Stroop Effect

1. Independent and dependent variables

Independent variable is the word/ink colour congruency (incongruent and congruent). Dependent variable is the time taken to name the ink colours

2. Hypothesis

H0: There is no significant difference in time taken to read in congruent and incongruent condition ($\mu_B \leq \mu_A$), where A denotes the congruent condition and B denotes the incongruent condition.

H1: There is a significant difference, i.e. the time taken to read colours of the ink in incongruent condition is more than the time taken for congruent condition ($\mu_B > \mu_A$)

One tail dependent samples t-test will be performed to measure whether the incongruent condition of Stroop test increases the time taken to read the colour of the ink compared with the congruent condition. Disadvantages such as carry-over effects and order of the treatment are not relevant in this experiment since participants are tested for psychology, where they do not learn anything from an experiment which could affect the second treatment.

One tail test is used for this experiment since there is considerable evidence to believe that the time taken to read the colours in incongruent condition will be increased. From the experiment of Shepard and Fogelsonger (1913), it is seen that response time increased as the complexity of situation increased. Similarly, Woodworth and Wells (1911, p. 52) attribute the time increase in reading colours on wrong words is due to interference and preceding use, where the words are on the tip of the tongue and equally likely to get in each other's way (Psychclassics.yorku.ca, 2016).

Assumptions made for this test (NCSS Statistical Software-Chapter 208, 2016):

- The data is continuous (not discrete)
- The differences for matched pairs follow a normal distribution
- The sample of pairs is a simple random sample from its population. Each individual in the sample has an equal probability of being selected.

3. Descriptive Statistics

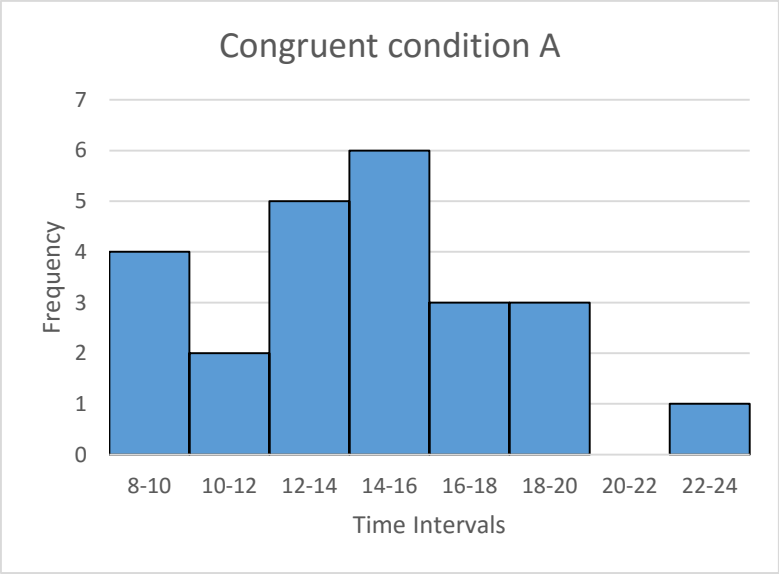
Congruent (A)	Incongruent (B)	Difference D=B-A
12.079	19.278	7.199
16.791	18.741	1.95
9.564	21.214	11.65
8.63	15.687	7.057
14.669	22.803	8.134
12.238	20.878	8.64
14.692	24.572	9.88
8.987	17.394	8.407
9.401	20.762	11.361

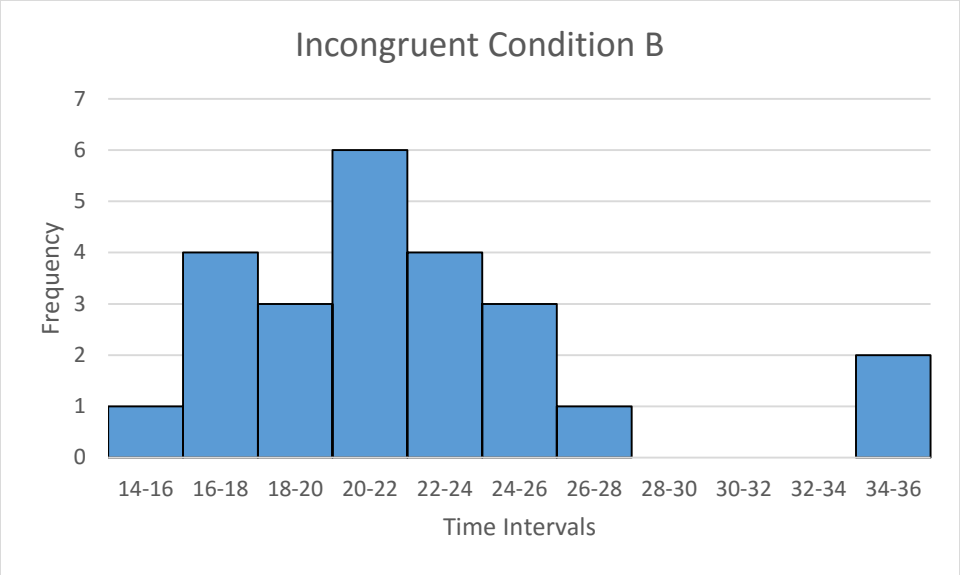
14.48	26.282	11.802
22.328	24.524	2.196
15.298	18.644	3.346
15.073	17.51	2.437
16.929	20.33	3.401
18.2	35.255	17.055
12.13	22.158	10.028
18.495	25.139	6.644
10.639	20.429	9.79
11.344	17.425	6.081
12.369	34.288	21.919
12.944	23.894	10.95
14.233	17.96	3.727
19.71	22.058	2.348
16.004	21.157	5.153

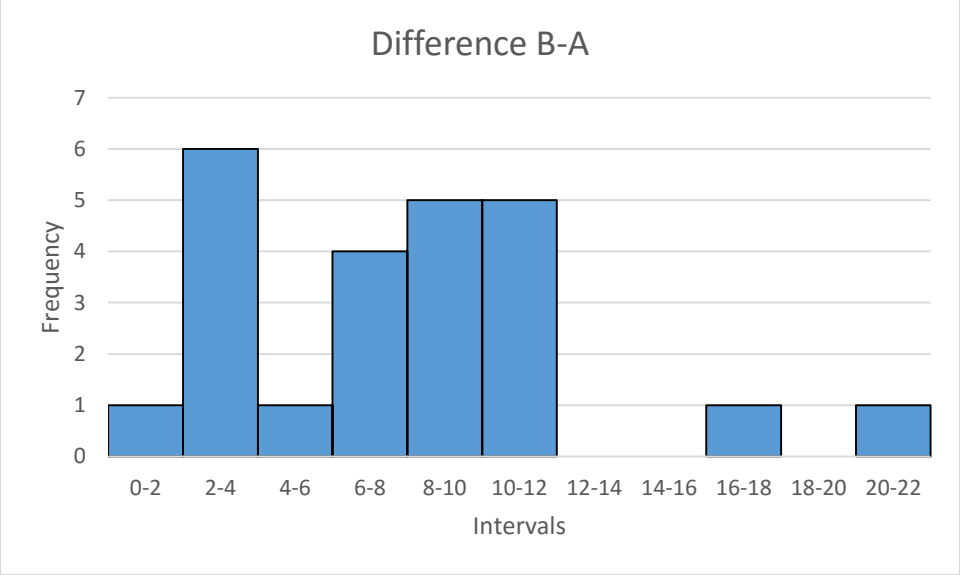
Sample A	**Sample B**	**Difference D=B-A**
$\bar{x}_A$=14.05	$\bar{x}_B$ = 22.02	$\bar{x}_{B-A}$ = 7.96
Median = 14.36	Median = 21.02	Median = 7.67
s_A = 3.56	s_B = 4.80	s_{B-A} = 4.86

From the above parameters, it is seen that mean and median are similar for each sample. It rules out the presence of outliers in the sample. Thus, the mean values represent the sample quite accurately. Standard deviation of sample A is less than sample B. It reveals that there is greater variance in values of sample B than sample A.

4. Visualization







We can see that the sample data and its difference are normally distributed from the histograms, which satisfies one of the assumptions that the difference between the pairs is normally distributed. The mode for sample A lies between 14-16 and mode for sample B is between 20-22. The means and medians of both samples are also in the range of the respective modes. Hence the normal distribution of data can be confirmed.

5. Statistical Test

Degree of freedom, df = n-1 = 24-1 = 23

$t_{critical}$= 1.714 at $\alpha = 0.05$ and df = 23.

$t_{statistic} = (\bar{x}_B - \bar{x}_A) / (s/\sqrt{n}) = (22.02 – 14.05) / (4.86/\sqrt{24}) = 8.03$

We see that $t_{statistic} > t_{critical}$.

The result is significant at $p < 0.05$

Hence we can reject null hypothesis H0.

Margin of error = $t_{critical} * s/\sqrt{n} = 1.714 * 0.99 = 1.7$

Confidence Interval, CI = Mean difference of samples ± Margin of error

$= 7.97 \pm 1.7$

CI = (6.27, 9.67)

$r^2 = t^2 / (t^2 + df) = 0.738 = 73.8\ \%$

6. Conclusion

Since it was a controlled experiment with the same sample used for both conditions, a causality can be concluded. Thus the incongruent condition of the treatment leads to increase in the time taken for reading the colour of the ink. This result is in line with the assumptions made at the beginning through literature review to perform a one-tail test.

I think that such results are due to two conflicting stimuli presented to our brain. When the word doesn't match with the colour of the ink, the brain takes time to resolve the situation and give the correct answer. One other reason could be that humans are accustomed to always associating the right colour with the right word. Thus such a situation is new to everyone and it is difficult to not consider the association while making a decision. This causes an increase in time to respond.

7. References

Psychclassics.yorku.ca. (2016). *Classics in the History of Psychology -- Stroop (1935)*. [online] Available at: http://psychclassics.yorku.ca/Stroop/ [Accessed 3 Apr. 2016].

Shepard, J.F. and Fogelsonger, H.M., 1913. Studies in association and inhibition. *Psychological Review*, *20*(4), p.290.

Woodworth, R.S. and Wells, F.L., 1911. Association tests. *The Psychological Monographs*, *13*(5), p.i.

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