Music Genres Effect on Brain Waves Power Spectrum

and their Relation to Mental States assessed by EEG

Submitted By: Yasamin Medghalchi, Maryam Maghsoodi, Ali Ghavampour, Mohammad Amin Alamalhoda
To: Foundation of neuroscience Sharif university of technology
Proposal Submission Date: November 20, 2020

- **Introduction**

  For centuries, music has been used for healing and stimulating emotions. It is considered a powerful tool for arousing emotions in human beings. So far, there are many studies about the impact of music on human emotions [1], frequency bands of the brain [2], the bioelectrical oscillations of the brain [3], and brain activity in the process of learning [4]. In this study, the impact of different genres of music (Pop, Rock, Classical, Jazz, and Rap) on the activity of frequency bands (Gamma, Beta, Alpha, Theta, Delta) will be investigated by the analysis of power spectrum captured from EEG.

- **Literature Review**

  In 1975, Michael J. Wagner et al. assessed the effect of two music stimuli and silence on alpha rhythm production in the temporal lobes of 30 musicians and 30 non-musicians. By analysis of time spent in alpha rhythm, they observed more alpha rhythm content in electroencephalograms of musicians than in electroencephalograms of non-musicians. Furthermore, by Analysis of verbal reports, they figured out that subjects ascribed a significantly lower attentiveness rating to silence conditions than to either music condition. They claimed that there was low correlation between time spent in alpha and verbal reports of attentiveness. [5]

  In 1993, Michinori Kabuto et al. studied the relation between Power Spectrum changes while listening to 2-minute fractions of 6 famous classical music and 16 psychosomatic feelings. (happiness, sadness, fear, fatigue, etc.). Their results indicated that the changes in total δ power for all the regions were significantly associated with both the "pleasant & relaxed" and "calm" component scores. They also declared that the α-peak frequency was inversely related to the decrease of the "calm" score in the left occipital region [6]

  In 2005, Joydeep Bhattacharya et al. researched the differences in functional and topographical connectivity patterns between musicians and non-musicians, during listening to three different pieces of music and to a text of neutral content through EEG phase synchrony analysis in five standard frequency bands (Gamma, Beta, Alpha, Theta, and Delta). Their results pointed out that the musicians had increased phase synchrony over distributed cortical areas, both near and distant, in the delta, and significantly in the gamma frequency band, whereas non-musicians had enhancement only in the delta band. Further, they reported that the degree of phase synchrony in musicians reduced during listening to the text as compared to music [2].

  In the music information retrieval conference (ISMIR, 2012), Rafael Cabredo et al. used EEG to record the subject's reaction (joy, sadness, relaxation, stress) to music. They observed that EEG and ESAM can be used for annotating emotion in music especially when the subject experiences a strong intensity of that emotion. [7]

In 2015, Walter Verrusio et al. studied the influence of Mozart's music on brain activity through spectral analysis of the EEG. They observed increased alpha band and median frequency index of background alpha rhythm activity (a pattern of brain wave activity linked to memory, cognition, and an open mind to problem-solving), after listening to Mozart. They also claimed that there were no changes in EEG activity after listening to Beethoven. [8]

In 2018, Domantė Kučikiene et al. investigated the changes in the bioelectrical brainwave activity that occurs while listening to music. They believed that music may be used in clinical practice in the future [3].

Materials & Methods

This is a quasi-experimental study on 10 right-handed men and women aged 18 to 22 years old.

P: 10 right-handed men and women aged 18 to 22 years old.
I: 5 genres of Pop, Rock, Classical, Jazz, and Rap.
C: EEG signals before and after listening to music.
O: the impact of different genres of music on the activity of frequency bands (Gamma, Beta, Alpha, Theta, and Delta)

This study is divided into three phases.

- **Phase 1**

  The best iTunes song from each of the five genres of Pop, Rock, Classical, Jazz. and Rap is selected and will be played for subjects. To settle down at the beginning, we will consider a three-minute-silence. Each song will be played for three minutes, and there will be a five minutes break between two songs. During each gap between two music stimuli, participants will be asked to complete the questionnaire. The obtained data from this questionnaire will be used in Phase II.

  We will record EEG signals in pre-music stimuli, during music stimuli, and post-music stimuli.
  The participant's eyes should be closed during data recording. The relation between each music genre and different frequency bands will be determined according to analysis of EEG signals and measuring the average Power Spectrum of each frequency Bands (Table 1).

Table 1: Characteristics of the five basic brain waves [9]

Frequency band	Frequency	Brain states
Gamma (γ)	>35 Hz	Concentration
Beta (β)	12–35 Hz	Anxiety dominant, active, external attention, relaxed
Alpha (α)	8–12 Hz	Very relaxed, passive attention
Theta (θ)	4–8 Hz	Deeply relaxed, inward focused
Delta (δ)	0.5–4 Hz	Sleep

- **Phase 2**

  Participants will be asked to answer the questions in the questionnaire (Table 2) with a number in the range 0 - 10 before and after the song is played. The feeling which will be asked in the questionnaire is related to the specific frequency band (for example if someone is relaxed, the Alpha Frequency band is active [10]). In this phase, we are going to answer the question of whether the reverse relation between frequency band and mental state is true.

  A brief explanation is figured in diagram 1.

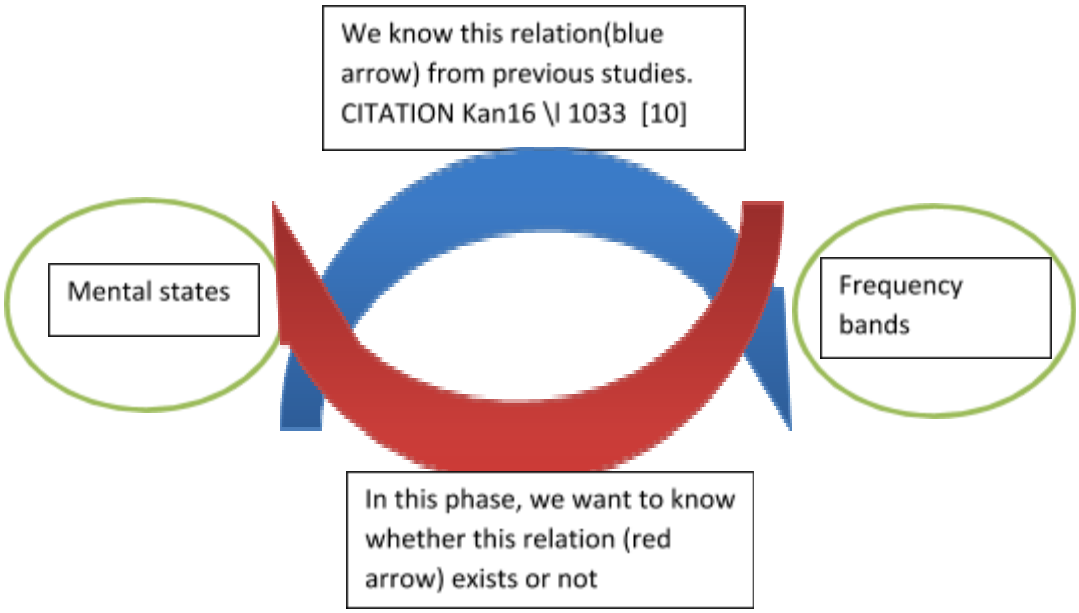

Diagram 1: phase 2 description

Based on the phase 1 results, we will know which frequency band of each person will be activated during listening to a specific song. The question of whether the reverse relation between frequency bands and mental states is true will be answered based on the analysis of this questionnaire.

Table 2: Questionnaire

Rate your following states from 0 to 10:

-wakefull/drowsy-

-anxious/calm-

-distracted/focus-

-nervous/relaxed-

- **Phase 3**
  In the case of correct reverse relation in phase 2, phase 3 will be started.
  In this phase, we will investigate the relation between music genres and the mental states using previous results.
  A simple diagram of the experiment is figured in diagram2.

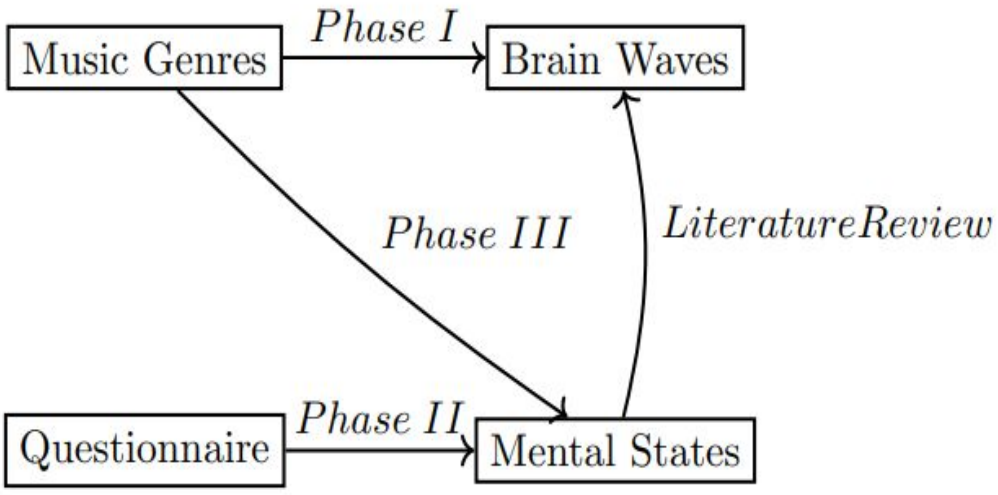

Diagram 2: diagram of the experiment

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