Measuring Reading Attention Based on Music Genre

Team #3 “The Brainy Bunch”: Tiffany Streitenberger, Aashna Setia, Nicholas Willison, Neel Shah, Shania Ie, Yukti Vijay

Introduction and Motivation - Nicholas

- **Motivation:** How can we as UCSD students improve our study habits?
- **Problem:** What type of music is best for studying?
  - How does BPM factor into this question?
  - Are there any other factors to consider?
- Music is a powerful tool and when used properly it can help boost the efficiency of one's study habits, attention and focus

Related Work - Yukti

Impact of Music on Brain Function during Mental Task using Electroencephalography

Geethanjali, B. et al. “Impact of Music on Brain Function during Mental Task using Electroencephalography.” *World Academy of Science, Engineering and Technology, International Journal of Medical, Health, Biomedical, Bioengineering and Pharmaceutical Engineering* 6 (2012): 256-260.

Effects of Musical Tempo on Musicians’ and Non-musicians’ Emotional Experience When Listening to Music

Liu, Ying et al. “Effects of Musical Tempo on Musicians' and Non-musicians' Emotional Experience When Listening to Music.” *Frontiers in psychology* vol. 9 2118. 13 Nov. 2018, doi:10.3389/fpsyg.2018.02118

Independent Component Analysis of Electroencephalographic and Event-Related Potential Data.

Jung, Tzyy-Ping, et al. “Independent Component Analysis of Electroencephalographic and Event-Related Potential Data.” Central Auditory Processing and Neural Modeling, 1998, pp. 189–197., doi:10.1007/978-1-4615-5351-9_17.

Related Work - What we learned -Yukti

1. Classical Indian music (high BPM) produces high beta activity when compared to Jazz (low BPM) and hard rock (Various).
2. Jazz music is pleasant induces positive emotion and reduces mental stress
3. Listening to a preferred genre of music produces greater alpha wave amplitudes than listening to an unpreferred genre.
4. Faster paced songs with higher BPM produce greater beta brain wave amplitudes
5. There is a strong connection between music tempo and emotional experiences/brain activity
6. Preference in music may play a large role in how a student's studying changes while music is playing.
7. ICA may be a useful tool for making further analysis on the data from this project

Methods -Tiffany

Research Problem:

How do different genres of music affect attention and accuracy while reading out loud?

Basic Plan:

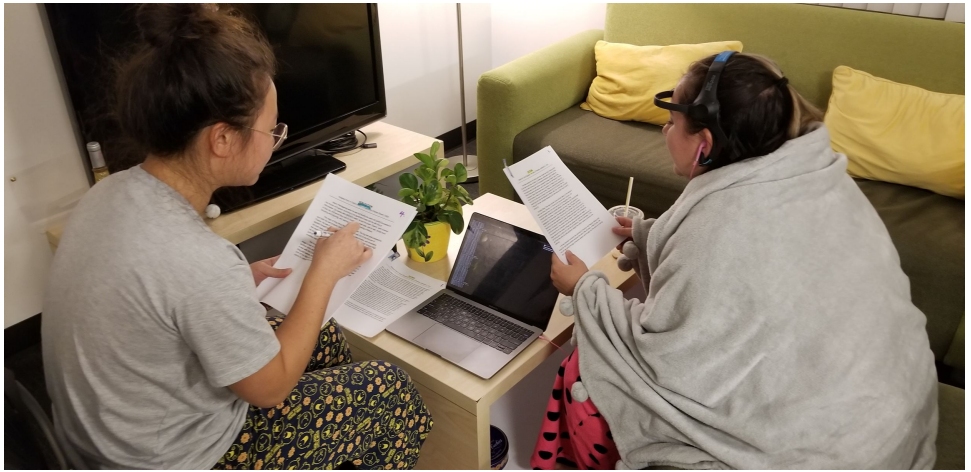
1. Record attention and accuracy of participants while they read
    - For each trial, we sampled different music and reading genres
2. Compare the results of the participants across the different music genres

Note: Accuracy is judged based on the performance of the participants, which is indicated by their pronunciation, any sign of stuttering, and lag time.

Methods -Tiffany

Participants:

7 UCSD college students



Design:

- 6 trials per participant of reading fiction with Lo-fi, EDM, and Pop, and reading non-fiction with Lo-fi, EDM, and Pop
- Give a pre- and post- survey of asking the participant to rate how confident they are with reading speed and accuracy given a specific trial (i.e. fiction with Lo-fi, non-fiction with EDM, etc.)

Methods -Tiffany

Procedure:

We used Neurosky headsets to record participant's accuracy and attention level while reading SAT preparation passages.

Passages and Music:

	Fiction Passages: link	Non-Fiction Passages: link
Lo-fi	Thoughts of You-Spencer Hunt (84 bpm)	Firefly-less.people (84 bpm)
EDM	Burn Out-Deorro (145 bpm)	Rising from the Ashes-Sublab (136 bpm)
Pop	HandClap-Fitz and The Tantrums (140 bpm)	Everybody Talks-Neon Trees (155 bpm)

Methods -Shania

Procedure:

1. Before the experiment: Give a pre-survey asking the participant to rate on a scale from 1 (not confident) to 10 (very confident) for all 6 trials
2. During the experiment: Let the participant listen to the song for 30 seconds and then start reading the passage for 1 minute. The participants are asked to read as fast and accurately as possible.
3. During reading: The experiment observer will circle any words if the participants shows signs of stuttering, pronunciation error, or lag time.
4. Repeat step 2 and 3 for another 5 times, changing the music and passage accordingly. With that, the observer will judge the performance of the participants.
5. At the end of the experiment: Give a post-survey asking the participant to rate on a scale from 1 (not focused) to 10 (very focused) for all 6 trials as well as their enjoyment of the songs from 1 (dislike) to 10 (like)

Results - Aashna

	Attention	BPM	Genre	Narrative Form	Song	Timestamp	paritcpant	passage
0	[84, 57, 63, 88, 75, 67, 78, 77, 50, 90, 43, 7...	84	Lo-fi	Fiction	Thoughts of You	[0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0,...	7	1
1	[61, 69, 75, 51, 74, 56, 63, 67, 56, 63, 75, 5...	145	EDM	Fiction	Burn Out	[0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0,...	7	2
2	[43, 41, 34, 47, 40, 41, 21, 37, 48, 34, 38, 4...	140	Pop	Fiction	HandClap	[0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0,...	7	3
3	[67, 67, 50, 30, 47, 43, 35, 50, 40, 34, 38, 4...	84	Lo-fi	Non-Fiction	Firefly	[0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0,...	7	4
4	[53, 37, 48, 41, 34, 56, 35, 50, 51, 30, 53, 4...	136	EDM	Non-Fiction	Rising from the Ashes	[0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0,...	7	5
5	[48, 48, 47, 40, 75, 48, 50, 51, 43, 37, 38, 3...	155	Pop	Non-Fiction	Everybody Talks	[0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0,...	7	6

- Above is an example of the data collected for each participant, in this case, Participant 7
- We can see the the attention scores for each passaged read, as well as the timestamps
- Also included: BPM of each song used, genre and name of each song used, and form of passage read (i.e. Fiction or Non-Fiction)

Results - Attention - Aashna

Participant	Attention
1	43.807692
2	40.294872
3	53.153846
4	52.858974
5	55.576923
6	49.333333
7	50.833333

Genre	Attention
EDM	50.197802
Lo-fi	50.153846
Pop	47.873626

Narrative Form	Attention
Fiction	50.25641
Non-Fiction	48.56044

- Here, we calculate and display the average attention for each participant (left-most chart), each genre (top-right chart), and each narrative form (bottom-left chart).
- We can calculate that the average attention across all participants is ~49.4
- We observe that Pop music had a lower attention average attention compared to the other two genres of music

Results - Accuracy - Aashna

- We then calculated the average accuracy using the following formula:

$$\frac{(Total\ words\ read - Incorrect\ words)}{Total\ words\ read} \times 100$$

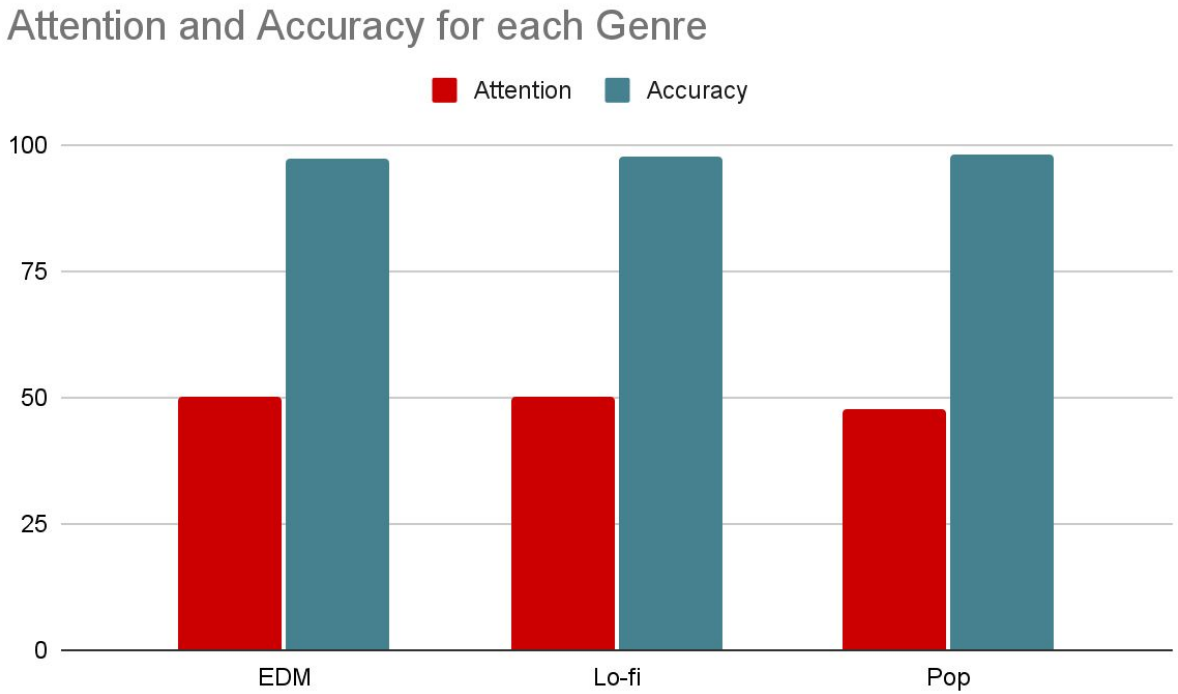
- The top-left chart shows the average accuracy for Fiction vs Non-Fiction passages, the bottom-left shows average accuracy for each genre, and the chart on the right shows average accuracy for each participant.

Fiction or Non Fiction	Accuracy
Fiction	97.907640
Non Fiction	97.514115

Genre	Accuracy
EDM	97.367483
Lo-fi	97.590450
Pop	98.174699

Participant	Accuracy
1	95.454901
2	98.757922
3	97.063685
4	99.484977
5	98.196780
6	98.121942
7	96.895933

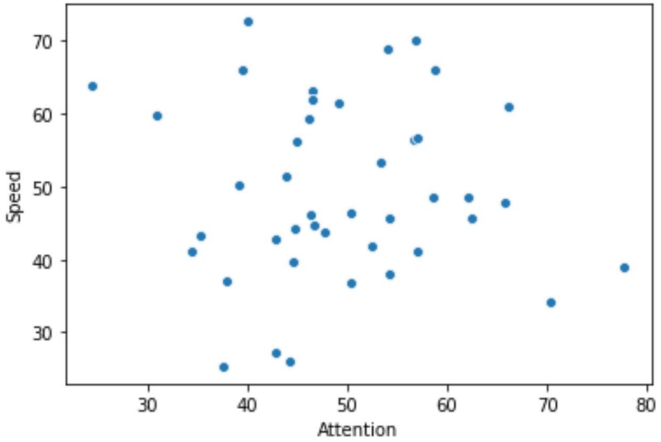
Results - Aashna



Results - Speed - Aashna

Lastly, we take into consideration the **speed** at which the participants read

- We allow the participants to each read for a minute per iteration of the experiment - the number of words they read gives us a `**words per minute**` score.
- On comparing Speed with Attention, we see a subtle positive correlation, showing that increased attention could attribute to the higher speeds
- Here, we also see numerical variation across genres with both Speed and Attention.



Genre	Speed	Attention
EDM	178.5	49.461538
Lo-fi	167.5	48.384615
Pop	183.0	47.192308

Results - Discovering Limitations -Shania

- It is important to take into consideration that one genre of music that we used, Pop music, had lyrics while the other two genres, Lo-fi and EDM, had no lyrics. In this case, the one with the lyrics would have more of an affect on the results and performance of the participants.
- Another limitation we discovered was that because the data we were recording involved physical movement of the face (the participant's mouth is moving while reading the passages out loud), the data we have collected is almost 100% likely to be corrupted in some way.
- Bias may play in affect when gathering the results of the correctness as the judgement is dependent on the proctor.
- The headset is outdated, so some of the performance does not reflect the participants attention level.
- During COVID we were not able to get as many participants and data points due to social distancing measures, therefore we are unable to generalize.

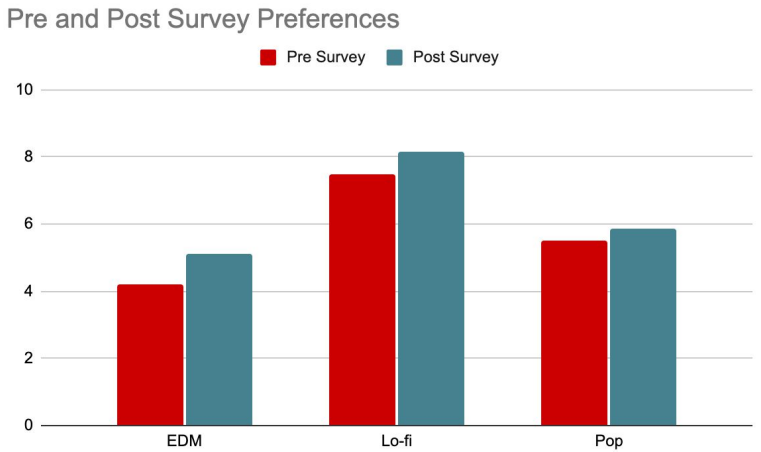
Results - Difficulties in Recording Phase -Shania

- It was challenging to set up the Neurosky headset as the version is pretty outdated and was not compatible with newer versions of Python.
- Often times, the bluetooth connection disconnected therefore the attention values were not recorded properly.
- Most of the Neurosky modules are not properly documented and out-of-date, therefore we had to adjust and debug the code by ourselves.
- Since forehead size varies, the headset piece did not fit well and it affected the results as it disconnected often.

Discussion - Neel

What did we learn?

- The surveys given to participants allowed us to track confidence and feedback before and after the experiment
- We learned from that surveys that participants had changed music preferences while reading after the experiment
- From comparing the values we see that the preferences between the genres do not change
- Lo Fi Music is most preferred by the readers and subsequently increases in popularity after the experiment



Discussion - Neel

What did we learn?

- Lo Fi Music is generally considered to be great for focussing on tasks and reading. Through our experiments we see that while the speed is significantly lower for Lo Fi Music, the attention score is in the higher range of our findings.

- For the right balance between speed and attention we find that ‘Pop Music’ performs the best with 90th percentile scores for both attention and speed.

- Factors that could attribute to this -
    - Increased Familiarity with the Music
    - Mid range BPM, as opposed to EDM and Lo Fi Beats

Discussion - Neel

What could be improved/changed?

- Working across different mediums that affect ‘Attention Score’, not limited to music
- Engage a larger test set, for scaling the data set and making more robust predictions
- Divide test groups into a control group and experimental group
- Attempting different tasks while listening to music to engage a test subject - brain teasers, meditation, breathing exercises
- Developments in experimental design, to minimize data noise and variability in recordings

Discussion - Neel

Follow-up ideas and questions

- Further experimental research of having lyrics vs no lyrics
- Exploring music genres further differentiated by BPM, Pitch, Culture, Instruments
- Accounting for personal preferences in music choice and focus environments, exploring if those factors correlate to higher attention and meditation scores
- Use cluster analysis techniques to make inference based predictions about the data
- Developing ML models to classify waves, attention and meditation levels
- Expand the technology set of EEG and Brain Wave data to better understand the results

Conclusion - Nicholas

- On a broader scale, the type of music we listen to while executing mental tasks does cause a significant change in our attention and speed
- Factors like BPM, familiarity with the music are strong factors in determining which music is “best” for mental tasks like reading.
- It may be interesting to focus more on the effects of the lyrics versus no lyrics with different genres in a future study