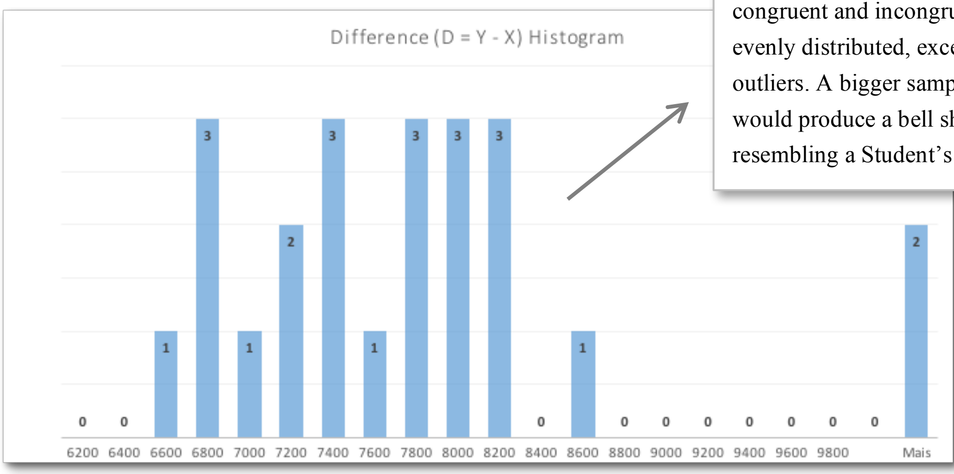


The plot shapes resemble bell-shaped curves, but as the data are samples, the data on the t-curves are more spread than with its population normal curve.

It is noticeable that subjects took more time to complete the incongruent test, in general. This is intuitively expected.



The difference in time between congruent and incongruent tests are evenly distributed, except for a few outliers. A bigger sample size would produce a bell shaped graph, resembling a Student's t curve.



5. Statistical Test

One sample t test, two-tailed.

<u>Calculations</u>:

$\overline{D} = 7{,}965$

$\mu_D = 0\ (because\ H0 = 0)$

$n = 24$

$df = 23$

$S = 4{,}865$

$SE\ = 993$

$\alpha = 0.05$

$t^* = 2.069\ (t\ critical\ @\ t\ table)$

$$t = \frac{\overline{D} - \mu_D}{SE} = \frac{7.965 - 0}{993} = 8.02$$

$$probability\ (p) < .05 \rightarrow Reject\ H0.$$

$$d = \frac{\overline{D} - \mu_D}{S} = \frac{7.965 - 0}{4.865} = 1.64$$

$$r^2 = \frac{t^2}{t^2 + df} = \frac{8.02^2}{(8.02^2 + 23)} = .74$$

$$CI(confidence\ interval) = \overline{D} \pm (t^* \times \mathrm{SE})$$

$$95\%\ CI = 7{,}965 \pm (2.069 \times 993)$$

$$95\%\ CI = (5{,}910\ , 10{,}019)$$

APA-style results:

$t(23) = 8.02$, $p < .05$, two-tailed

95% CI = (5,910 , 10,019)

$d = 1.64$

$r^2 = .74$

Conclusion:

In the calculation, the t-critical value is 2.069. We reject H0, because the t-test result of 8.02 with 23 degrees of freedom is higher than the critical t-value. It means the probability of such result be the mere act of chance is less than 5% (less than 2.5% on the right tail).

The result matched my expectations of having a higher time to complete the incongruent test than to complete the congruent test, in a consistent manner.

Bibliography

Microsoft Inc. 2016. *How to use the Histogram tool in Excel.* 11 09. https://support.microsoft.com/en-us/kb/214269.

Wikipedia. 2016. *Stroop Effect.* 11 09. https://en.wikipedia.org/wiki/Stroop_effect.