Stroop Effect

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.

My Test Results:

For congruent words:11.814 seconds
For incongruent words:33.064 seconds

INVESTIGATION:

1.What is our independent variable? What is our dependent variable?

Answer: Here our independent variable is the congruency condition including congruent words condition and incongruent words condition.
Dependent variable will be the response time of the participants to these congruent and incongruent words.

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

Answer: I choose the two tailed t-test for my given data set. The dependent t-test compares the mean of two paired groups to see if there are statistically significant differences between these means. The same subjects were tested for congruent and incongruent words. By using the same subject to test two different condition, we eliminate the individual differences that occur between subjects.

Reason of Selecting Two Tailed t-test:
We don't have any information about the population, we have just 24 sample datasets. The ability to compare the means of the dataset for the pre and post-test validates the benefit of this test selection We don't have direction of the test, so we choose two tailed tests.

HYPOTHESES:

H0: There would be a lower mean time for the incongruent tests than the congruent tests or no noticeable difference in time duration between the congruent and incongruent tests

HA: There would be a noticeable increase in time duration between the congruent and incongruent tests. The experiment should be a single-tailed type scenario as there the question does mention "...does incongruency increase response times" as well as the incongruent times were predominantly larger than the congruent times.

μ:Population mean

H0: μi ≤ μc (μi - population mean of incongruent values, μc - population mean of congruent values)

HA: μi > μc (μi - population mean of incongruent values, μc - population mean of congruent values)

3. Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability.

In [1]:
```
import math
import seaborn as sns
import numpy as np
import pandas as pd
from scipy.stats import t as pt
import matplotlib.pyplot as plt
%matplotlib inline
```

In [4]:
```
data = pd.read_csv("stroopdata.csv")
data
```

Out[4]:

	Congruent	Incongruent
0	12.079	19.278
1	16.791	18.741
2	9.564	21.214
3	8.630	15.687
4	14.669	22.803
5	12.238	20.878
6	14.692	24.572
7	8.987	17.394
8	9.401	20.762
9	14.480	26.282
10	22.328	24.524
11	15.298	18.644
12	15.073	17.510
13	16.929	20.330
14	18.200	35.255
15	12.130	22.158
16	18.495	25.139
17	10.639	20.429
18	11.344	17.425
19	12.369	34.288
20	12.944	23.894
21	14.233	17.960
22	19.710	22.058
23	16.004	21.157

In [6]:
```
#Finding the mean,Median and standard deviation for congruent and incongruent
#mean
con_mean = data['Congruent'].mean()
incon_mean = data['Incongruent'].mean()
#Find the median
con_median = data['Congruent'].median()
incon_median = data['Incongruent'].median()
#Find the standard deviation
con_std = data['Congruent'].std()
incon_std = data['Incongruent'].std()
#print mean,median and standard deviation in a table
ls = [[int(24),int(24)],[c_mean,i_mean],[c_median,i_median],[c_std,i_std]]
detail = pd.DataFrame(ls,index=['Sample Size','Mean','Median','Standard Deviation'])
detail
```

Out[6]:

	0	1
Sample Size	24.000000	24.000000
Mean	14.051125	22.015917
Median	14.356500	21.017500
Standard Deviation	3.559358	4.797057

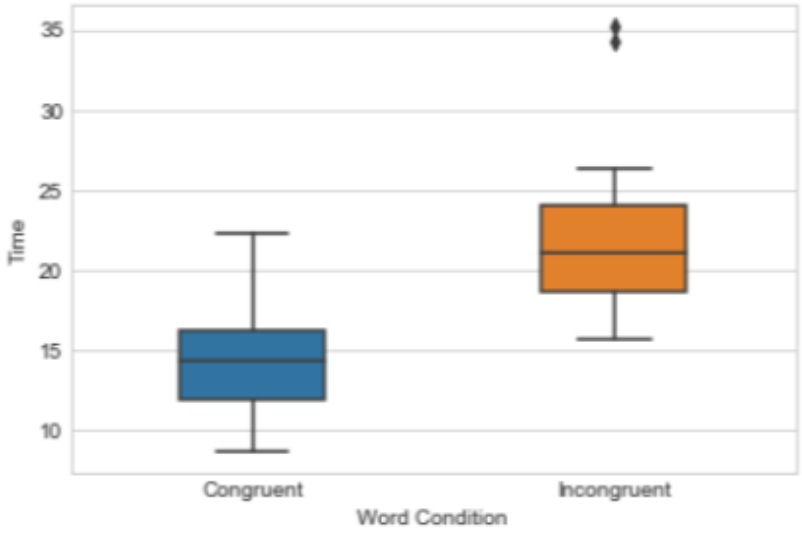
In [7]:
```
data.describe()
```

Out[7]:

	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

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 [26]:
```
sns.set_style("whitegrid")
sns.boxplot(data=data[['Congruent', 'Incongruent']], orient="v",width=0.4)
plt.ylabel("Time");
plt.xlabel("Word Condition");
```



The box plot clearly displays the difference between the median of two datasets.

As we can see in the box plot the distribution of time taken to name the color for congruent words are between 8 to 23 and the distribution of time taken to name the color for incongruent words are between 16 to 26. And we can see two outliers in the distribution of incongruent words.

5. Now, perform the statistical test and report your results. What is your 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?

The Test is two tailed t- test so,

find the critical value of t at 95% confidence level.

Sample Size(n) = 24

Degree of freedom(df) = n - 1 = 23

In [16]:
```
#find t-critical value for 95% confidance interval and 23 degree of freedom
print("t-critical value for two tailed test is: ",round(pt.ppf(0.975,23),4))
```

```
t-critical value for two tailed test is:  2.0687
```

In [17]:
```
#find the diffenence of each data
data['difference'] = data['Congruent'] - data['Incongruent']
data
```

Out[17]:

	Congruent	Incongruent	difference
0	12.079	19.278	-7.199
1	16.791	18.741	-1.950
2	9.564	21.214	-11.650
3	8.630	15.687	-7.057
4	14.669	22.803	-8.134
5	12.238	20.878	-8.640
6	14.692	24.572	-9.880
7	8.987	17.394	-8.407
8	9.401	20.762	-11.361
9	14.480	26.282	-11.802
10	22.328	24.524	-2.196
11	15.298	18.644	-3.346
12	15.073	17.510	-2.437
13	16.929	20.330	-3.401
14	18.200	35.255	-17.055
15	12.130	22.158	-10.028
16	18.495	25.139	-6.644
17	10.639	20.429	-9.790
18	11.344	17.425	-6.081
19	12.369	34.288	-21.919
20	12.944	23.894	-10.950
21	14.233	17.960	-3.727
22	19.710	22.058	-2.348
23	16.004	21.157	-5.153

```
In [18]: #sd and mean of the differenced dataset
         s_std = data['difference'].std()
         print("Standard Deviation of the diffenenced dataset: ", round(s_std,4))
         s_mean = c_mean - i_mean
         print("Mean of Difference: ", round(s_mean,4))

         Standard Deviation of the diffenenced dataset:  4.8648
         Mean of Difference:  -7.9648

In [19]: # Calculate the t-value
         t_value = s_mean/(s_std/math.sqrt(24))
         print("t-Value is: ",t_value)

         t-Value is:  -8.020706944109955
```

Following are the results for two tailed t-test at 95% confidence level:

Standard Deviation (SD) = 4.8648

Mean of difference data ($\bar{x}$) = -7.9648

Confidence Interval (CI) at 95% level = (-10.019028, -5.910555)

Conclusion:

Given that the T-Statistic found was - 8.0207 it leads us to reject the null hypothesis **H0** due to T-Statistic being in the critical area of tested at 95% Confidence Level.

The t-test confirms what was expected that incongruent tests would normally take longer than congruent tests as congruent test linked both visual colors with the correct printed name of the color while incongruent required to try to separate the visual color and the name of the color which required a bit more time to do.

References:

https://en.wikipedia.org/wiki/Stroop_effect
http://www.statisticshowto.com/when-to-use-a-t-score-vs-z-score/
https://stats.idre.ucla.edu/other/mult-pkg/faq/general/faq-what-are-the-differences-between-one-tailed-and-two-tailed-tests/