

How Music Affects Retention

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Introduction & Motivation

- The Wide Use of Background Music when Studying
- The Mozart Effect

Speaker: Katelyn

Research Question

Does the genre of music and type of stimuli
(word or image) improve recall retention?

Related Work/ Background



Mozart Effect

Verrusio, W, et al. "The Mozart Effect: A Quantitative EEG Study." *Science Direct*, Academic Press, 29 May 2015, <https://www.sciencedirect.com/science/article/abs/pii/S1053810015001130>.



Music and Retention

Makada, Tasnim, et al. "Enhancing Memory Retention by Increasing Alpha and Decreasing Beta Brainwaves Using Music: Proceedings of the 9th ACM International Conference on Pervasive Technologies Related to Assistive Environments." *ACM Digital Library*, 1 June 2016, <https://dl.acm.org/doi/abs/10.1145/2910674.2935851>.

Methods - Overview

The Task

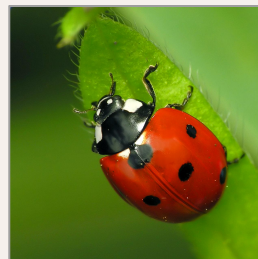
In order to test retention, we used a method known as “Paired Associate Task.” Each participant was presented with 15 word or 15 image pairs.

The Experiment

The experiment consisted of three separate trials with different stimuli (no music, heavy metal music, and classical music). Each trial had a separate task and post-test which measured the accuracy of their recall performance.

Methods - The Task

Each participant was asked to complete three paired associate learning tasks. The task consisted of paired images or words as follows:



- Participants are presented with either 15 pairs of words or 15 pairs of images for five seconds (75 seconds total) with headphones for each condition
- After 10 minutes - still listening to the music - the participant is asked to recall information about the pairs with a test. It contained questions involving:
 - Which items were paired
 - Which side an image was located
- Post-test was 10 questions and accuracy of their recall performance was assessed
- Experimenter sits behind participant for task & test, and participant sits in silence for ten minute break between task and test, for one minute between changing task and music.

Methods - The Experiment

Total Participants: 8

- Counterbalanced the participants and conditions
 - 4 completed word task and 4 completed image tasks
 - 4 STEM majors and 4 non-STEM majors
 - 4 males and 4 females
 - Everyone started with the no music condition first as a control, and depending on the person and their task, classical and heavy metal was switched in what came second.

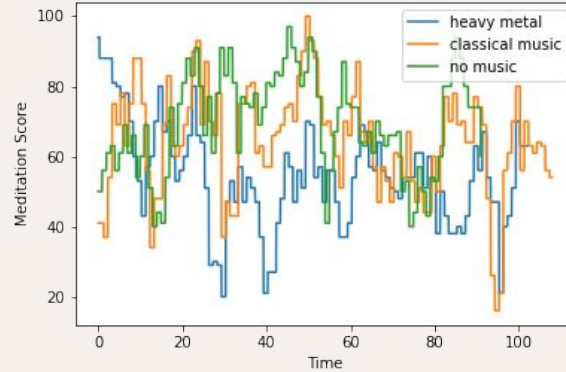
Each data collection session consisted of three trials,(no music, heavy metal music, and classical music. During the trial, participants were:

- Presented the Task
 - Asked to remember the 15 pairs (words or images) that are shown (5 seconds each)
 - During the task meditation scores were recorded using Neurosky headset/software & OpenVibe
- Test Retention
 - After 10 minute waiting period, each participant was asked to take a 10 question test
 - Test consisted of 10 questions regarding the paired associate task
 - During the test meditation scores were recorded using Neurosky headset/software & OpenVibe

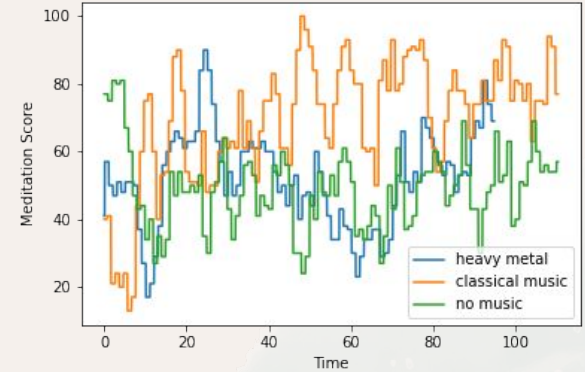
Results

	Participant	No Music	Heavy Metal	Classical	Task
0	Manny	0.5	0.6	0.9	Word
1	Kassie	0.7	0.2	0.5	Word
2	Raunit	0.7	0.8	1.0	Word
3	Alina	0.7	0.8	0.8	Word
4	Blake	0.7	0.9	0.8	Image
5	Andrea	1.0	0.3	0.9	Image
6	Rachel	1.0	1.0	1.0	Image
7	George	0.9	0.7	0.3	Image

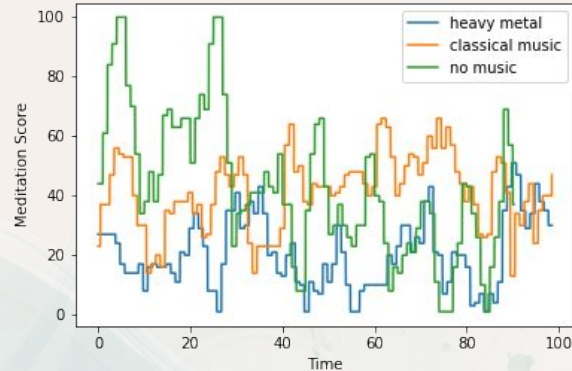
Alina's Meditation Score during Task



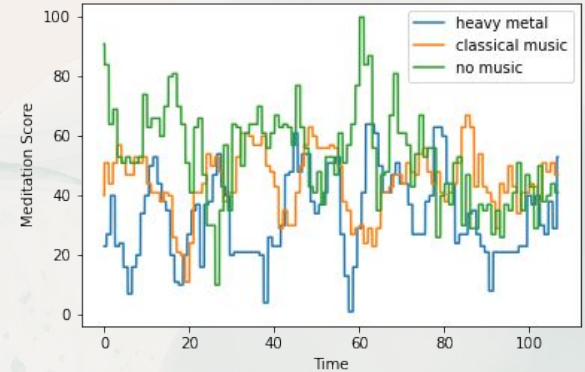
Manny's Meditation Score during Task



George's Meditation Score during Task

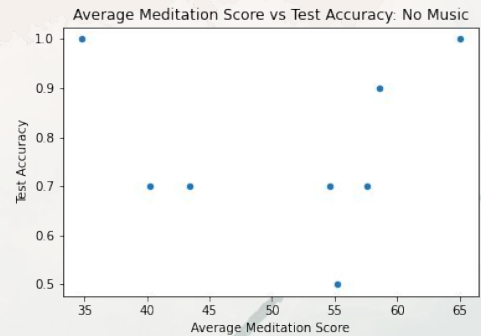
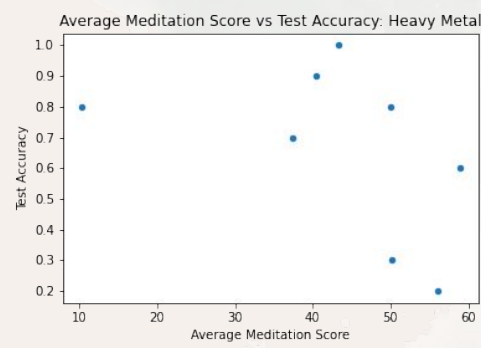
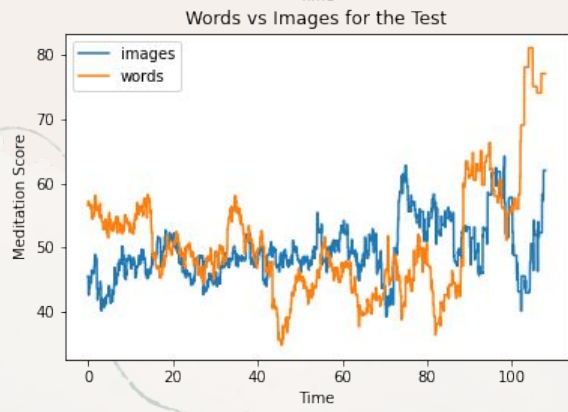
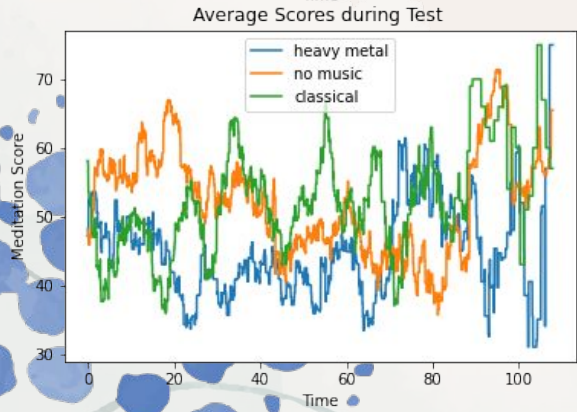
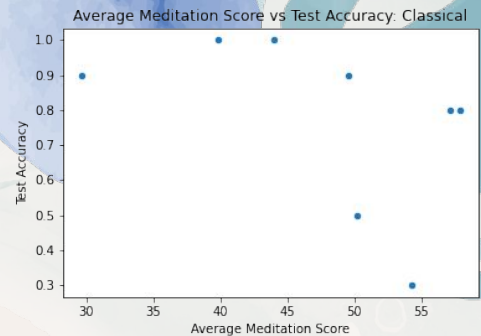
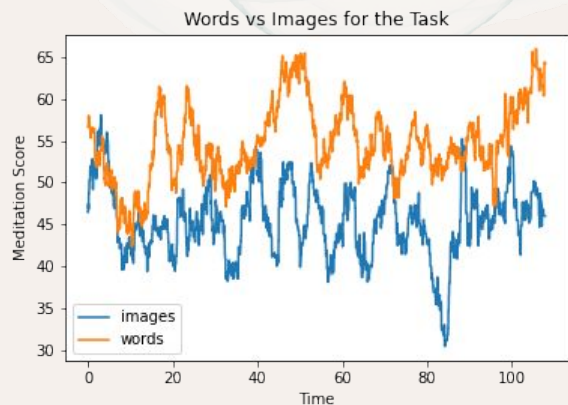
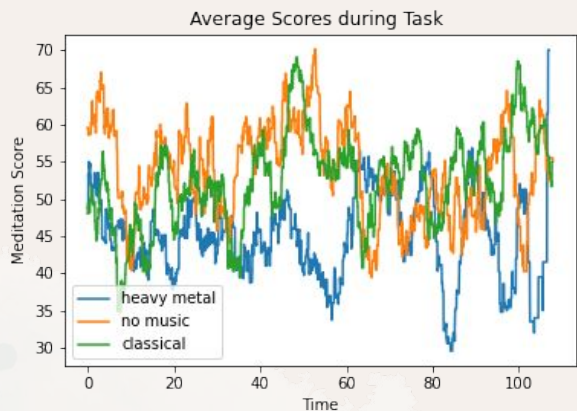


Rachel's Meditation Score during Task



Speaker: Carolyn

Results



Speaker: Carolyn

Results

- Heavy metal was the lowest states
- No music and classical were very similar in scores - not enough correlation to say that the classical music

note: sample size was small so we can't generalize or make too much cause and effect

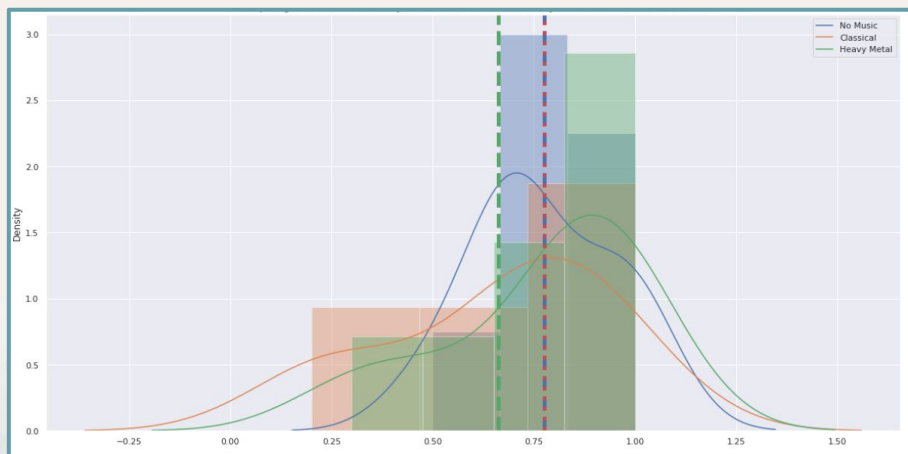
- **What Went Well:** Testing overall went well, it was a hassle to figure it out, especially how to record and get the scores, but we did get everything to work properly. In addition, heavy metal was shown to have lower results in meditation score and retention score even though we didn't have many participants.

Not work as well as planned: We didn't get statistically significant results for classical music, and in fact it was almost on par with no music. This could have also been because no music is equivalent to silence and some people can focus better in that environment.

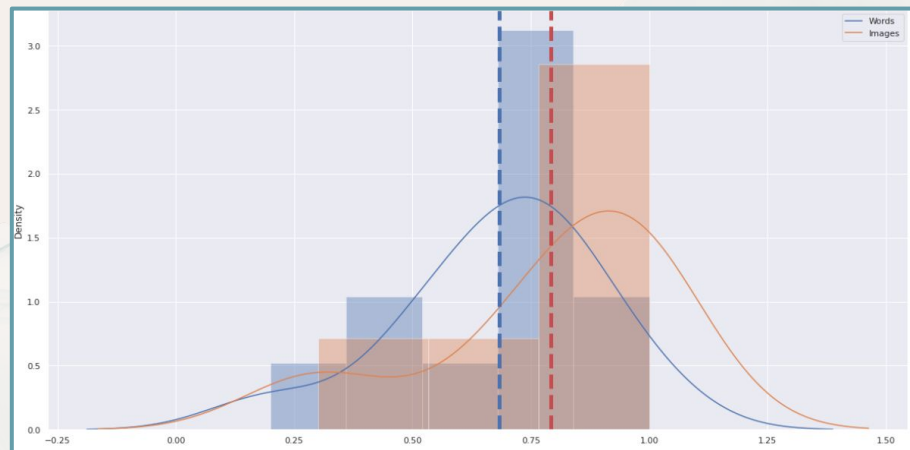
Speaker: Rhea

Analysis - Accuracy Scores (Plot)

Comparing the Mean Accuracy Score
Distributions of No Music, Heavy Metal
Music, and Classical Music



Comparing the Mean Accuracy Score
Distributions of Words and Images



Analysis - Accuracy Scores (T-Test)

No Music vs Heavy Metal Music:

H_0 : The mean accuracy score is the same between no music and heavy metal music.

T-statistic: 1.655
P-value: 0.120
Alpha: 0.05

We fail to reject the null hypothesis; there is no significant difference between the mean accuracy score of no music and that of heavy metal music.

No Music vs Classical Music:

H_0 : The mean accuracy score is the same between no music and classical music.

T-statistic: -0.401
P-value: 0.694
Alpha: 0.05

We fail to reject the null hypothesis; there is no significant difference between the mean accuracy score of no music and that of classical music.

Heavy Metal Music vs Classical Music:

H_0 : The mean accuracy score is the same between heavy metal music and classical music.

T-statistic: -2.951
P-value: 0.011
Alpha: 0.05

We **reject the null hypothesis**; there is a *significant difference* between the mean accuracy score heavy metal and that of classical music.

Words vs Images:

H_0 : The mean accuracy score is the same between word paired associate task and image paired associate task.

T-statistic: 0.233
P-value: 0.818
Alpha: 0.05

We fail to reject the null hypothesis; there is no significant difference between the mean accuracy score of word paired associate task and image paired associate task.

```
def compare_groups(arr1, arr2, alpha, sample_size):  
    stat, p = ttest_ind(arr1, arr2)  
    print('Statistics=%.3f, p=%.3f' % (stat, p))  
    if p > alpha:  
        print('Same distributions (fail to reject H0)')  
    else:  
        print('Different distributions (reject H0)')
```

****this is the function we implemented to calculate and interpret our T-Test****

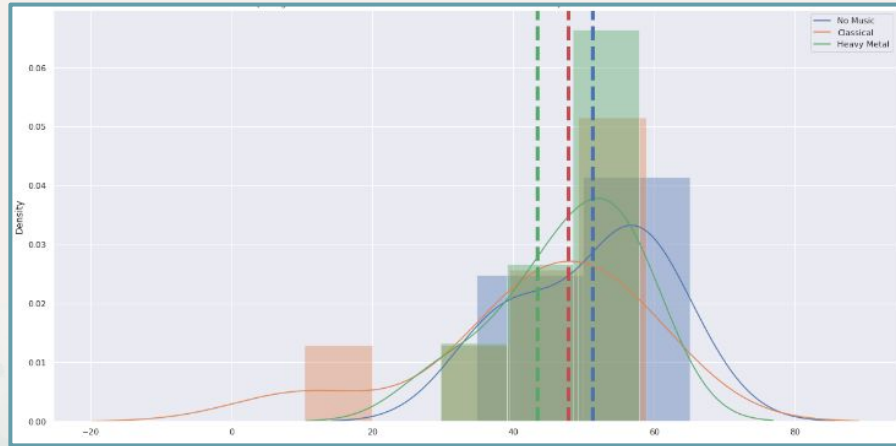
Analysis - Accuracy Scores (T-Test)

To see the significance of our results, we conducted several two-sample t-tests that compared the mean distribution of accuracy scores for each of the stimuli as well as the test conditions.

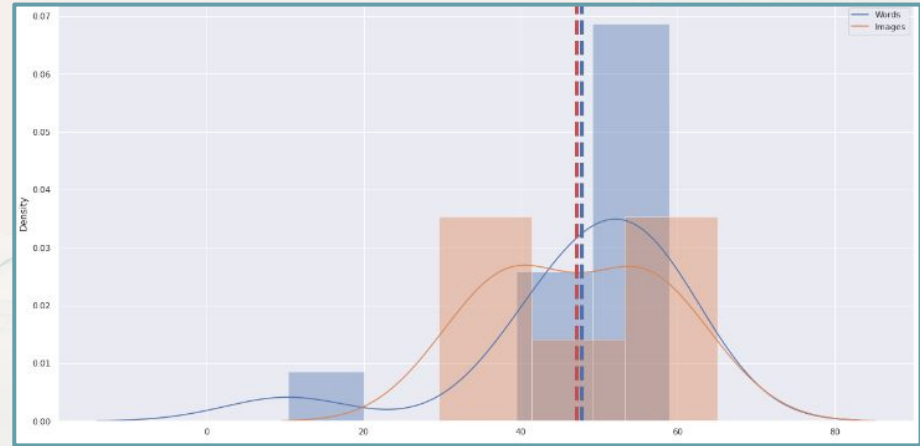
We believe that the t-test would be a sufficient parametric test since we had a small number of samples and our observations of different individuals were outcomes of statistically independent, normally distributed, and random variables.

Analysis - Meditation Scores (Plot)

Comparing the Mean Meditation Score Distributions of No Music, Heavy Metal Music, and Classical Music



Comparing the Mean Meditation Score Distributions of Words and Images



Analysis - Meditation Scores (T-Test)

No Music vs Heavy Metal Music:

H_0 : The mean meditation score is the same between no music and heavy metal music.

T-statistic: 4.270
P-value: 0.001
Alpha: 0.05

We **reject the null hypothesis**; there is a *significant difference* between the mean meditation score of no music and that of heavy metal music.

No Music vs Classical Music:

H_0 : The mean meditation score is the same between no music and classical music.

T-statistic: 3.334
P-value: 0.005
Alpha: 0.05

We **reject the null hypothesis**; there is a *significant difference* between the mean meditation score of no music and that of classical music.

Heavy Metal Music vs Classical Music:

H_0 : The mean meditation score is the same between heavy metal music and classical music.

T-statistic: -0.894
P-value: 0.387
Alpha: 0.05

We fail to reject the null hypothesis; there is no significant difference between the mean meditation score of heavy metal and that of classical music.

Words vs Images:

H_0 : The mean meditation score is the same between word paired associate task and image paired associate task.

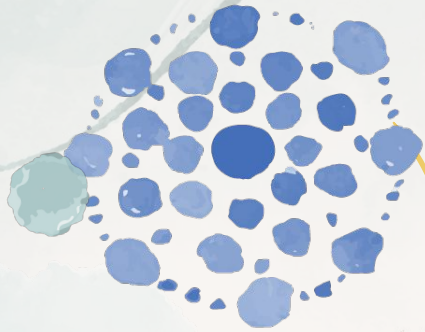
T-statistic: -1.146
P-value: 0.264
Alpha: 0.05

We fail to reject the null hypothesis; there is no significant difference between the mean accuracy score of word paired associate task and image paired associate task.

```
def compare_groups(arr1, arr2, alpha, sample_size):  
    stat, p = ttest_ind(arr1, arr2)  
    print('Statistics=%.3f, p=%.3f' % (stat, p))  
    if p > alpha:  
        print('Same distributions (fail to reject H0)')  
    else:  
        print('Different distributions (reject H0)')
```

****this is the function we implemented to calculate and interpret our T-Test****

Analysis - Overview



Accuracy Scores

The accuracy scores for heavy metal were significantly worse than that of classical music.



Meditation Scores

The meditation scores for both classical music and heavy metal music were significantly worse than that of no music.

Discussion

Learning how to use the EEG headset software to gather data from participants was tough in the beginning. Even with the data gathered, it still was not too clear but it worked and gave us results. Although the study found that music paired with stimuli does have an effect on recall, the data is not precise enough.

For future research, a better headset would give more accurate results. The headset used in this study, only gathered results for an average meditation score. This means that the measured brain activity may not be correlated towards working memory.

More participants would allow for a clear picture of the study. Although we had 8 participants, the sample size is not large enough to say that this could apply to the general public. The larger the sample size the better the results for this type of study.

Strengths & Limitations

- **Strengths**
 - Three different groups gave clear results for the study (Control, Classical, Heavy Metal).
 - Approach allowed for visualizations to be clear, which gave a better statistical analysis.
 - Having EEG data gave the comparison of meditation and score results of participants and find if any correlation was between them.
- **Limitations**
 - Sample size of participant was small, which does not allow for the study to assume that this applies to a general population.
 - Does not take into account any other genres' of music which could have an impact on recall.
 - EEG headset does not give specific bands(Alpha, Beta, Gamma) but rather a general guide of brain waves.

Conclusion


The results show that the genre of music playing while paired with a stimuli can affect recall information. So if you're someone who is studying or working, your music choice affects your ability to recall information. For clear results of this study, a larger group of participants will be necessary to gather more data and form a definitive answer, as the current sample size allows for a hypothetical conclusion.



Reference

Makada, Tasnim, et al. "Enhancing Memory Retention by Increasing Alpha and Decreasing Beta Brainwaves Using Music: Proceedings of the 9th ACM International Conference on Pervasive Technologies Related to Assistive Environments." *ACM Digital Library*, 1 June 2016, <https://dl.acm.org/doi/abs/10.1145/2910674.2935851>.

Verrusio, W, et al. "The Mozart Effect: A Quantitative EEG Study." *Science Direct*, Academic Press, 29 May 2015, <https://www.sciencedirect.com/science/article/abs/pii/S1053810015001130>.





**Thank you for
Watching**