

TESTING A PERCEPTUAL PHENOMENON

Background Information:

In psychology, the **Stroop effect** is a demonstration of interference in the reaction time of a task.

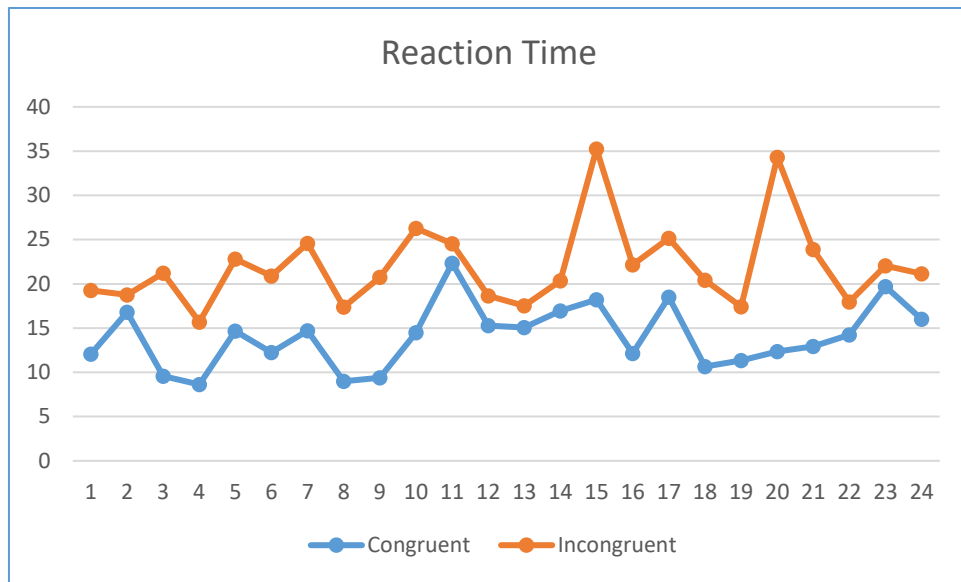
[Wikipedia]

In a Stroop task, participants are presented with a list of words, with each word displayed in a colour of ink. The participant's task is to say out loud the *colour 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 colour words whose names match the colours in which they are printed: for example **RED**, **BLUE**. In the *incongruent words* condition, the words displayed are colour words whose names do not match the colours in which they are printed: for example **PURPLE**, **ORANGE**. In each case, we measure the time it takes to name the ink colours in equally-sized lists. Each participant will go through and record a time from each condition. [Udacity]

The Data:

24 people were selected at random and they participated in a Stroop Task as described above. Their net reaction times (in seconds) in both the cases of congruent and incongruent conditions were recorded and are as follows along with the calculated differences:

#	Congruent	Incongruent	Difference
1	12.079	19.278	7.199
2	16.791	18.741	1.95
3	9.564	21.214	11.65
4	8.63	15.687	7.057
5	14.669	22.803	8.134
6	12.238	20.878	8.64
7	14.692	24.572	9.88
8	8.987	17.394	8.407
9	9.401	20.762	11.361
10	14.48	26.282	11.802
11	22.328	24.524	2.196
12	15.298	18.644	3.346
13	15.073	17.51	2.437
14	16.929	20.33	3.401
15	18.2	35.255	17.055
16	12.13	22.158	10.028
17	18.495	25.139	6.644
18	10.639	20.429	9.79
19	11.344	17.425	6.081
20	12.369	34.288	21.919
21	12.944	23.894	10.95
22	14.233	17.96	3.727
23	19.71	22.058	2.348
24	16.004	21.157	5.153



[Generated using Microsoft Excel]

The above line chart depicts the reaction times of each participant in the congruent and incongruent conditions. We can observe right away that in the **samples** under considerations, the participants on an average, took longer to identify the ink colours of the words in the incongruent conditions than in the congruent condition.

By treating these data sets as dependent samples, we can perform a **t-test** to determine whether there is a significant difference in the means of the reaction times of the **populations** from which these samples originate.

The Experiment:

Variables in the experiment:

Dependent variable: Duration (time) to recognise the colours or the texts.

Independent variable: The congruency of the colour and text

Assumptions:

1. The sample consists of participants chosen **at random** and all *pairs* of reaction times are independent.
2. The distribution of the means of the differences between reaction times of all the samples from the population is normal.

Hypotheses:

Mathematically	In words
$H_0 : M_c = M_{ic}$	Null Hypothesis: There is <i>no</i> difference between the population means of the reaction times in the congruent and incongruent conditions.
$H_A : M_c \neq M_{ic}$	Alternate Hypothesis: There <i>is</i> a difference between the population means of the reaction times in the congruent and incongruent conditions.

Statistical Test:

We conduct t-test for two dependent samples check whether we're able to reject the null hypothesis or if we fail to reject the null hypothesis, based on the probability of randomly obtaining a t-statistic as that of the set of calculated differences between the reaction times from the recorded samples.

[Using a Microsoft Excel spreadsheet, we calculated the following with respect to the t-test]

Symbol	In Words	Value
\bar{X}_c	Mean reaction time in the congruent condition	14.051125
S_c	Standard deviation in congruent condition	3.559357958
\bar{X}_{ic}	Mean reaction time in the incongruent condition	22.01591667
S_{ic}	Standard deviation in the incongruent condition	4.797057122
\bar{X}_d	Mean difference in reaction times	7.964792
S_d	Standard deviation of differences in reaction times	4.864827
n	Sample size	24
SE	Standard error of differences in reaction times	0.993028635
df	Degrees of freedom	23
t	t-statistic of the differences in reaction times	8.020706944

Results:

If we choose an α – level of 0.05, we find the t-critical values at 23 degrees of freedom to be ± 2.069 , since it's a two tailed test.

Which means that the probability of randomly obtaining a sample from the population, at 23 degrees of freedom with a t-statistic greater than +2.069 or less than -2.069 is **0.05 or 5%**.

Comparing the t-critical value with our calculated t-statistic, we find that our t-statistic falls in the critical region (the region cut off by the t-critical values in the sampling distribution)

Using the “QuickCalcs” statistics calculator available on www.graphpad.com to calculate the probability of randomly obtaining a sample with a t-statistic of **8.020706944** and **23** degrees of freedom, we find the probability to be less than **0.0001**

Decision:

So based on all these calculations and observations, we **REJECT** the null hypothesis which states that there is no difference between the population means of the reaction times in the congruent and incongruent conditions, since we see that there is a significant difference between the reaction times and it is highly unlikely that this difference is due to chance.

An alternate approach to testing the Stroop effect would be to record the maximum number of ink colours that the participants would be able to read out correctly within a fixed amount of time (say one minute) in both the congruent and incongruent conditions. This would result in a similar observation as the above experiment.