1. WHAT ARE THE DEPENDENT AND INDEPENDENT VARIABLES?

In this experiment the dependent variable is the time to name the ink colors. The independent variable is words condition: either the words are written in a color that matches the color word (congruent condition) or they are written in a different color (incongruent condition).

2. HYPOTHESES

As we only have samples and there is no knowledge about population parameters, the appropriate test is a t-test.
Intuitively, we would expect an increased mean of the incongruent words condition, as it seems more difficult to name the color when the word is actually written in a different color. Therefore, a one-tailed test in positive direction is appropriate.

Hence, the null hypothesis H_0 is that the difference between the congruent and incongruent data is purely by chance and that the population means for both are actually the same:
H_0: $\mu_{Congruent} = \mu_{Incongruent}$

And the alternative hypothesis H_A is that the time to name ink colors is indeed impact by the incongruent condition, which means that the population mean is increased:
H_A: $\mu_{Congruent} < \mu_{Incongruent}$

The t-test in this case is a dependent t-test or paired samples t-test, as the goal is to determine whether there is a statistically significant difference between the means of the congruent and the incongruent data. In this case, the data is coming from the same group of participants, i.e. the same person will record their time to name the ink color for both the congruent and the incongruent condition, so we are speaking of a "within-subjects" or "repeated-measures" test.

3. DESCRIPTIVE STATISTICS

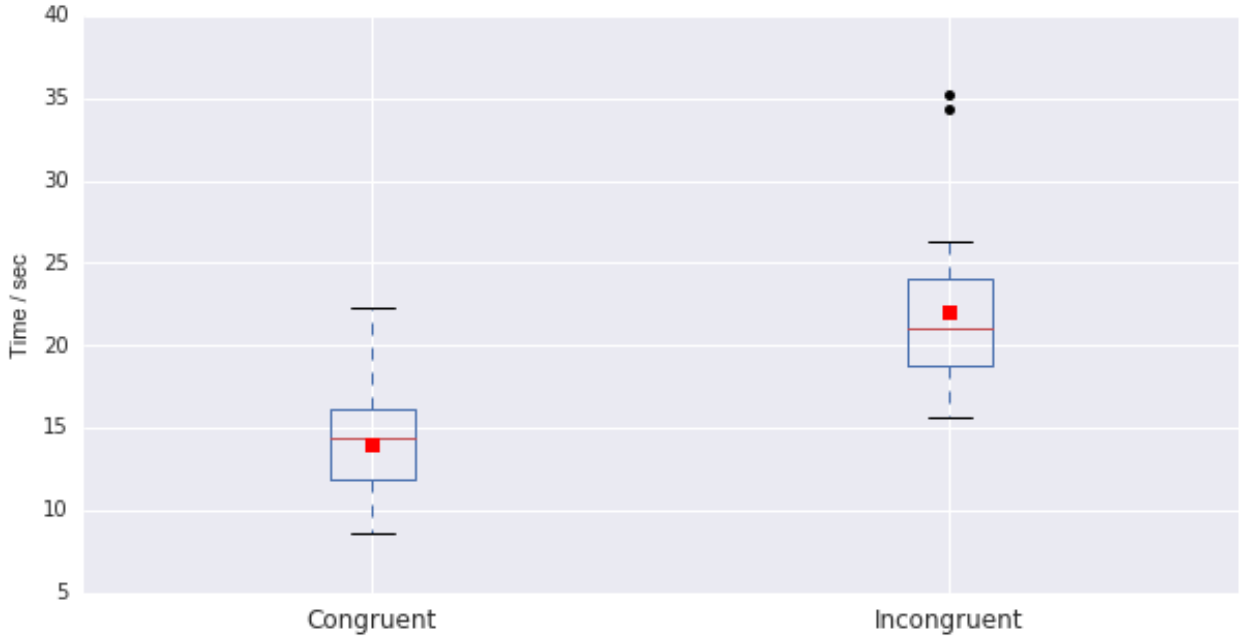
The following table summarizes

- the sample size *n*
- the sample mean $\overline{x}$
- the standard deviation σ (calculated with Bessel's correction)
- the minimum value
- the first quartile Q1
- the median
- the third quartile Q3
- the maximum value
- the range, i.e. max-min
- the interquartile range IQR, i.e. Q3-Q1

	Congruent	Incongruent
n	24	24
$\overline{\mathbf{x}}$	14.05	22.02
σ	3.56	4.80
min	8.63	15.687
Q1	11.90	18.72

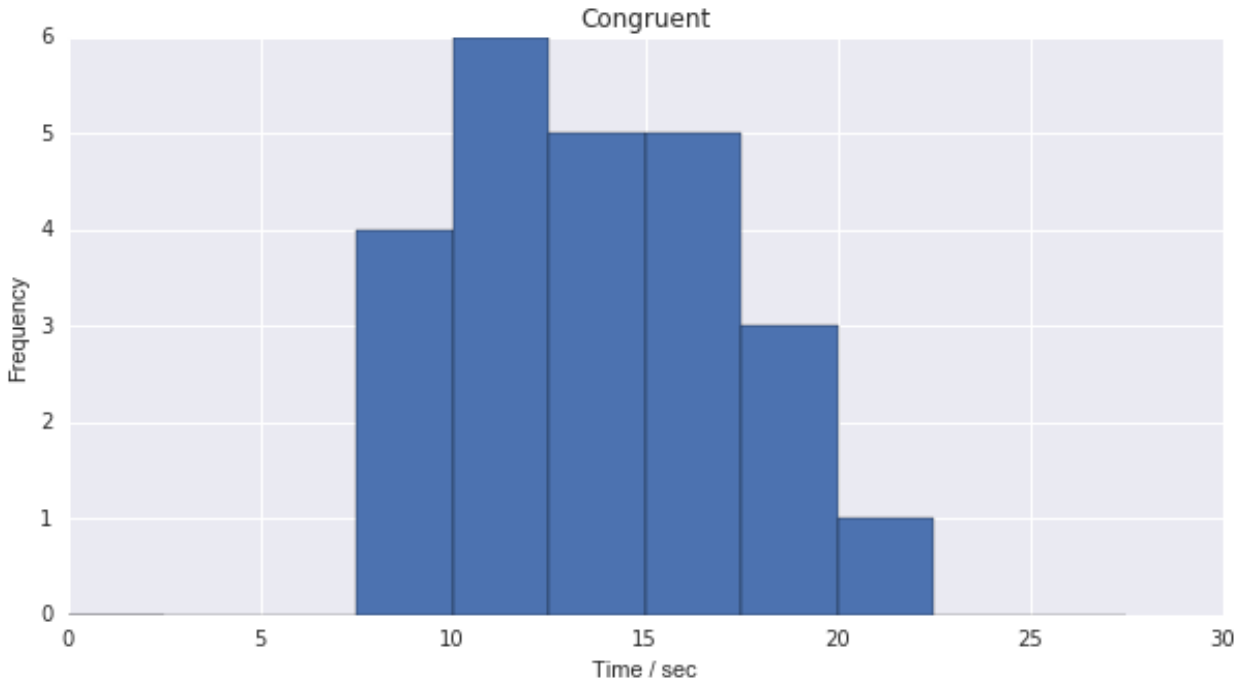
median	14.36	21.02
Q3	16.20	24.05
max	22.33	35.26
range	13.70	19.57
IQR	4.31	5.33

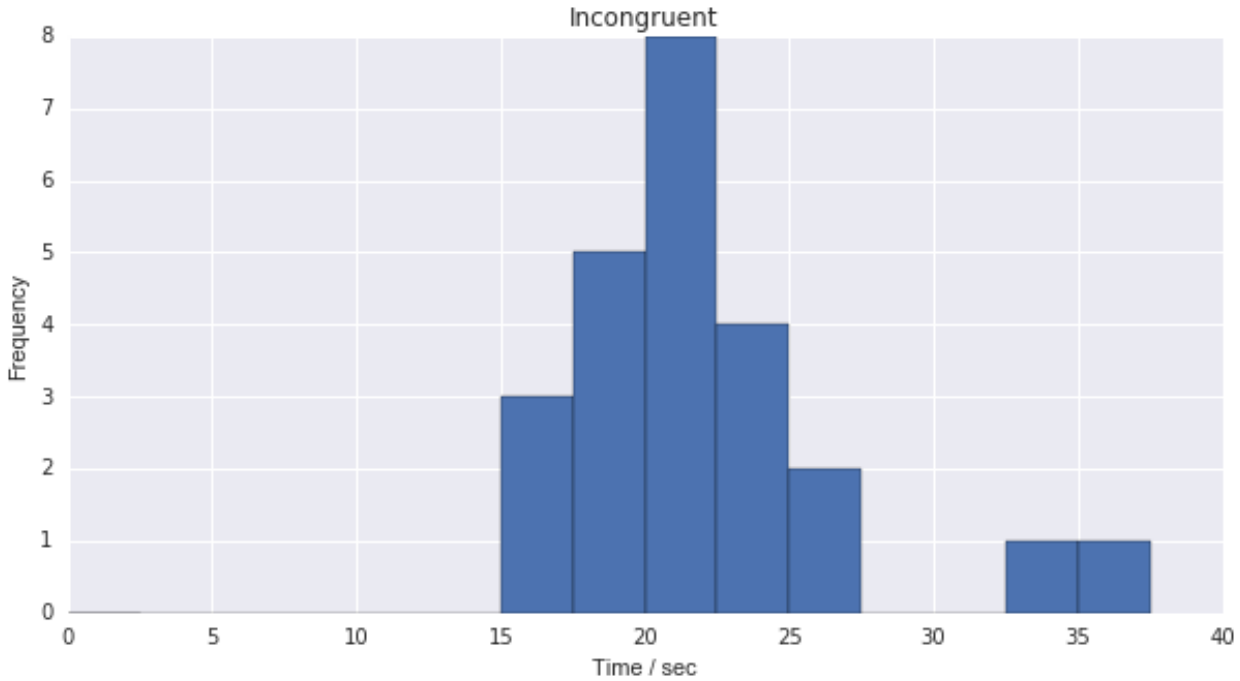
This is also plotted in the following boxplot for both the congruent and incongruent data. Please note that two data points of the incongruent data are marked as outliers as they are greater than Q3 + 1.5 IQR = 32.05.
Furthermore, the mean values are also plotted in the boxplots (red squares).



4. PLOTS

The following plot shows the distributions of the congruent and the incongruent data. The bin size for both plots has been set to 2.5.





It can be seen that the mode of the congruent data is in the bin between 10.0 and 12.5; the mode of the incongruent data is between 20.0 and 22.5.

Looking at the table in Section 3, it can be seen that for both samples the mean and the median fall into the same range. When removing the two outliers of the incongruent data, the mean becomes 20.86 (with outliers the value was 22.02) and the median becomes 20.82 (previously 21.02), so the values are almost identical.

Therefore, it can be concluded that both distributions are normal.

5. STATISTICAL TEST

The standard deviation of the differences is:

$$SD = 4.86$$

With a sample size n = 24, this results in the following standard error:

$$SE = \frac{SD}{\sqrt{n}} = 0.99$$

Using the difference of means of 7.96 (see table in Section 3), the *t* value is:

$$t = \frac{\bar{x}_{Incongruent} - \bar{x}_{Congruent}}{SE} = 8.02$$

The degrees of freedom are:

$$df = n - 1 = 23$$

Using an alpha-level of 0.05 for a one-tailed t-test, the *t* critical value is:

$$t_{Critical}(23) = 1.714, p = 2.05 \times 10^{-8}, \text{one-tailed}$$

(please note that the p-value has been computed using the python scipy library)

Based on this, we can reject the null hypothesis; the results are statistically significant.

Cohen's d is computed as follows:

$$d = \frac{\bar{x}_{Incongruent} - \bar{x}_{Congruent}}{SD} = 1.64$$

r^2 is given by:

$$r^2 = \frac{t^2}{t^2 + df} = .74$$

The 95% confidence interval on the mean difference is

$$95\%\ CI = (-2.10, 18.03)$$

The t-test confirms the initial intuition that it is more difficult to name the color of the word if the actual color and the word color do not match.

According to Reference 1, there are several theories as to why the reaction time is slowed down when presented with conflicting information, such as processing speed (reading is faster than recognizing colors) or automation of reading (the brain is conditioned to immediately understand the meaning of a word, whereas color recognition is not automatic).

6. REFERENCES

1. http://www.wisegeek.org/what-is-the-stroop-effect.htm
2. https://statistics.laerd.com/statistical-guides/dependent-t-test-statistical-guide.php
3. https://statistics.laerd.com/statistical-guides/independent-t-test-statistical-guide.php