Algorithmic Music Modulates Oscillatory Markers of Sustained Attention

Psyche Loui and MIND Lab at Wesleyan University

Abstract

Brain.fm is a music software that claims to use the principle of auditory entrainment via neuronal oscillations to modulate attention, thus helping users maintain focus on their task at hand while they listen to Brain.fm music. We investigate this claim by comparing oscillatory activity in electroencephalography (EEG) recordings obtained during the Sustained Attention to Response Task (SART) while subjects listened to Brain.fm music, compared to Spotify music, pink noise, and a silent control. Comparisons of spectra of neuronal oscillations show higher activity in the gamma band (30 Hz) and lower activity in the alpha band (10 Hz) while listening to Brain.fm. Results suggest that Brain.fm can enhance attention by increasing 30 Hz and decreasing 10 Hz activity in the brain.

Background

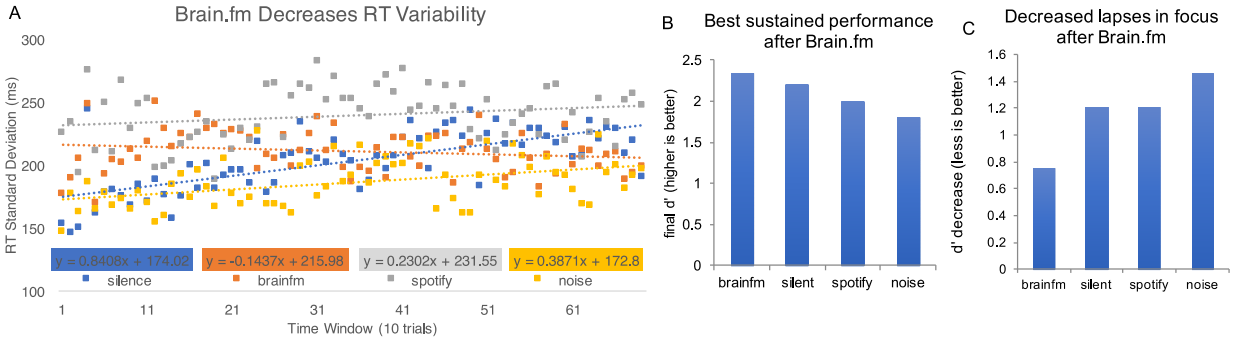
For decades, neuroscientists have tried to map specific frequencies of brainwaves to cognition and behavior. Neuronal oscillations ("brainwaves") are electrical patterns from groups of neurons that reflect information processing and communication in the brain. Auditory neuroscience studies have shown that these oscillations reflect sustained attention and can entrain, or tune into, external stimuli at precise frequencies. Thus, external stimulation such as music may affect behavior by enhancing sustained attention and reducing mind-wandering. Brain.fm uses music to enhance attention via rhythmic amplitude modulations that are inserted in algorithmically generated music. Here, we test the hypothesis that listening to Brain.fm music would affect attention by changing the oscillatory activity of the brain.

Methods

We recorded electroencephalography (EEG) from 12 healthy adult participants (average age 19 years; 8 females) who completed the Sustained Attention to Response Task (SART) while listening to Brain.fm, compared against three control conditions: Silence, Spotify music, and Noise.

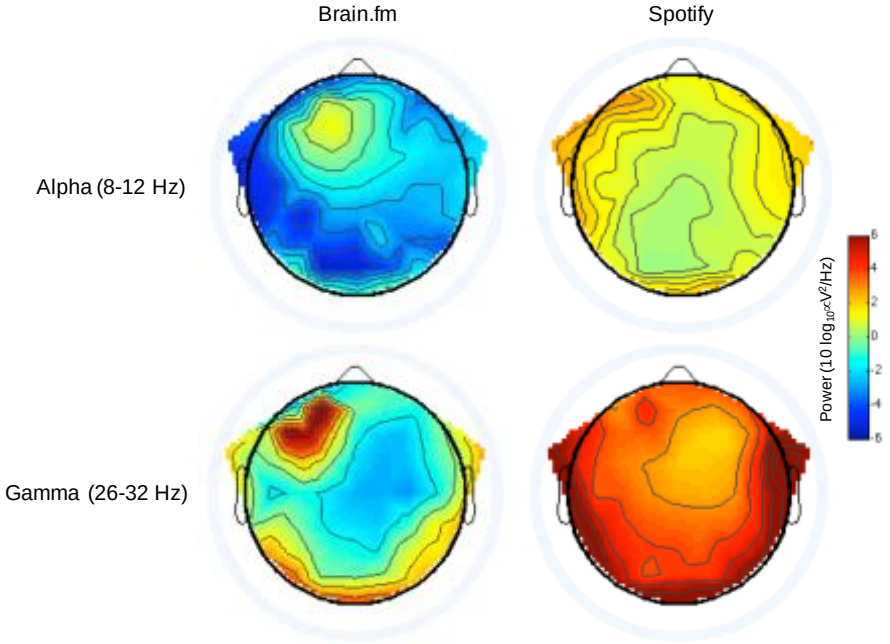
In the SART, numbers are presented sequentially on a screen. Participants pressed a button upon seeing each number ("Go trials"), except for when the number is a 3, when participants refrain from pressing the button ("No-Go trials"). We record the participants' reaction time (ms) and accuracy (d'), and the variability of reaction time and change in accuracy (d') is an index of mind-wandering, or lapses of sustained attention.

Behavioral results show better sustained attention during Brain.fm



Reaction time variability decreases over time during Brain.FM. It increases in all other conditions, indicating that Brain.FM helps sustain attention over time.

EEG during Brain.fm shows decreases in low-frequency and specific increases high-frequency oscillatory activity



Maps of neuronal oscillations show that compared to the Spotify control condition, Brain.fm elicits lower activity in the alpha (8-12 Hz) range, coupled with localized increases in activity in frontal regions in the gamma (26-32 Hz) range.

Conclusions

Results show that external stimulation, delivered via algorithmically generated music, can affect oscillatory activity in the brain.

Compared to silence, Spotify, and noise control conditions, listening to Brain.fm music during a sustained attention to response task elicits lower power at low-frequency oscillations (alpha) and boosts power at high-frequency oscillations (gamma) in specific regions. The increases in high-frequency power are localized to left frontal regions and may reflect activity in attention networks, sustained by entrainment to Brain.fm.

Mind-wandering, or the lapse of sustained attention, hurts productivity and is associated with lower well-being. By changing neuronal oscillations that enable sustained attention, Brain.fm can reduce mind-wandering, thus boosting productivity and increasing focus.