

Project 1

Introduction:

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.

Method:

Subject: There are 24 participants and each of them performed 25 trials in both congruent and incongruent condition.

Procedures:

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, in seconds. Each participant would conduct the test with congruent condition first, and then that with incongruent condition.

Aim of the Investigation:

The purpose of the study is to investigate the Stroop effect of the participants. We would like to test if people take longer time to finish the incongruent words condition, than that to finish the congruent words condition, with the same number of trials.

Analysis:

Independent variable: the font colors and the printed name of the word

Dependent variable: the total reaction time of the participants to finish test in each condition

Hypothesis:

We define μ_c be the population mean of congruent condition and μ_i be the population mean of incongruent condition

Null Hypothesis: $H_0: \mu_i = \mu_c$

Null hypothesis (H_0) is often the statement based on existing knowledge. In this case, it states that the population mean of the reaction time used to finish the congruent condition equals to the incongruent condition.

Alternative Hypothesis: $H_A: \mu_i > \mu_c$

Alternative hypothesis (H_A) states that the two population parameters in the null hypothesis are different in value, and it is the statement which we hope to conclude it is true. In this case, we hope to prove that the population mean of the reaction time taken to finish the incongruent condition is significantly longer than that to finish the congruent condition.

Type of Hypothesis Testing Used:

We try to test the relationship between the population means by the sample statistics.

In this case, based on the way the experiment is conducted, same group of people have done both the congruent and incongruent condition. We could use a “dependent t-test” to carry out the hypothesis testing. It is also called a “paired t-test” which compares the means of two related sample groups to determine if there is a statistically significant difference between the means.

An “**one-tailed T-test**” would be conducted based on the above hypothesis. It is because from the Stroop task, the data collected is only a sample but not a population. With the unknown population parameters, using a T-test is better than a Z-test. Also a one-tailed is used rather than a two-tailed T-test in chosen as we would like to measure whether population mean of reaction time taken is longer to finish the incongruent condition. There is a direction of comparison between the congruent and incongruent condition.

Assumptions:

1. The dependent variable must be continuous (interval/ratio).
2. The observations are independent of one another.
3. The dependent variable should be approximately normally distributed.
4. The dependent variable should not contain any outliers.

Descriptive Statistics:

	Mean	Median	Mean Difference (Point estimate for $\mu_i - \mu_c$)	Standard Deviation of mean difference
Congruent, N =24	14.05	14.36	7.96	4.86
Incongruent, N =24	22.02	21.02		

In this case, mean is a better choice to measure the central tendency of congruent condition as the shape of distribution on a histogram (Figure 1) is similar to that of a normal distribution, which does not contain outliers. For incongruent condition, we find the shape of the distribution (Figure 2) is a bit skewed to the right, as the reaction time recorded is centralized from 14 to 27, but two participants took more than 33 to finish the test. This would slightly affect the accuracy of the central tendency of the mean. Therefore the median would be a better choice to measure the central tendency of incongruent condition.

Figure 1

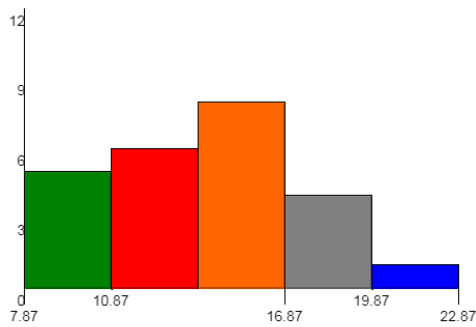
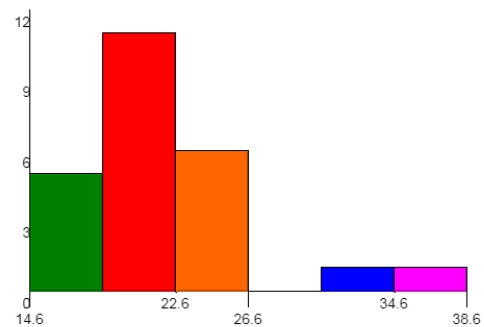
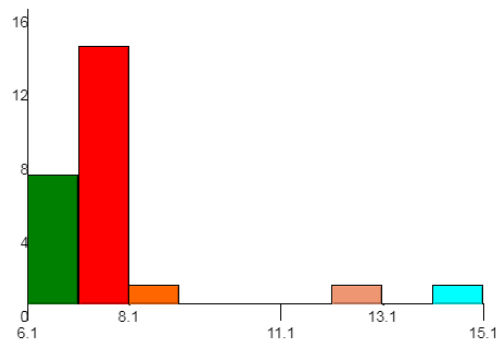


Figure 2



When we compute the mean difference of congruent and incongruent condition (Figure 3), it shows that the sampling distribution is heavily skewed to the right, as there are two outliers appeared in the sample.

Figure 3



Standard deviation is used to measure the variability of the test conditions. The standard deviation of the mean difference of the two samples is calculated as 4.86, by the formula below.

$$s = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2}$$

As we are working on the samples, this sample standard deviation is used to estimate the population standard deviation.

Hypothesis Testing Results:

	Mean Difference (Point estimate for $\mu_i - \mu_c$)	Standard Deviation of mean difference	Degree of Freedom	Standard Error	t-Statistics	t-Critical value ($\alpha = 0.05$)	p value
Incongruent	7.96	4.86	23	0.99	8.02	1.714	< 0.0001
Congruent							

As in the Alternative Hypothesis, we want to test if $\mu_i > \mu_c$, therefore we would use $(Y_i - X_i)$ to find the mean difference, which Y_i is the observed reaction time for incongruent condition and X_i is the observed reaction time for congruent condition.

After computing the standard error as 0.99, the t-Statistics is 8.02. As the α level chosen is 0.05, with degree of freedom equals to 23, the t-Critical value is 1.714.

By comparing the t-Statistics and the t-Critical value, we can see that the t-Statistics (8.02) is significantly greater than the t-Critical value (1.714). It results in the p-value smaller than 0.0001, which is much smaller than α at 0.05, meaning the probability is too small to obtain a result that the reaction time taken to finish both the congruent and incongruent condition are the same. Thus with an alpha level of 0.05, we would have enough evidence to **reject the null hypothesis**. As it is an experimental test, we could conclude that, the reaction time taken to finish the Stroop task for incongruent condition is significantly longer than that for the congruent condition.

Discussion: The reason that is responsible for the Stroop Effects observed

The Stroop effect happens for a few possible reasons. The first reason maybe that people read words faster than colors. When the word and color appear at the same time, people would recognize the word faster and thus the reaction time to say out the word is faster than saying out the color of the word. The second reason maybe that the learning pattern of people since small is to read words printed on books with black color. Therefore they would pay less attention on the color of the word, but more focus on how to pronounce the word. Saying out the color of the word in the Stroop task is a different practice for usual people while reading, thus they may have to spend more time familiarizing or saying out the color of the word, regardless of the pronunciation of the word. The third reason is regarding to the level of Stroop effect. The difference in reaction time between the congruent and incongruent condition may varies between each person. The type of people taking the test may affect the result. For example, man tends to have faster reaction time than woman; younger participants tends to have faster reaction time than the older ones; people who did not learn words may finish the incongruent condition faster as they would not be interfered by the pronunciation of words. However we do not know what kinds of participants are taking the above test within the two samples, which we could not include this element in the analysis.

Discussion: Alternative or similar task that would result in similar effect

Regarding the original paper on the research of Stroop Effect by Stroop (Stroop, 1935), we may conduct two tasks and compare the results with the congruent condition. The first task would be all words printed in black color, and spelled with different color names. Participants have to say out each color name and time is recorded. The second task would be words are replaced by a number of squares, printed in different color. Participants have to say out the colors of the squares and time is recorded. When we compare the results of the two tasks with the incongruent condition, we could see the difference in reaction time to say out the spelled words, regardless the effect of the font color (1st task); difference in reaction time to say out the color, regardless the effect of the words spelled (2nd task). Then we could conclude if the Stroop Effect is happened when participants have to say out the font color which does not match the printed word.

Another test maybe that each word is spelled with different color name, but they are all printed in the one/two color(s), like the first task mentioned above done by Stroop (e.g. RED, BLUE, YELLOW, GREEN are all printed in yellow/yellow + orange color). Then we could see the difference in reaction time and make estimation for the Stroop Effect.

Reference:

Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18, 643-662, <http://psychclassics.yorku.ca/Stroop/>