Team 05 Data Supplement

1.0 Box Plot and Quartiles

As shown in the summary and box plot below, the mean of the words per minute for each genre of auditory stimuli are very similar. First visualizing the data with box plots (Figure 1), there was no apparent difference in the means, this was confirmed by the summary table (Figure 2).
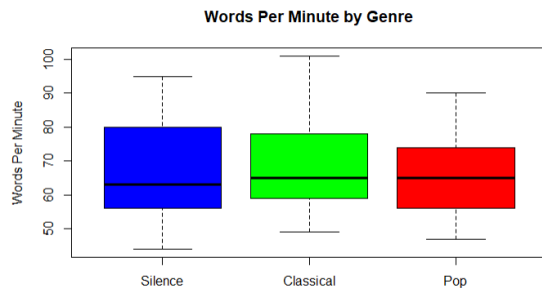

Figure 1. Box plots of words per minute by genre

```
     silence         Classical              Pop
Min.   :44     Min.   : 49.00     Min.      :47
1st Qu.:56     1st Qu.: 59.00     1st Qu.:56
Median :63     Median : 65.00     Median :65
Mean   :66     Mean   : 67.76     Mean      :65
3rd Qu.:80     3rd Qu.: 78.00     3rd Qu.:74
Max.   :95     Max.   :101.00     Max.      :90
```

Figure 2. Summary of words per minute data

2.0 Testing Independence

To test the assumption of independence, we created three different plots to visualize the data for each stimuli against the observation order (Figure 3). All the graphs have no patterns and look random indicating that the assumption of independence is fulfilled
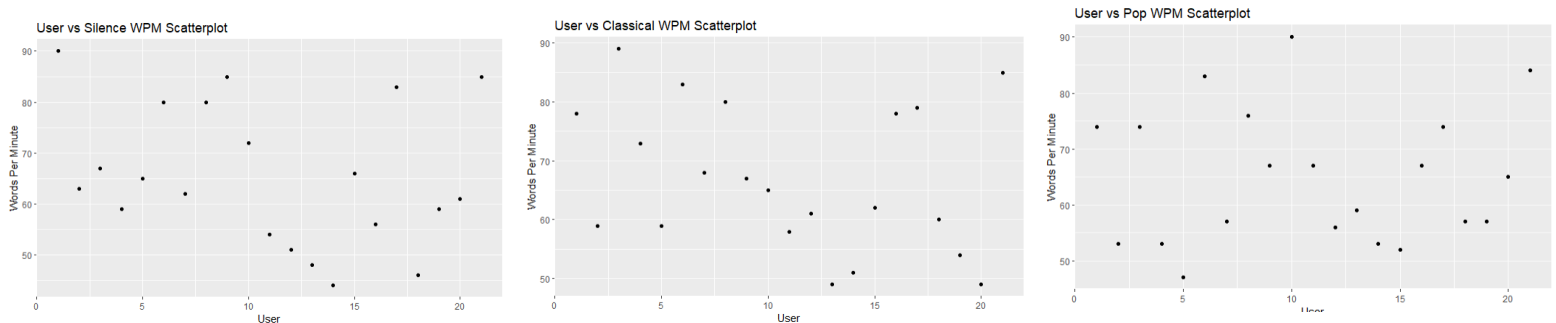

Figure 3. User vs Silence, Classical, Pop Scatterplots

3.0 Testing Normality

To check the assumption of normality, we plotted histograms (Figure 4) of the words per minute with bin sizes of 5 words per minute. All the graphs look to follow a normal distribution indicating that the assumption is fulfilled.
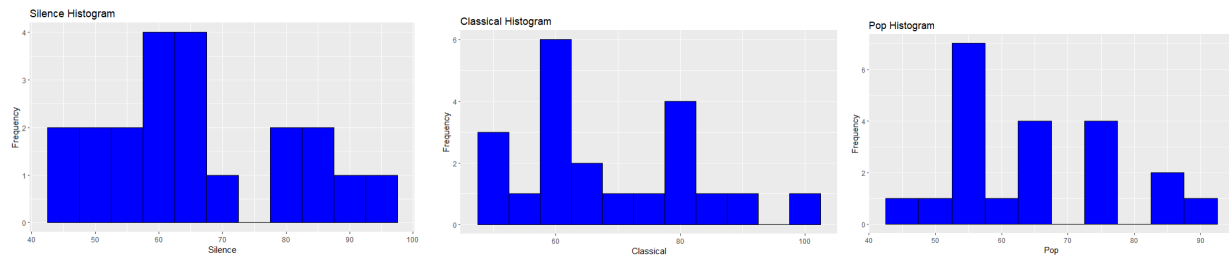
Figure 4. Silence, Classical, Pop Histograms

Further checking the assumption of normality due to the limited number of data points, we created QQ-plots for each type of audio stimuli (Figure 5). The figures below shows that the data follows the line relatively well further indicating that the data collected is normal.
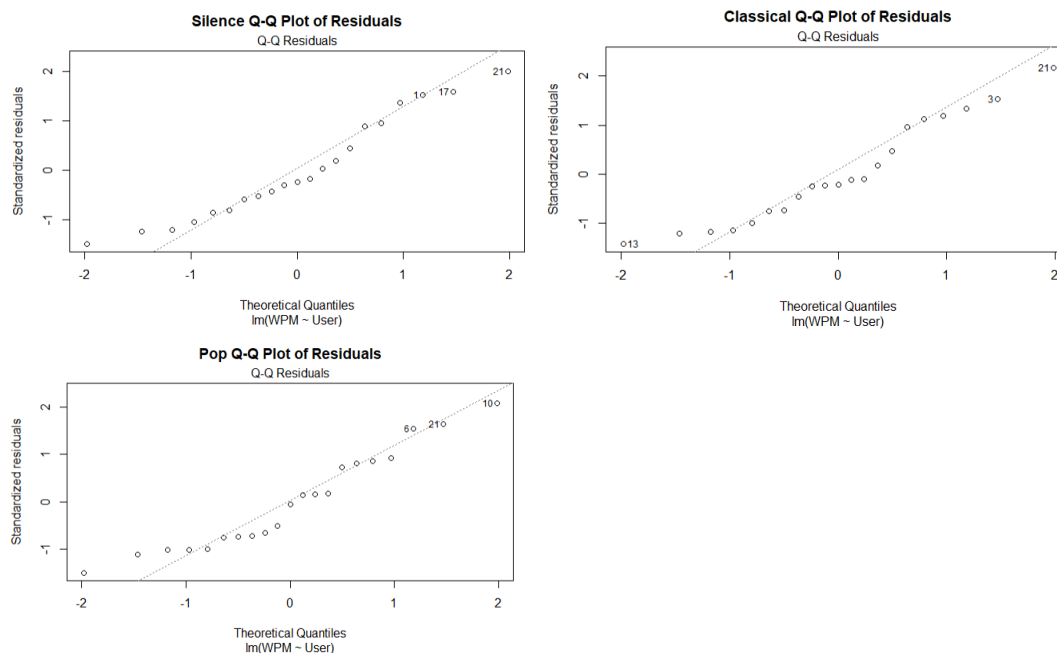

Figure 5. Q-Q Plots for Silence, Classical, and Pop Samples

To check the assumption of sphericity associated with the one-factor ANOVA test, we used Mauchly's test (Figure 6). The results shown below indicate that analysis on variances of pairwise differences can be conducted.

```
$`Classical - Silence`
[1] 115.5905

$`Classical - Pop`
[1] 122.0905

$`Silence - Pop`
[1] 124.9
```

Figure 6. Sphericity Test (Comparison between Silence, Classical, and Pop)

4.0 ANOVA and T-tests

Now that we have confirmed that our data is normal and independent we can begin our analyses. We conducted a one-way ANOVA with repeated measures (Figure 7) to determine if any of the mean words per minute typed for each stimuli were not equal to the others. This test accounted for the paired samples used. After conducting the test, the f-statistic was not significant indicating the auditory stimuli did not affect participant's typing words per minute. Before failing to reject the null hypothesis and concluding that there is no evidence to suggest that the different types of audio had no effect, we conducted a paired t-test to analyze the difference in means between each pair of stimuli (Figure 8). All paired tests produced insignificant t-tests further confirmed that the different types of audio had no effects on words per minute of participants typing speed.

```
          Df Sum Sq Mean Sq F value Pr(>F)
Condition  2     42    21.0   0.123  0.884
User       1    228   228.2   1.337  0.252
Residuals 59  10066   170.6
```

Figure 7. One-way ANOVA with repeated samples

```
        Paired t-test

data:  WPM$Silence and WPM$Classical
t = -0.75098, df = 20, p-value = 0.4614
alternative hypothesis: true mean difference is not equal to 0
95 percent confidence interval:
 -6.655838  3.132029
sample estimates:
mean difference
      -1.761905


        Paired t-test

data:  WPM$Classical and WPM$Pop
t = 1.1455, df = 20, p-value = 0.2655
alternative hypothesis: true mean difference is not equal to 0
95 percent confidence interval:
 -2.267747  7.791557
sample estimates:
mean difference
       2.761905


        Paired t-test

data:  WPM$Silence and WPM$Pop
t = 0.41004, df = 20, p-value = 0.6861
alternative hypothesis: true mean difference is not equal to 0
95 percent confidence interval:
 -4.087194  6.087194
sample estimates:
mean difference
            1
```

Figure 8. Paired t-tests per genre

5.0 Testing for Outliers

To check for outliers, standardized residual plots were created (Figure 9). Since some of the residuals for the data collected with silence are close to the -2 and 2 thresholds, and one data point in both of the plots with classical and pop music exceeds the -2 to 2 range, we decided to check the studentized residuals.
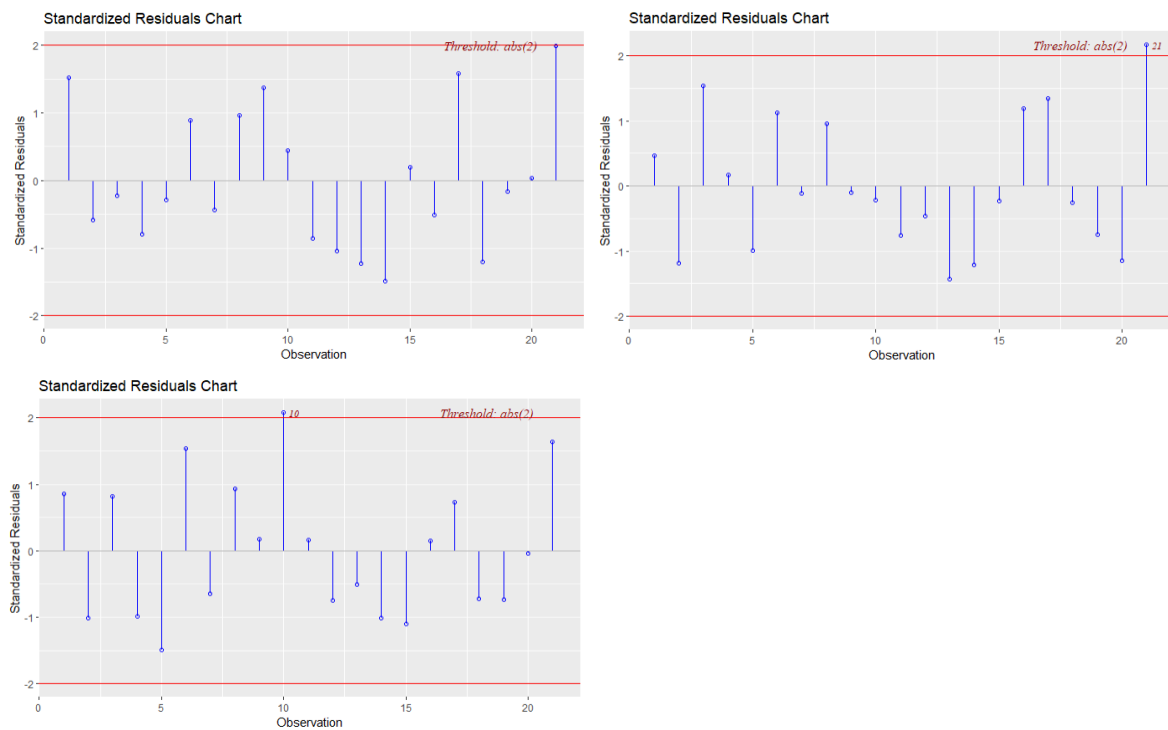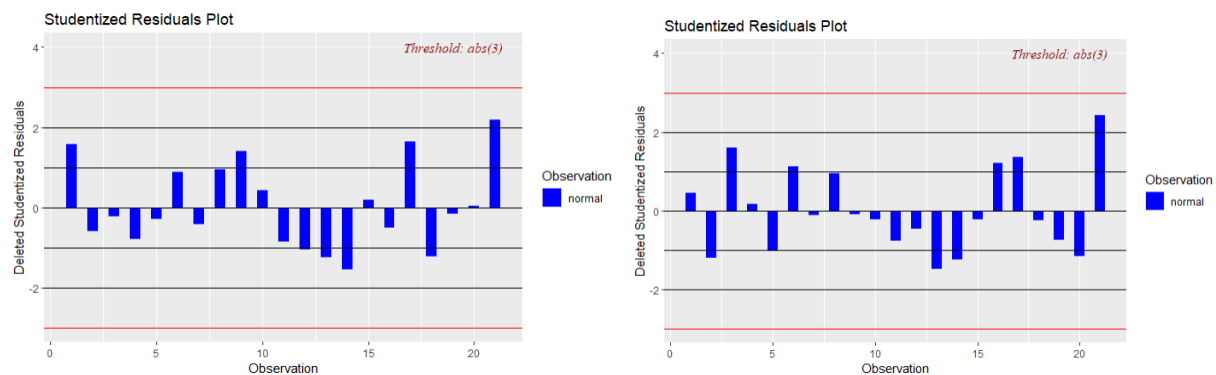

Figure 9. Standardized Residual Plot (Silence, Classical, Pop)

The studentized residual plots below (Figure 10) show that all data points fall between the -3 to 3 bounds. This further indicates that our data is normal aligning with our conclusions from creating the histogram plots and QQ-plots as shown earlier.
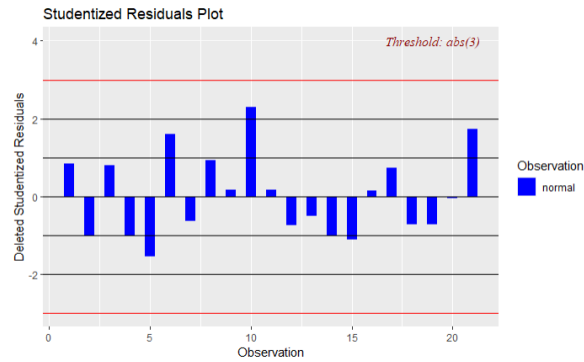
Figure 10. Studentized Residual Plot (Silence, Classical, Pop)

6.0 Conclusion

The conclusion of the experiment is that different types of auditory stimuli did not affect typing speed, which was shown through a one-factor ANOVA test. There was also no difference in the mean typing speed of the three different samples (silence, classical, and pop). This could be visualized using box plots. The use of these different tests were justified by proving normality of data through histograms, and Q-Q plots. In addition, the data was shown to be random using a scatter plot. Finally, using standardized and studentized residual data, we showed that the data did not contain any outliers.

7.0 References

[1] S. I. Staff, "Music for homework: 4 best genres to help you study better," Study International, https://studyinternational.com/news/best-music-for-homework-students/#:~:text=Around% 2060%25%20of%20students%20tend,juggled%20studying%20with%20another%20task. (accessed Apr. 10, 2024).

[2] "TypeRacer - The Global Typing Competition," TypeRacer, https://play.typeracer.com/ (accessed Apr. 10, 2024).

[3] Y.-Y. Ma, "Yo-Yo Ma, Kathryn Stott - The Swan (saint-saëns)," YouTube, https://www.youtube.com/watch?v=3qrKjywjo7Q (accessed Apr. 10, 2024).

[4] T. Swift, "Taylor Swift - Shake it off," YouTube, https://www.youtube.com/watch?v=nfWlot6h_JM (accessed Apr. 10, 2024).

[5] F. Tedeschi, "Mauchly's test of sphericity in R: The definitive guide," Datanovia, https://www.datanovia.com/en/lessons/mauchlys-test-of-sphericity-in-r/ (accessed Apr. 10, 2024).

[6] "Here's how music can help you concentrate," Healthline, https://www.healthline.com/health/does-music-help-you-study#benefits-of-music-for-studying (accessed Apr. 10, 2024).