

Characterization of Steady-State EEG Responses to Familiar and Unfamiliar Music While Playing a Virtual Reality Rhythm Game

Xander Boit^{1*} and Nathalia Peixoto²

¹George Mason University, Fairfax, Virginia, USA

²University of Sao Paulo, Sao Paulo, Brazil

Abstract

Previous studies have shown that the brain processes familiar and unfamiliar music differently, yet there is a lack of EEG analysis focusing on active rhythm tasks during music listening. Our study aims to address this gap by investigating EEG responses to familiar and unfamiliar music while participants engage in a rhythm game within a virtual reality environment. We utilized a commercially available four-electrode headband to collect EEG data from 10 healthy subjects during experiments. Participants played the rhythm game Beat Saber, using virtual sabers to match the beat of the music. This experiment employed a matched pair design, with each subject serving as their own control in EEG comparisons. EEG data were categorized into delta, alpha, beta, and gamma frequency bands, and power within each band was analyzed to discern patterns across trials. Our findings revealed significant differences in how the brain processed familiar versus unfamiliar music across both audio-only and virtual reality settings. These changes occurred predominantly on the right side of the brain, suggesting hemispheric specialization in music processing. Overall, our study contributes new insights into neural dynamics underlying music perception during active engagement, highlighting distinct EEG responses to familiar and unfamiliar music across sensory contexts.

Keywords: EEG; music familiarity; rhythm game; virtual reality; frequency bands

Citation: Boit, X., & Peixoto, N. (2026). Characterization of steady-state EEG responses to familiar and unfamiliar music while playing a virtual reality rhythm game. *NeuroRegulation*, 13(1), 43–53. <https://doi.org/10.15540/nr.13.1.43>

***Address correspondence to:** Xander Boit, George Mason University, 4400 University Drive, Fairfax, VA 22030, USA. Email: xboit@gmu.edu

Edited by: Rex L. Cannon, PhD, Currents, Knoxville, Tennessee, USA

Copyright: © 2026. Boit and Peixoto. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC-BY).

Reviewed by: Rex L. Cannon, PhD, Currents, Knoxville, Tennessee, USA
Randall Lyle, PhD, Mount Mercy University, Cedar Rapids, Iowa, USA

Introduction

Electroencephalography (EEG) records brain signals from electrodes placed on the scalp surface related to various cognitive states, and these signals can be analyzed to understand human behavior (Kumar & Bhuvaneshwari, 2012). One area of focus is how the brain reacts to musical stimuli in various settings. Familiarity with music has been linked to positive emotions and therefore been applied in therapies for Alzheimer's disease, depression, and anxiety patients (Freitas et al., 2018; Hailstone et al., 2009). The familiarity principle is a psychological phenomenon which suggests that the more exposed to something, the more that thing is liked (Zajonc, 1968). The anatomical locations related to this behavior are the left superior frontal gyrus, the

ventral lateral nucleus of the left thalamus, and the left medial surface of the superior frontal gyrus for familiar music, whereas the left insula and the right anterior cingulate cortex were activated during unfamiliar music (Freitas et al., 2018). This indicates that different pathways in the brain are activated while processing familiar music and unfamiliar music.

The existing body of research provides little information on the impact of familiar music while the participants complete a task directly related to the music (such as playing an instrument or a rhythm game). This study aims to fill this gap by investigating the impact of unfamiliar and familiar music on a person's brain while completing a rhythm game in a virtual reality (VR) environment. The use

of a VR environment also allows for the control of both the auditorial and visual stimuli, thus allowing for a more controlled experimental design. This has potential applications in future research as VR becomes a more common tool for stimulating the brain in specific contexts or for developing therapeutic systems.

This study evaluated the impact of familiar and unfamiliar music on the brain during a music-related task, which in this case was a VR rhythm game. The data collected in this study enabled the investigation of electrophysiological brain responses to music listening and interaction, which could have significant implications for the music industry. This study also aims to demonstrate the usefulness of VR environments in controlling sensory stimuli during EEG-based research on the brain.

Most prior investigations into the effects of familiar and unfamiliar music on brain behavior have utilized very short portions of songs (1–10 s; Freitas et al., 2018; Jagiello et al., 2019; Malekmohammadi et al., 2023). While this approach can investigate the immediate response to familiar and unfamiliar music, the steady-state response is not able to be properly evaluated. These responses to short stimuli are also usually focused on auditory event-related potentials which are primarily associated with sensation rather than cognitive state. Therefore, this investigation opted to explore longer term responses to familiar and unfamiliar musical stimuli by having participants listen to the entire duration of a song. To help combat participants losing interest with the experimental paradigm or ignoring the stimuli, the VR rhythm game condition was utilized alongside a traditional listening task. Furthermore, the previous studies have little agreement as to the ideal musical stimuli for studies regarding familiarity. Malekmohammadi et al. (2023) and Kumagai et al. (2017) used classical music while Jagiello et al. (2019) utilized popular music from several different genres tailoring the stimuli to each individual participant (Kumagai et al., 2017; Malekmohammadi et al., 2023). There are even examples of studies preparing new musical stimuli specifically for use in their experiment, such as Klostermann et al. (2009). For this study it was determined that using musical stimuli tailored to each individual participant was

ideal, as it was a goal of the study to keep the work relevant to the applications as much as possible.

EEG recordings were split into canonical frequency bands for analysis. The delta frequency band has been correlated with cortical plasticity (Malik & Amin, 2017). The theta frequency band has been correlated with learning and memory in EEG recordings (Herweg et al., 2020). The alpha frequency band helps calm down the person when necessary and promote feelings of deep relaxation. If suppressed it can cause anxiety, high stress, and insomnia (Abhang et al., 2016). The beta frequency band correlates with a state of higher awareness and focus (Rakel and Faass, 2006). The gamma frequency is correlated with attention, working memory, and long-term memory processes (Malik & Amin, 2017).

Methods

Participants

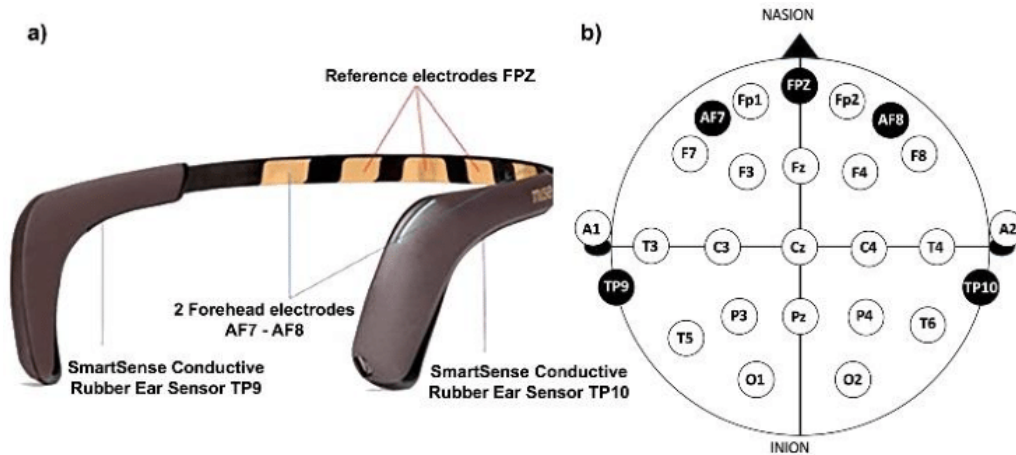
The experiment was approved by the Internal Review Board (IRB) at George Mason University (IRB# 1978051-2). Each participant was given a copy of the informed consent document. Before signing the document, each participant was read the entire document and given the opportunity to ask any questions.

Ten participants were recruited for the experiment. Nine of the participants were 21 years old, and the remaining participant was 60 years old. Of the 10 participants, three were male and seven were female. All participants had normal hearing and had normal or corrected-to-normal vision.

Hardware

EEG data were collected using the Muse Monitor 2 (Muse, 2023), a commercially available device chosen for its ease of use and broad accessibility. These features support the potential for this research and its outcomes to be integrated into practical applications. Additionally, the device's small form allows it to fit comfortably beneath the VR headset. The Muse Monitor 2 uses four electrodes placed at TP9, AF7, AF8, and TP10, with a sampling rate of 256 Hz. Electrode placement is illustrated in Figure 1. The VR system used for this study was an HTC Vive.

Figure 1. a) Muse Monitor 2 Headband b) Electrode Placement – Indicated by Black Circles. FPZ Is Utilized as Ground by the Muse Monitor 2, While the Other Highlighted Electrodes Are Recording Electrodes (Mansi et al., 2021).



Experimental Task

The VR videogame, Beat Saber, is a rhythm game that involves using imaginary sabers to slash boxes that indicate a specific direction along with the song playing during the game. The saber in each hand are different colors which must match the color of the box that is being slashed (Beat Saber, 2018). For safety purposes, the game was adjusted to only use arm movements (no leg movement). This adjustment also served to reduce motion artifact in the EEG recordings.

Each participant was required to fill out a Google Form when signing up for the experiment. In this form, they were instructed to list five songs that they considered familiar. Four of these songs would be used for the familiar audio and familiar VR scenarios. For the VR scenarios, unfamiliar songs were chosen from the default list in the game. For the audio-only scenarios, unfamiliar songs were chosen from popular bands. The song was selected from unpopular songs from these bands. All participants confirmed that they were not familiar with these songs before recording. See Appendix Table A1 for a list of familiar songs.

Participants first put on the EEG recording device, then the VR headset. Prior to data collection, each participant completed a practice session by playing a randomly selected song in the game. This familiarization period helped them understand the game mechanics, adjust to the recording equipment, and reduce potential confusion during the actual EEG recording. A baseline EEG recording was collected before each experimental section to allow for normalization during data analysis. Participants were also instructed to minimize head movements and blink naturally during EEG recordings. If a prolonged disconnection was observed (10 s), the trial would be stopped, the EEG equipment would be adjusted, and a new recording would be done from the start.

The order of trials and stimuli was randomized for each participant. First, the presentation order of the VR and audio-only sections was randomized. Within each section, the order of familiar and unfamiliar songs was also randomized. EEG responses recorded during the Beat Saber (VR) trials were compared to those from the audio-only recordings, facilitating detection of changes in brain activity during analysis. An example of a possible trial arrangement is shown in Figure 2.

Figure 2. Example of Randomized Experiment.

Training for VR Headset	
VR Recordings	Baseline Recording
	Trial (VR, Familiar song then unfamiliar song)
	Baseline Recording
	Trial (VR, Unfamiliar song then familiar song)
Short break	
Audio Recordings	
Audio Recordings	Baseline Recording
	Trial (Audio Only, Familiar song then unfamiliar song)
	Baseline Recording
	Trial (Audio Only, Unfamiliar song then familiar song)

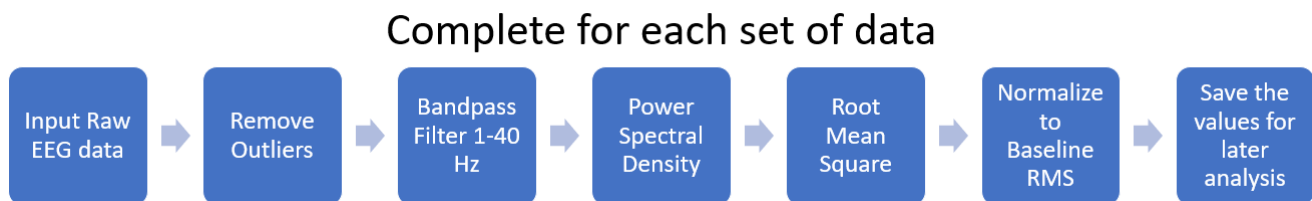
Note. Baseline recordings were 30 s long. the training (approximately 10 min) and short break (approximately 5 min) were determined based off the participant's preference. for each set of trials, the entire song (3 to 4 min) was completed during the recording.

Data Preprocessing

The data preprocessing was performed using MATLAB (Matlab, n.d.). During EEG recordings, several brief disconnections occur during recording. These disconnection artifacts were removed using a Hampel filter (Hampel, n.d.). The Hampel filter was chosen due to its robustness against outliers. EEG signals were segmented into 2-s nonoverlapping epochs. For each channel, artifact rejection was performed by calculating the standard deviation of each epoch. Epochs with a standard deviation exceeding 100 μV were excluded from analysis to remove high-amplitude artifacts. Welch's method was used to extract the power spectral density of the EEG. Following this, data were separated based on the frequency to the appropriate canonical frequency

bands: delta (1–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), beta (13–30 Hz), and gamma (30–40 Hz).

After separating the data into canonical frequency bands, the root mean square (RMS) was calculated for each band; for example, one RMS value was 17.6362. This procedure was performed on all baseline and trial recordings for each stimulus type. The RMS values from the trial recordings were then normalized by dividing them by their corresponding baseline values, as shown in Figure 3. These normalized values were saved for subsequent analysis. This procedure was applied to the data of every participant.

Figure 3. The Data Preprocessing Steps.

Note. A custom-designed script in MATLAB was used for all steps.

Signal Processing and Statistical Analysis

After preprocessing was completed for all data from all participants, the distributions of RMS values were organized and graphed using boxplots. The data were organized such that each figure created corresponds to one of the canonical frequency bands. In each figure, there are four subplots that correspond to each of the electrodes used on the recording device. In each subplot, there are four separate boxplots that each refer to the four circumstances of recording: familiar audio, unfamiliar audio, familiar VR, and unfamiliar VR. Finally, statistical significance was determined using the Wilcoxon signed rank test. This test determined if there is a statistically significant difference between the baseline value and the median of the corresponding scenario.

Results

The results are organized by frequency band and then further divided by whether the Wilcoxon signed rank test was comparing the power spectral density of the trial to baseline or its paired unfamiliar/familiar trial. If a boxplot was significant, it was highlighted

green (significance from baseline) or red (significant between familiar/unfamiliar pair) in the figure for easier viewing. If both significance from baseline and significance between the familiar/unfamiliar pair existed, the boxplot was highlighted blue.

Delta Frequency Results

In Figure 4, only three scenarios showed a difference: unfamiliar audio and familiar VR for the AF8 electrode and familiar audio for the TP10 electrode. There are no significant differences between the familiar and unfamiliar components for the delta frequency.

Theta Frequency Results

In Figure 5, all scenarios show a significant increase in the theta band for the AF8 electrode. Additionally, the familiar audio scenario showed a significant increase in power compared to the baseline in the TP10 electrode. Only one pair of scenarios had a significant difference between each other. The audio-only scenario for the TP10 electrode showed that the familiar audio has more activity than the unfamiliar audio.

Figure 4. Delta Frequency Results.

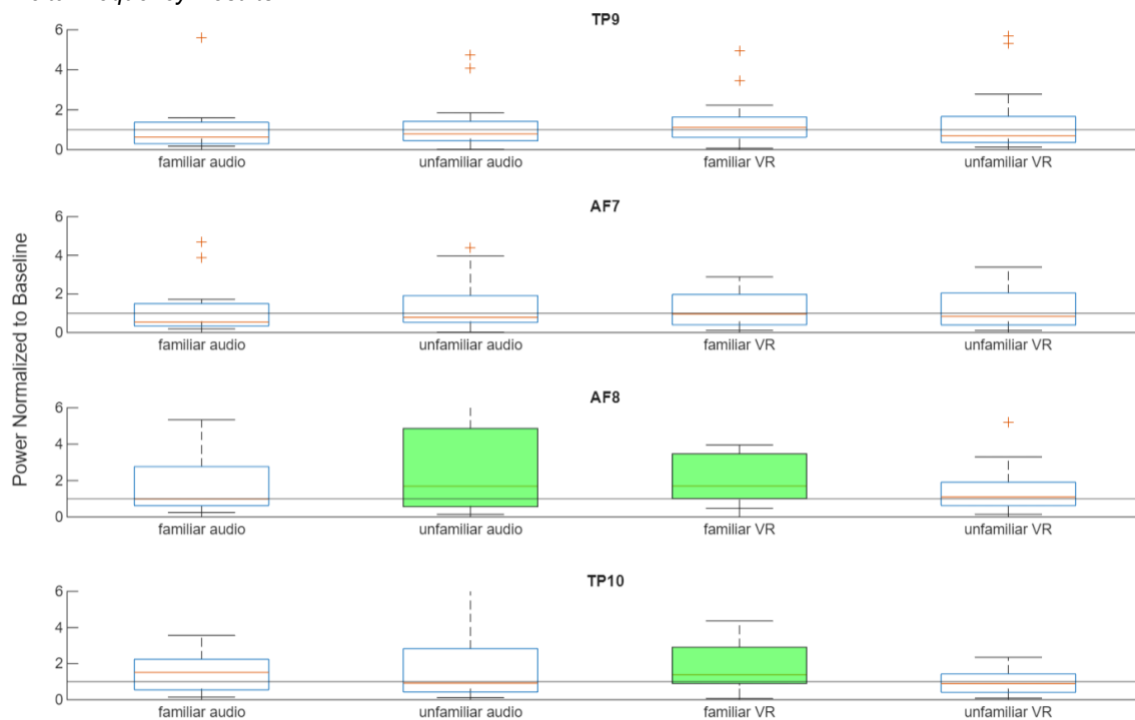
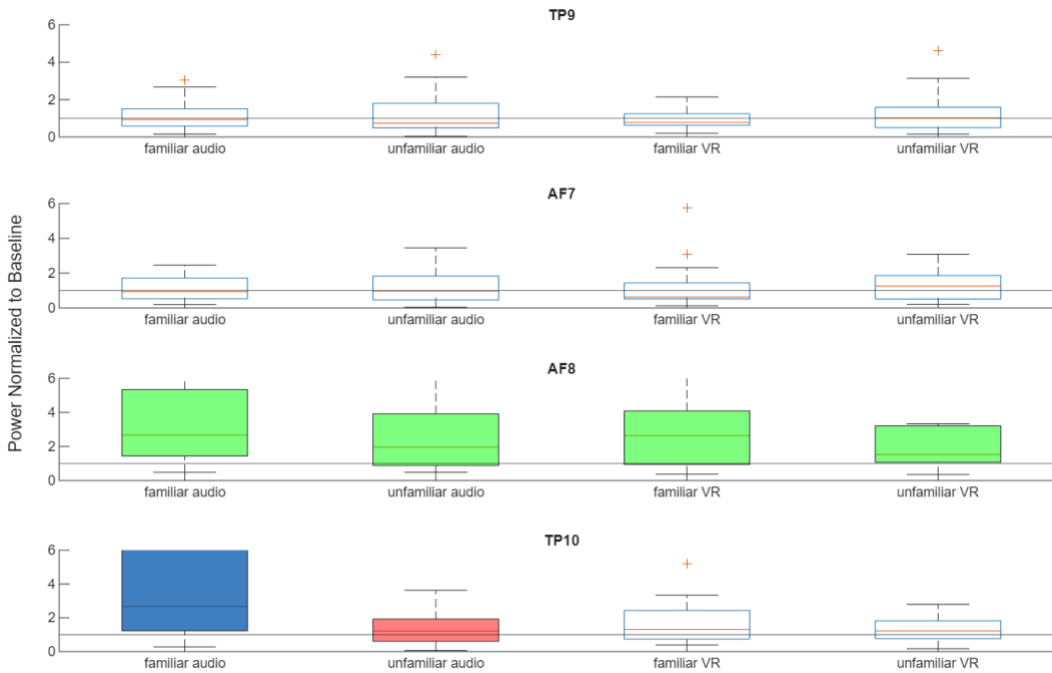


Figure 5. Theta Frequency Results.

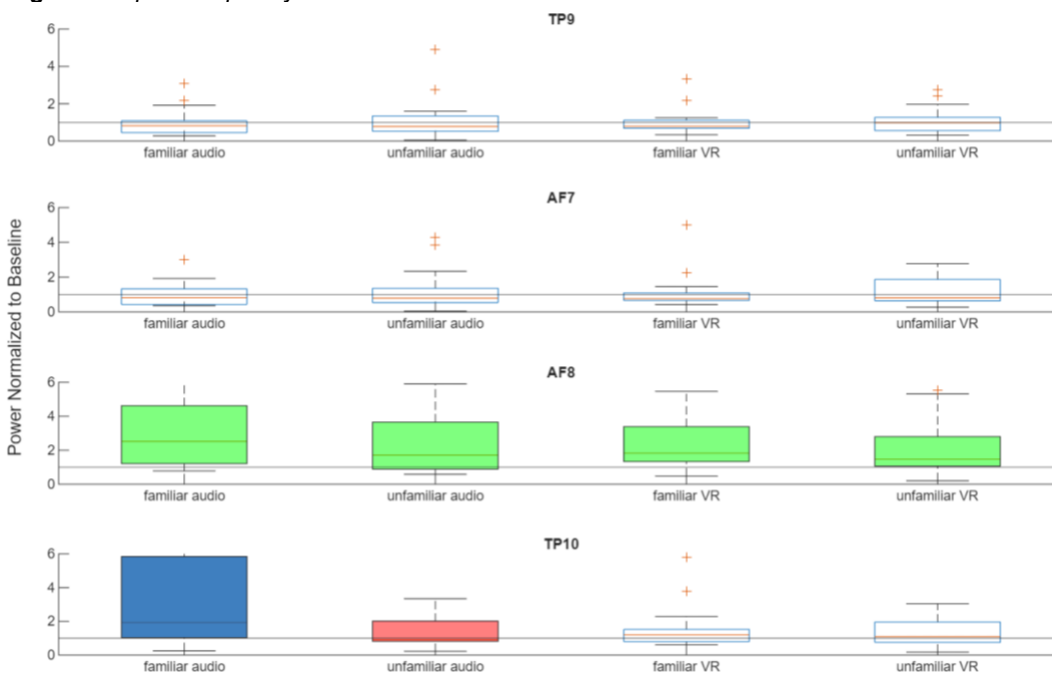


Alpha Frequency Results

In Figure 6, all scenarios show a significant increase in the alpha band for the AF8 electrode. Additionally, the familiar audio scenario showed a significant increase in power compared to the baseline in the

TP10 electrode. Only one pair of scenarios had a significant difference between each other. The audio-only scenario for the TP10 electrode showed that the familiar audio has more activity than the unfamiliar audio.

Figure 6. Alpha Frequency Results.

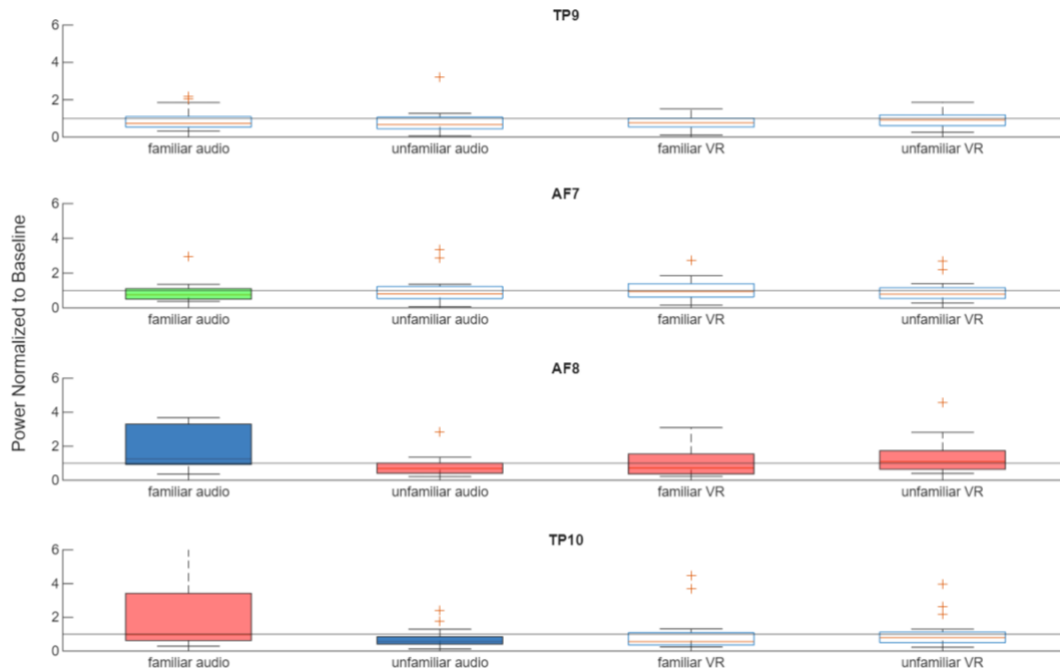


Beta Frequency Results

In Figure 7, there is a significantly lower power compared to baseline for the familiar audio in the AF7 electrode. Across AF8, there is a significant difference between the familiar and unfamiliar scenarios. There is also a significant difference

above the baseline for the familiar audio of AF8. For TP10, there is a significant difference between the audio-only scenarios. There is a significant difference below the baseline for the unfamiliar audio of TP10.

Figure 7. Beta Frequency Results.



Gamma Frequency Results

In Figure 8, the unfamiliar audio scenario is significantly lower than baseline for the AF8 and TP10 electrode. There are significant differences between the familiar and unfamiliar scenarios for both audio-only and VR sections at the AF8 and TP10 electrodes.

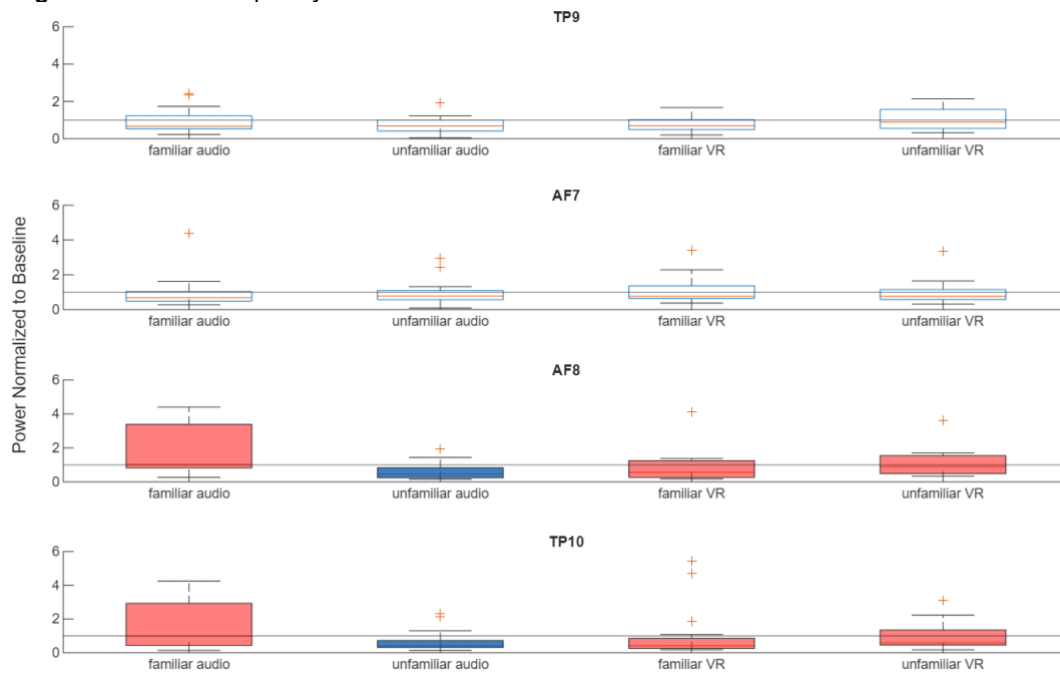
Discussion

Interpreting Results – Significance From Baseline

The delta frequency band results indicate increased activity during two scenarios: unfamiliar audio-only and familiar VR. The AF8 electrode showed increased delta power in both the familiar VR and unfamiliar audio-only conditions, while the TP10 electrode showed increased activity only in the familiar VR condition. These increases in delta activity are likely associated with enhanced cortical plasticity (Malik & Amin, 2017). The difference between the AF8 and TP10 electrodes is likely due to the distinct brain regions they monitor. The AF8

electrode corresponds to the right frontal region, which is partly responsible for spatial awareness and attention (Corbetta & Shulman, 2002). This may explain the increased delta power in the familiar VR condition; however, it is unexpected that the unfamiliar VR condition did not show a similar increase. The TP10 electrode, which corresponds to the right temporal region involved in auditory processing, may reflect increased auditory engagement with familiar music during a music-related task (Hickok & Poeppel, 2007).

The theta frequency band results show increased activity across all scenarios at the AF8 electrode. Additionally, the TP10 electrode exhibited increased activity specifically during the familiar audio-only condition, with a significant difference between the familiar and unfamiliar audio scenarios. Because theta activity is associated with learning and memory, these increases at the AF8 site likely reflect engagement with music-related tasks in the right frontal region of the brain (Herweg et al., 2020).

Figure 8. Gamma Frequency Results.

The additional increase at TP10 during familiar audio-only suggests that familiar and unfamiliar music may be processed differently in the right temporal region. This distinction may reflect enhanced memory retrieval or recognition processes associated with familiar auditory stimuli.

The alpha frequency band results mirror the trends observed in the theta band. Specifically, there is increased alpha activity across all scenarios at the AF8 electrode, suggesting greater relaxation in the right frontal region of the brain (Abhang et al., 2016). However, this pattern does not extend to the TP10 electrode. At TP10, increased alpha activity is seen only in the familiar audio condition, with a significant difference compared to the unfamiliar audio condition. This increase is not observed in the familiar VR scenario. These findings may suggest that the brain processes familiar music differently depending on whether it is experienced in a VR environment or through audio-only, particularly in the right temporal region.

The beta frequency band results show significant differences between familiar and unfamiliar scenarios across multiple conditions: audio-only (AF8), VR (AF8), and audio-only (TP10). Notably, the familiar VR condition at AF8 exhibited significantly lower beta activity compared to its unfamiliar counterpart—opposite the trend observed in the other scenarios. In contrast, familiar

audio-only at AF8 showed a significant increase from baseline, while unfamiliar audio-only at TP10 showed a significant decrease. For the first time, a significant result was also observed at the AF7 electrode, where familiar audio-only produced a significant decrease in beta activity compared to baseline. Elevated beta activity is typically associated with increased alertness and focus (Rakel & Faass, 2006). Based on this, participants appear to be more focused when listening to familiar songs in the audio-only condition, but this does not hold true for familiar VR scenarios. Similarly, the significant decrease in beta activity during unfamiliar audio-only suggests reduced focus. The result at AF7, showing a decrease during familiar audio-only, contrasts with the increased activity on the right side (AF8), suggesting potential lateralization in how music is processed across the two hemispheres of the brain.

The gamma frequency band results reveal significant differences between familiar and unfamiliar songs in both audio-only and VR scenarios. At the AF8 electrode, unfamiliar audio-only elicited a significant decrease in gamma activity, suggesting reduced attention to unfamiliar music in this condition (Malik & Amin, 2017). A similar pattern was observed at the TP10 electrode. In contrast, the VR scenarios showed the opposite trend; gamma activity was significantly lower in the familiar VR condition compared to the unfamiliar VR

condition. These opposing patterns further highlight a distinction in how the brain processes familiarity in audio-only versus VR environments.

Interpreting Results – Unfamiliar Versus Familiar

The delta frequency band shows no significant differences between familiar and unfamiliar trials. In contrast, the theta, alpha, beta, and gamma bands all show significant differences between familiar and unfamiliar audio-only conditions, with familiar audio eliciting higher power across these bands. For the VR conditions, significant differences appear in the beta and gamma bands, whereas unfamiliar VR scenarios exhibit higher power than their familiar counterparts. These findings suggest distinct patterns of brain activity depend on the context in which music is experienced. Specifically, familiar music evokes stronger neural responses during passive audio-only listening, whereas unfamiliar music elicits greater activity during active engagement in the VR environment. This highlights a fundamental difference in how the brain processes musical familiarity during passive versus immersive tasks.

Limitations

The data collected only used four electrodes, thus limiting how much of the brain's electrical activity can be recorded. It may be possible to see the differences between VR and audio-only scenarios in finer detail if more electrodes were used to record. However, the Muse Monitor 2 allowed for easier recording during VR.

Another complication is that most participants had never used VR or played the game Beat Saber. This adds another element of novelty, since the participant had to learn how to adjust to the virtual environment and understand the game mechanics. It is entirely possible that the differences observed between the audio only and VR scenarios were due to the novelty of their situation instead of the music. Further research will need to be done that removes this issue to declare more certainly that these results are due to the music familiarity and not the experimental paradigm.

An additional limitation is the presence of motion artifacts in the data. While the experiment design attempted to limit the amount of movement occurring by the participant, they still had to move their arms to play the rhythm game, resulting in some motion artifacts being created. A more robust method of motion artifact removal may be necessary for research moving forward.

Conclusions

When comparing the EEG of familiar and unfamiliar music, it appears that there are significant differences between how the brain processes familiar and unfamiliar music in both an audio-only and VR scenario. Significant results almost exclusively occurred on the right side of the brain, indicating that most music-related processing likely occurs on this side of the brain. This makes sense, since this study had participants focus on mainly listening to music, rather than producing music (Peretz & Zatorre, 2005). Overall, it is logical to conclude that there are differences between how the brain processes familiar and unfamiliar music. Additionally, it is concluded that how music is processed in terms of familiarity during a VR game is different than just listening to the music alone. Further research will need to be completed to determine what causes these differences.

Author Acknowledgments

We would like to thank Connor Delaney, a doctoral student at George Mason University, for his contributions and assistance throughout this project.

Author Declaration

George Mason University provided a total of \$1500 through the Undergraduate Research Scholars Program (URSP). These funds were used to fund equipment used during the experiment. We have no other financial interest or known conflicts of interest to disclose. AI tools were used solely to assist with rephrasing and improving clarity of the manuscript text. All content was developed by the authors who take full responsibility for the work.

References

- Abhang, P. A., Gawali, B. W., & Mehrotra, S. C. (2016). *Introduction to EEG- and speech-based emotion recognition*. Academic Press.
- Beat Saber. (2018). *Beat Saber – VR rhythm game* [video game]. Beat Games. <https://beatsaber.com/>
- Corbetta, M., & Shulman, G. L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nature Reviews Neuroscience*, 3(3), 201–215. <https://doi.org/10.1038/nrn755>
- Freitas, C., Manzato, E., Burini, A., Taylor, M. J., Lerch, J. P., & Anagnostou, E. (2018). Neural correlates of familiarity in music listening: A systematic review and a neuroimaging meta-analysis. *Frontiers in Neuroscience*, 12, Article 686. <https://doi.org/10.3389/fnins.2018.00686>
- Hailstone, J. C., Omar, R., & Warren, J. D. (2009). Relatively preserved knowledge of music in semantic dementia. *Journal of Neurology, Neurosurgery & Psychiatry*, 80(7), 808–809. <https://doi.org/10.1136/jnnp.2008.153130>
- Hampel. (n.d.). Filter outliers using Hampel identifier – Simulink. *MathWorks*. <https://www.mathworks.com/help/dsp/ref/hampelfilter.html>

- Herweg, N. A., Solomon, E. A., & Kahana, M. J. (2020). Theta oscillations in human memory. *Trends in Cognitive Sciences*, 24(3), 208–227. <https://doi.org/10.1016/j.tics.2019.12.006>
- Hickok, G., & Poeppel, D. (2007). The cortical organization of speech processing. *Nature Reviews Neuroscience*, 8(5), 393–402. <https://doi.org/10.1038/nrn2113>
- Jagiello, R., Pomper, U., Yoneya, M., Zhao, S., & Chait, M. (2019). Rapid brain responses to familiar vs. unfamiliar music – An EEG and pupillometry study. *Scientific Reports*, 9, Article 15570. <https://doi.org/10.1038/s41598-019-51759-9>
- Klostermann, E. C., Loui, P., & Shimamura, A. P. (2009). Activation of right parietal cortex during memory retrieval of nonlinguistic auditory stimuli. *Cognitive, Affective, & Behavioral Neuroscience*, 9(3), 242–248. <https://doi.org/10.3758/cabn.9.3.242>
- Kumagai, Y., Arvaneh, M., & Tanaka, T. (2017). Familiarity affects entrainment of EEG in music listening. *Frontiers in Human Neuroscience*, 11, Article 384. <https://doi.org/10.3389/fnhum.2017.00384>
- Kumar, J. S., & Bhuvaneshwari, P. (2012). Analysis of electroencephalography (EEG) signals and its categorization—A study. *Procedia Engineering*, 38, 2525–2536. <https://doi.org/10.1016/j.proeng.2012.06.298>
- Malekmohammadi, A., Ehrlich, S. K., Rauschecker, J. P., & Cheng, G. (2023). Listening to familiar music induces continuous inhibition of alpha and low-beta power. *Journal of Neurophysiology*, 129(6), 1344–1358. <https://doi.org/10.1152/jn.00269.2022>
- Malik, A. S., & Amin, H. U. (2017). *Designing EEG experiments for studying the brain: Design code and example datasets*. Elsevier.
- Mansi, S. A., Pigliautile, I., Porcaro, C., Pisello, A. L., & Arnesano, M. (2021). Application of wearable EEG sensors for indoor thermal comfort measurements. *ACTA IMEKO*, 10(4), 214. https://doi.org/10.21014/acta_imeko.v10i4.1180
- Matlab. (n.d.). *MathWorks*. <https://www.mathworks.com/products/matlab.html>
- Muse. (2023, March 29). The brain sensing headband store with worldwide shipping: Muse™ EEG-powered meditation & sleep headband. *Muse*. <https://choosemuse.com/>
- Peretz, I., & Zatorre, R. J. (2005). Brain organization for music processing. *Annual Review of Psychology*, 56, 89–114. <https://doi.org/10.1146/annurev.psych.56.091103.070225>
- Rakel, D., & Faass, N. (2006). *Complementary medicine in clinical practice: Integrative practice in American healthcare*. Jones and Bartlett.
- Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology*, 9(2, Pt. 2), 1–27. <https://doi.org/10.1037/h0025848>

Received: July 5, 2025

Accepted: August 25, 2025

Published: March 31, 2026

Appendix A

Table A1*Familiar Songs*

	Participant 1
Familiar VR 1	Beat It - Michael Jackson
Familiar VR 2	Banana Pie - Lil Darkie
Familiar Audio 1	Radioactive - Imagine Dragons
Familiar Audio 2	Gasolina - Daddy Yankee
	Participant 2
Familiar VR 1	Beat It - Michael Jackson
Familiar VR 2	Shake It Off - Taylor Swift
Familiar Audio 1	Country Roads - John Denver
Familiar Audio 2	Billie Jean - Michael Jackson
	Participant 3
Familiar VR 1	Landslide - Fleetwood Mac
Familiar VR 2	No Roots - Alice Merton
Familiar Audio 1	Waka Waka - Shakira
Familiar Audio 2	Both Sides Now - Joni Mitchell
	Participant 4
Familiar VR 1	Beat It - Michael Jackson
Familiar VR 2	Shake It Off - Taylor Swift
Familiar Audio 1	Untouched - The Veronicas
Familiar Audio 2	Treasure - Bruno Mars
	Participant 5
Familiar VR 1	Mr. Blue Sky - Electric Light Orchestra
Familiar VR 2	Heat Waves - Glass Animals
Familiar Audio 1	Stressed Out - Twenty One Pilots
Familiar Audio 2	Breezblocks - alt-J
	Participant 6
Familiar VR 1	Shake It Off - Taylor Swift
Familiar VR 2	Never Gonna Give You Up - Rick Astley
Familiar Audio 1	Don't Stop Believin' - Journey
Familiar Audio 2	Forget You - Ceelo Green
	Participant 7
Familiar VR 1	Don't Stop Believin' - Journey
Familiar VR 2	Forget You - Ceelo Green
Familiar Audio 1	Shake It Off - Taylor Swift
Familiar Audio 2	Never Gonna Give You Up - Rick Astley
	Participant 8
Familiar VR 1	Toxic - Britney Spears
Familiar VR 2	I Love It - Icona Pop
Familiar Audio 1	We Didn't Start the Fire - Billy Joel
Familiar Audio 2	Fat Bottomed Girls - Queen
	Participant 9
Familiar VR 1	Star Walkin' - Lil Nas X
Familiar VR 2	Lone Digger - Caravan Palace
Familiar Audio 1	Enemy - Imagine Dragons
Familiar Audio 2	Mic Drop - BTS
	Participant 10
Familiar VR 1	High Hopes - Panic at the Disco
Familiar VR 2	Boulevard of Broken Dream - Green Day
Familiar Audio 1	Radioactive - Imagine Dragons
Familiar Audio 2	Counting Stars - One Republic