

Test a Perceptual Phenomenon

January 20, 2018

0.0.1 Analyzing the Stroop Effect

Perform the analysis in the space below. Remember to follow [the instructions](#) and review the [project rubric](#) before submitting. Once you've completed the analysis and write up, download this file as a PDF or HTML file and submit in the next section.

- (1) What is the independent variable? What is the dependent variable?

Independent variable: Congruence of words Dependent variable: Response time

- (2) What is an appropriate set of hypotheses for this task? What kind of statistical test do you expect to perform? Justify your choices.

We want to see if there is a difference in response time when participants are shown words in different conditions, in this case, words whose names match the colors in which they are printed and words whose names do not match the colors in which they are printed.

We can run a hypothesis testing on the mean response time associated with each condition and see if there is a difference. The hypotheses should be set up as the followings (μ here represents average response time):

H0: $\mu_{incongruent} = \mu_{congruent}$ H1: $\mu_{incongruent} \neq \mu_{congruent}$

And we are going to perform a paired t-test as this is a comparison of two different methods of measurement where the measurements are applied to the same subjects.

- (3) Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability. The name of the data file is 'stroop-data.csv'.

```
In [1]: ### Import packages that are needed for the analysis
```

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import scipy.stats as st
sns.set_style('darkgrid')
%matplotlib inline
```

```
In [2]: ### Preliminary investigation on the dataset
```

```
df = pd.read_csv('stroopdata.csv')
```

```
df.isnull().any()
```

```
Out[2]: Congruent      False  
        Incongruent    False  
        dtype: bool
```

```
In [3]: df.describe()
```

```
Out[3]:
```

	Congruent	Incongruent
count	24.000000	24.000000
mean	14.051125	22.015917
std	3.559358	4.797057
min	8.630000	15.687000
25%	11.895250	18.716750
50%	14.356500	21.017500
75%	16.200750	24.051500
max	22.328000	35.255000

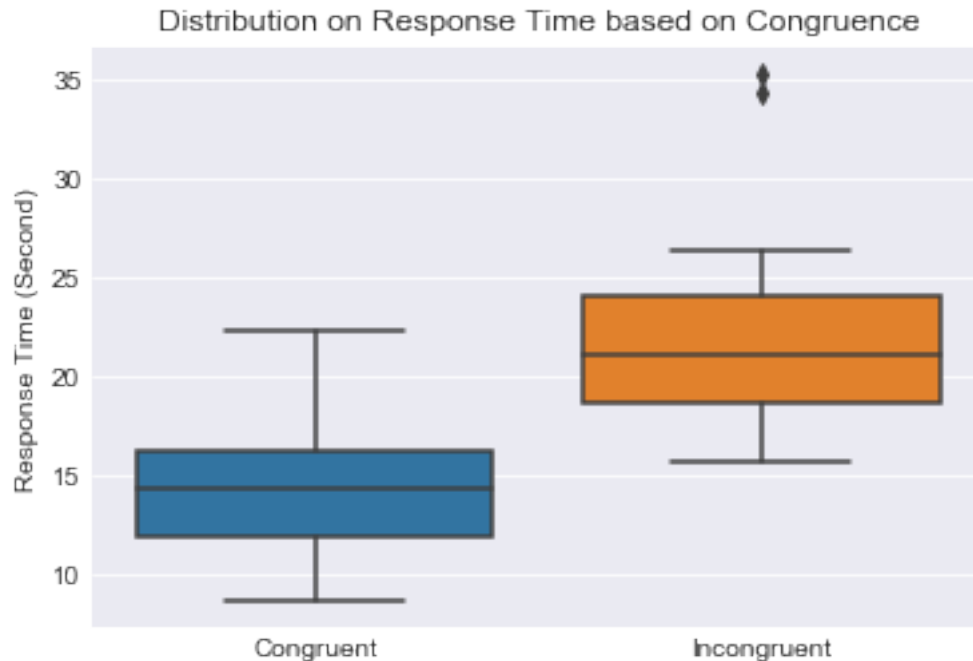
```
In [4]: ### Get the inter-quatile range
```

```
print(st.iqr(df.Congruent), st.iqr(df.Incongruent))
```

```
4.3055 5.33475
```

```
In [5]: sns.boxplot(data=df)  
plt.title('Distribution on Response Time based on Congruence')  
plt.ylabel('Response Time (Second)')
```

```
Out[5]: <matplotlib.text.Text at 0x10ab40dd8>
```



Based on the preliminary investigation, people obviously need more time to respond when being shown incongruent words. On average, they need about 8 more seconds to respond. There is also a greater standard deviation when people see incongruent words. The SD is about 1.2 higher. On top of that, the inter-quatile range is 5.335 seconds (Incongruent), compared to 4.3055 seconds (Congruent). In a nutshell, there is a greater spread with incongruence.

If we dive deeper and look at the boxplot, we can see that the congruent group performs obviously better than the incongruent group do, in a sense of response time. 75% participants of the congruent group responded at a time which only less than 25% participants of the incongruent group could do.

Although at this point we cannot draw any conclusions yet, this first glance of the dataset already gives us a general idea of the impact of congruence on people's response time.

- (4) Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

In [6]: *### Build the visualizations here*

```
sns.swarmplot(data=df)
plt.title('Distribution on Response Time based on Congruence')
plt.ylabel('Response Time (Second)')
```

Out[6]: <matplotlib.text.Text at 0x10ac48cf8>



The swarmplot aligns with the boxplot above which shows that people obviously need more time to respond when being shown incongruent words.

- (5) Now, perform the statistical test and report the results. What is the confidence level and your critical statistic value? Do you reject the null hypothesis or fail to reject it? Come to a conclusion in terms of the experiment task. Did the results match up with your expectations?

In [7]: *### 95% Confidence level and its associated critical values*

```
st.t.interval(alpha=0.95, df=23)
```

Out[7]: (-2.0686576104190406, 2.0686576104190406)

In [8]: *### 99% Confidence level and its associated critical values*

```
st.t.interval(alpha=0.99, df=23)
```

Out[8]: (-2.8073356837675227, 2.8073356837675227)

In [9]: *### T-statistic and P-value*

```
t_stat, p_val = st.ttest_rel(df.Incongruent, df.Congruent)
```

```
print('t-statistic = %6.3f, p-value = %6.4f' % (t_stat, p_val))
```

t-statistic = 8.021, p-value = 0.0000

The t-statistic is equal to 8.021. This test statistic tells us how much the sample mean deviates from the null hypothesis.

If the t-statistic lies outside the quantiles (Critical values) of the t-distribution corresponding to our confidence level and degrees of freedom, we reject the null hypothesis.

A p-value of 0.0000 means we'd expect to see data as extreme as our sample due to chance about basically 0% of the time assuming the null hypothesis is true.

In this case, the p-value is lower than our significance level (1 - confidence level or 0.05, even 0.01) so we should reject the null hypothesis.