

A Pilot Study on the Portable EEG-Based Music Effects

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Abstract

Previously electroencephalogram (EEG) based BCI (Brain Control Interface) is very complicated for the home-based users. This paper presents a pilot study on the portable EEG-based BCI system to find the music effect relation between music genres and human's attention and meditation. Music genres for various background music styles are analyzed for the experiment, to obtain the subjects' EEG data with various attention and meditation levels. Finally we found that the classical symphonic music makes subjects obtain the most significant response, and the proposed method can be adopted for the fields of music healing, education, and entertainment, hopefully.

Keywords: Portable EEG-based BCI; Attention; Meditation; Music genres; Background music

Introduction

The non-invasive EEG/BCI system is a huge system originally, which makes users much inconvenient in the traditional usages and requires complicated software and hardware implementations [1,2]. Nowadays the EEG/BCI products have been developed into the portable wearing technology based market in recent years. Some of the portable EEG-based BCI products have been even applied into the entertainment fields [3,4]. Several applications of BCI is used to control the medical facilities, such as the wheelchair [5]. Music healing is also becoming one of the EEG/BCI applications, such as the tension and stress release [6,7]. Currently some simplified portable EEG-based BCI have been developed for people to use easily, such as the TGAM (ThinkGear AM) chip [8] with many applications, including neuro-robotics [9], and learning [10,11]. There are some usages of the portable TGAM-based EEG/BCI for music, such as music player [12] and sound for virtual reality therapy with both attention and meditation level measurement [13]. In this paper, we would like to present a convenient home-based EEG/BCI system using TGAM to find the music categories related to human's attention and meditation.

Method

This research provides a convenient way to find the relation between human's attention/meditation levels and music categories. The follows shows more detailed methodology of this research.

Music classification

According to Gjerdingen RO and Perrott D's research [14], 10 main genres of popular music are widely recognized in the late 1990s, including (1) Blues, (2) Classical, (3) Country, (4) Dance, (5) Jazz, (6) Latin, (7) Pop, (8) R & B, (9) Rap, and (10) Rock. We choose Rock and Roll, and Pops Folk Song from the popular music genres as our music stimuli. In the meantime, Traditional Chinese Confucius Temple Music is also selected as one of the music genres for this research, while

Classical Symphonic Music is selected as the Classical genres. Figure 1 shows the music classification for the portable BCI/EEG experiment of this research. Table 1 shows the music genres with the correspondent pieces used for the experiment.

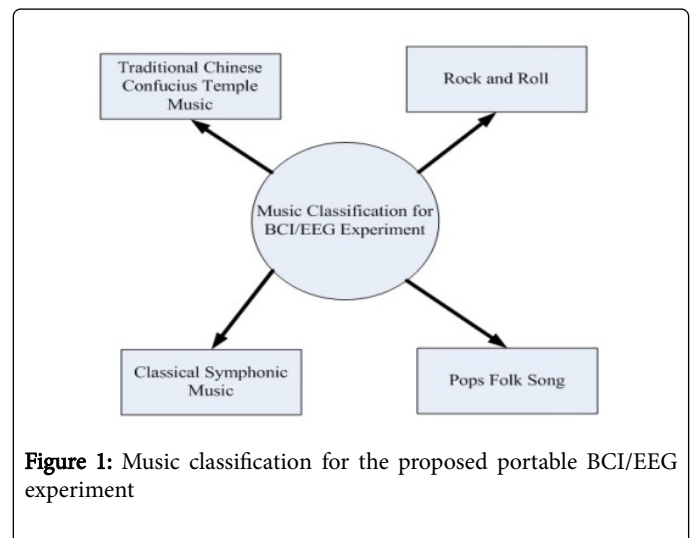


Figure 1: Music classification for the proposed portable BCI/EEG experiment

Music genres	Pieces used for the experiment
Rock and Roll	The Beatles
Pops Folk Song	Pops Chinese Folk Song
Traditional Chinese Confucius Temple Music	Taipei Confucius Temple Music
Classical Symphonic Music	Mozart's Symphony

Table 1: Music genres with the correspondent pieces used for the experiment

Elements of music

There are 8 elements of music including (1) Rhythm, (2) Melody, (3) Harmony, (4) Form in music, (5) Forms of music, (6) Tempo, (7) Dynamics, and (8) Tone color [15]. In this paper, we select four of the most significant music features to compare with the subjects' response, including (1) Rhythm, (2) Harmony, (3) Tempo, and (4) Dynamics, as shown in Table 2.

Elements of music	Range
Rhythm	Simple <--> Complex
Harmony	Consonant <--> Dissonant
Tempo	Slow <--> Fast
Dynamics	Quiet <--> Loud

Table 2: Four most significant music features used for the experiment.

Graphical interface for the EEG-based BCI

The proposed method to display the EEG-based BCI data is to use Max/MSP program [16] as the TGAM data acquisition system. The EEG raw data includes delta (0.5-2.75Hz), theta (3.5-6.75Hz), low-alpha (7.5-9.25Hz), high-alpha (10-11.75Hz), low-beta (13-16.75Hz), high-beta (18-29.75Hz), low-gamma (31-39.75Hz), and mid-gamma (41-49.75H) [17], as shown in Figure 2. However the most two signal levels are "attention" and "meditation", indicating human's attention and meditation activities.

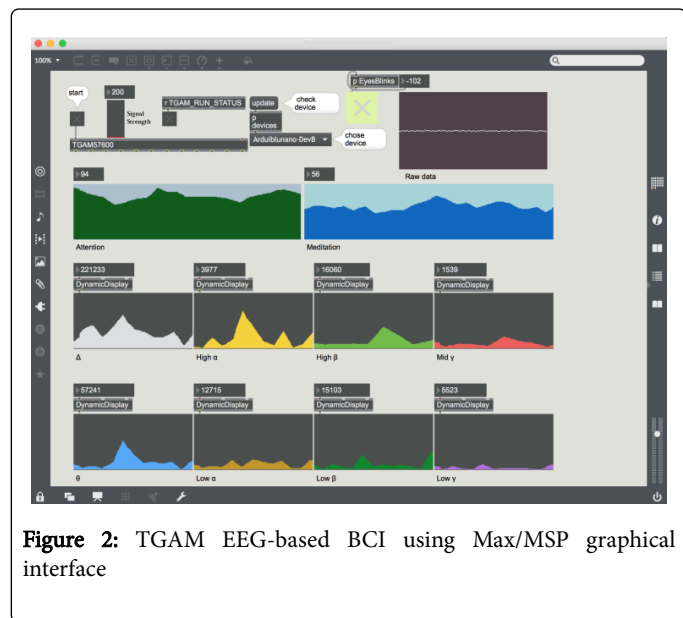


Figure 2: TGAM EEG-based BCI using Max/MSP graphical interface

Experiment

There are six subject listening to music in various styles, as the above mentioned. Three of them are musicians with more than 10 years professional instrumental training; and the remaining three non-musician subjects are amateur music lovers. The experiment procedure and experiment facility is depicted as the following sections.

Experiment procedure

- The experiment procedure can be described into the following steps:
- Find proper Music Stimuli for the proposed experiment context;
- Perform program execution for the prototypical BCI background music with various emotion situated selections;
- Make the subjects listening to various music content and styles;
- Perform portable BCI data analysis;
- Confirm to see if any change is needed for various music style;
- If it needs to change the music style, then go back to item (2); if not, then go to the end.

The flow chart of the experiment procedure is as shown in Figure 3.

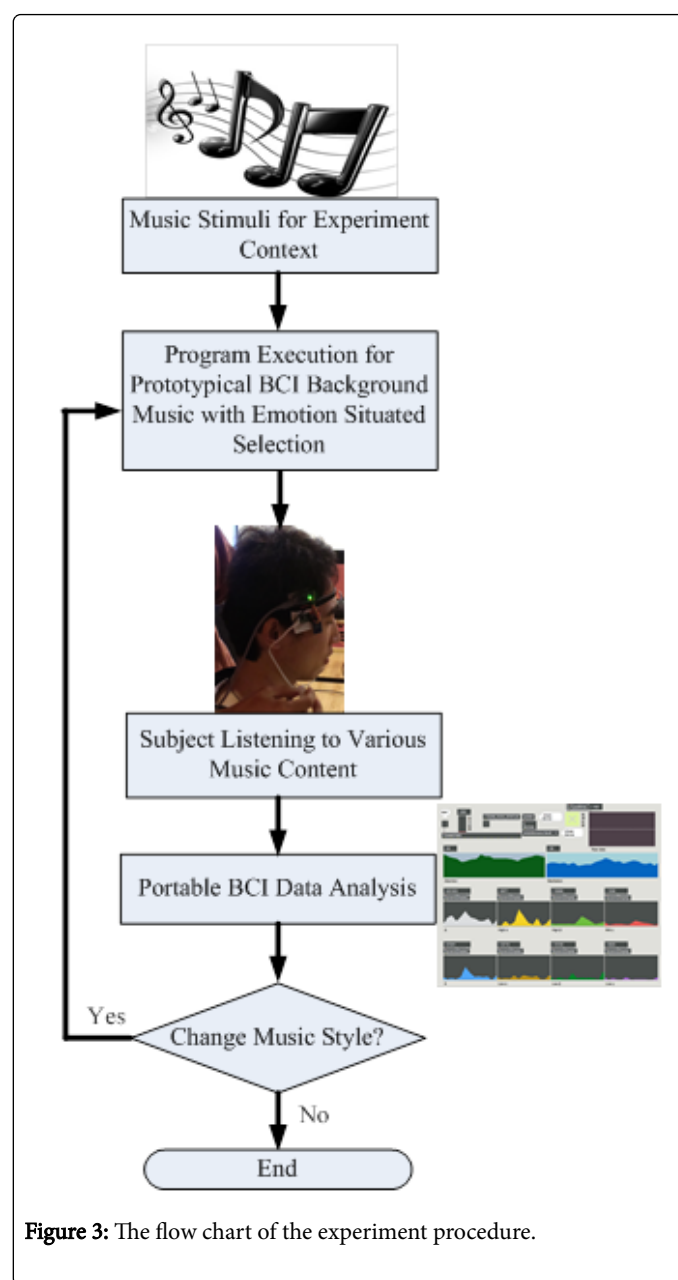


Figure 3: The flow chart of the experiment procedure.

Experiment facility

The following equipments are used for our proposed EEG/BCI music effect analysis:

Mixer: A 4-channel analog mixer for sound system

Speakers: A set of stereo speakers with amplifier

PC: Max/MSP program with PC to perform EEG/BCI data acquisition with GUI

Portable EEG/BCI: TGAM Chip with Blue Tooth 2.0 wireless communication for PC

Figure 4 shows the portable EEG/BCI music effect experiment.



Figure 4: Portable EEG/BCI music effect experiment.

Result

According to the experimental result, the classical symphonic music makes subjects obtain the most significant response, including both attention and meditation levels. However after it repeats several minutes, attention level decreases, and meditation level gradually maintains into the middle level. As we know, classical music shows its contrast in harmony, rhythm, tempo, and dynamics much more significant than other music genres. The second strength of music content attention/meditation associativity is derived from the traditional Chinese confucius temple music. It may happen significantly for Chinese people. We may need non-Chinese subjects to join the experiment for this issue in the future research.

No matter which category of music, in the first minute, the subjects' EEG data vary greater than the values after one minute. After one minute later, the subject may gradually get into the "music world", therefore EEG data varies slower and smaller, but the correspondent music features, especially the music chord changes make EEG vary up and down with greater values.

Basically the music effect strength in the degree of EEG associated with both Attention and Meditation levels is as follows (from the greatest to the smallest in sequence):

Classical Symphonic Music

Pops Folk Song

Traditional Chinese Confucius Temple Music

Rock and Roll

Musician subjects show higher degree of association between the EEG attention/meditation levels and the music content than the non-musician subjects, such as the chord, rhythm, and tempo changes.

Conclusion

This proposed method and experiment to find the relation between music genres and human's attention/meditation can be basically found from the portable EEG-based BCI device. This pilot study can be used in the fields of music recommendation system, music healing, music therapy, music education, and some other fields related to medical and music interdisciplinarily. The independent levels of attention and meditation related to music features should be investigated in the future research with further analysis. The future trends of cloud computing with big data analysis with the EEG-based bio-feedback can be also adopted in the future, to fulfill the intelligent home-based system with the integration of music therapy, entertainment, and education.

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