Statistical investigation of a well-known phenomenon from experimental psychology called the Stroop Effect

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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.

This dataset which contains results from a number of participants in the task.

#	Congruent	Incongruent	Difference
1	12.079	19.278	7.199
2	16.791	18.741	1.950
3	9.564	21.214	11.650
4	8.630	15.687	7.057
5	14.669	22.803	8.134
6	12.238	20.878	8.640
7	14.692	24.572	9.880
8	8.987	17.394	8.407
9	9.401	20.762	11.361
10	14.480	26.282	11.802
11	22.328	24.524	2.196
12	15.298	18.644	3.346
13	15.073	17.510	2.437
14	16.929	20.330	3.401
15	18.200	35.255	17.055
16	12.130	22.158	10.028
17	18.495	25.139	6.644
18	10.639	20.429	9.790
19	11.344	17.425	6.081
20	12.369	34.288	21.919
21	12.944	23.894	10.950
22	14.233	17.960	3.727
23	19.710	22.058	2.348
24	16.004	21.157	5.153

Investigations

Identify variables in the experiment

The words condition is the independent variable of a study; it is the variable that experimenters choose to manipulate.
The time needed for naming the color of the words from lists is the dependent variable of a study; it is the variable that experimenters want to measure during an experiment.

Establish hypotheses

“In psychology, the Stroop effect is a demonstration of interference in the reaction time of a task. When the name of a color is printed in a color that is not denoted by the name, naming the color of the word ***takes longer*** and is more prone to errors than when the color of the ink matches the name of the color.” Wikipedia

That means that the null hypothesis H_0 is that the time needed for naming the color of the incongruent words condition will not be significantly more from the time naming the color of the congruent words.
The alternative hypothesis H_A is that it will be significantly more.
If $\mu_{congruent}$ is population mean time for congruent words condition and $\mu_{incongruent}$ is population mean time for incongruent words condition then I can just write $\mu_{diff} = \mu_{incongruent} - \mu_{congruent}$, which means the difference between these two population means. That this is equivalent to writing hypotheses us:

$H_0: \mu_{diff} \leq 0$
$H_A: \mu_{diff} > 0$

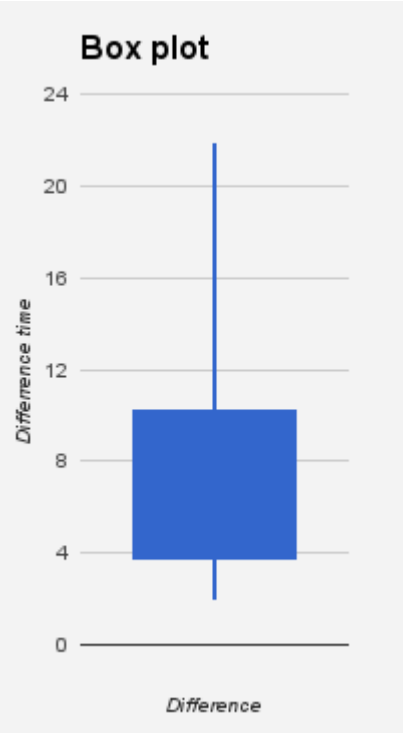
I made couple assumptions for this test. The samples from a population are random. The scores have a form close to a normal distribution, unimodal, and continuous. The samples depend because two measurements for the different condition of words repeated for each person.

I can use paired dependent t-test. But dependent t-test just calculates the difference between paired measurements and then performs a 1-sample t-test on the differences.

Because the sample size equals 24, I can not use a central limit theorem to find the standard deviation for the population so I can not use 1-sample z-test.

To check the null hypothesis, I am using the 1-sample t-test for differences with the one-tailed positive direction where $\alpha = 0.05$.

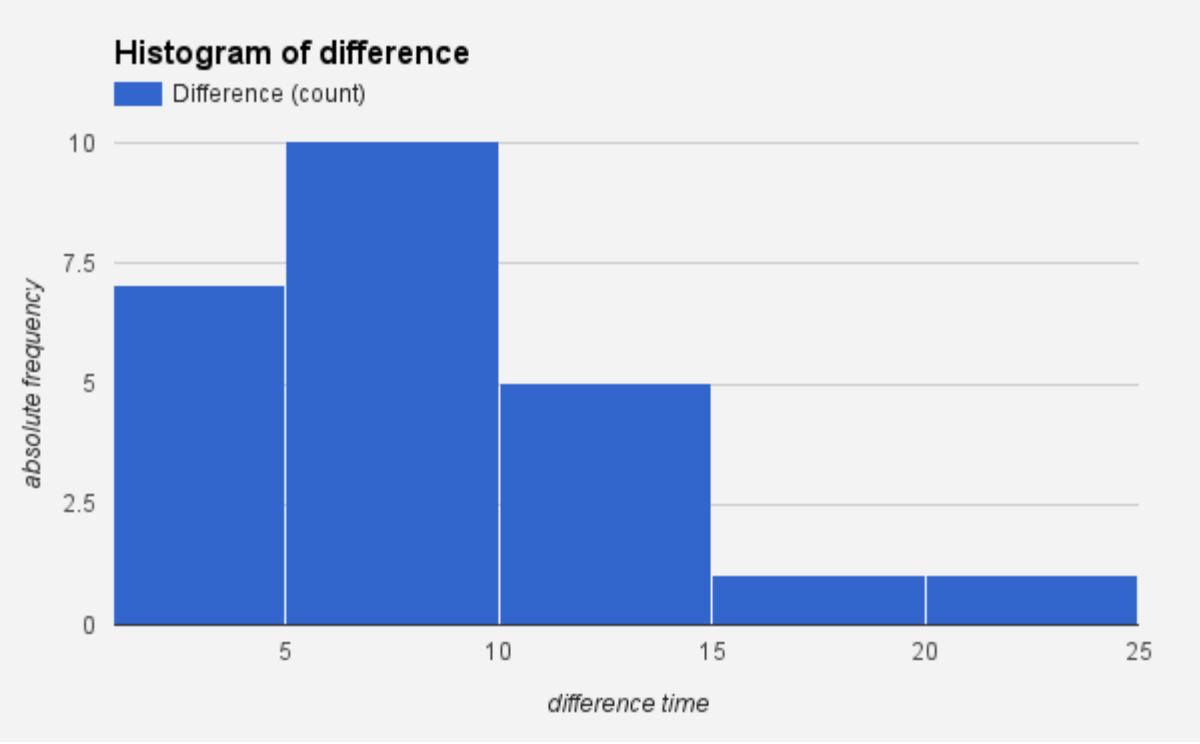
Descriptive statistics report



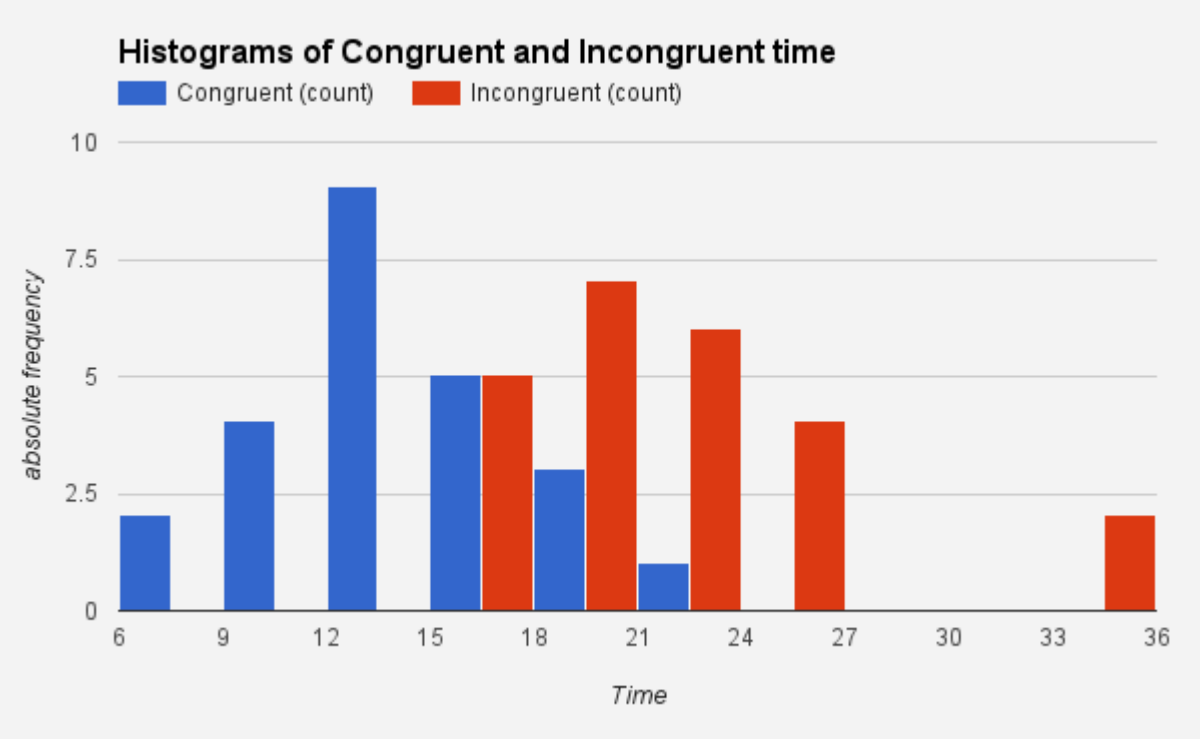
For the difference between two sample, I got some descriptive statistics.

minimum	1.95
Q1	3.65
Q3	10.26
maximum	21.92
median	7.67
mean	7.96
standard deviation	4.86

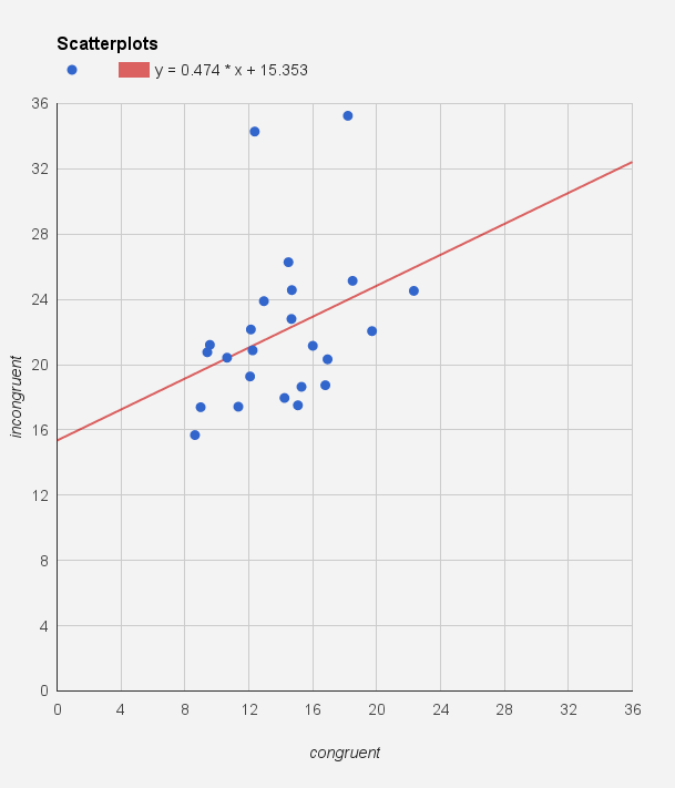
Since minimum greater than zero, in each test was positive difference between incongruent and congruent time.
Because outliers are present along the rightmost end of the distribution, then the distribution have the positive skew. The histograms have a form close to a normal distribution.



Plot the data



I used 3 for bin size. Both histograms have a form close to a normal distribution. The congruent histogram is wider that confirms variance value.



Scatterplots show us relationships and patterns in data. In each case, the incongruent test took longer than the completion of the congruent test. In general, the equation of the trendline to predict the time of the incongruent test depends on the congruent test.

Statistical test and results interpretation

For the difference, I got the following results.

The point estimate for the difference	7.96
The sample standard deviation of the differences	4.86
t-statistic	8.02
t-critical for one-tailed test with $\alpha = 0.05$ and df= 23	1.714

The confidence interval for the mean population difference is CI 95%: (5.91; 10.02).
The t-statistic > t-critical (8.02 > 1.714) and p-value is less than 0.001.
From the t-test result, I can reject the null hypothesis, and I can conclude that difference between the congruent test and the incongruent test is significant.
So I can say that if the name of a color is printed in a color that is not denoted by the name, had a causal effect on the naming the color of the word and was more prone to errors and took more time.

References

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6. Spreadsheets sources of project
7. t-table