



## ABSTRACT

*In this work the electrical activity in brain known as electroencephalogram (EEG) signal is being analyzed to study the various responses of music on the human brain activity due to different genres of musics. The effect is in the form of variation in either*

# **A** ANALYSIS RESPONSE OF EEG SIGNAL TO DIFFERENT GENRE OF MUSIC

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## INTRODUCTION

**M**usic can be defined as an art of sound in time that expresses ideas and emotions in significant forms through the elements of rhythm, melody, harmony and color. Many research studies conducted on the neurological effects of sound have shown that the human brain responds to pure tone in highly specific ways. Mostly, the themes are focused on the effect of music intensity, emotion and rhythm on the subject's state of mind. This is measured through electroencephalogram (EEG). Expectedly different quality of sound, i.e. loud or soft, high pitch or low pitch, audible or inaudible etc., will have different effects on human brain. In this work, the effect of different genre of music



*frequency or in the power of different EEG bands. An EMOTIV EPOC is being used to extract brain signal with high transfer rate as well as good SNR. This thesis focused on three types of brain waves which are theta (4-7 Hz), alpha (8-12 Hz) and beta wave (13-30 Hz). The analysis is carried out using Power Spectral density (PSD), transfer function and difference equation. The outcome of this research depicted that high amplitude Alpha and low amplitude Beta wave and low amplitude Alpha and high amplitude Beta wave is associated with melody and rock music respectively meanwhile theta has no effect. High power of alpha waves and low power of beta waves that obtained during low levels of sound (Melody) indicate that subjects were in relaxed state. When subjects exposed to high level of sound (Rock), beta waves power increased indicating subjects in disturbed state. Meanwhile, the decrease of alpha wave magnitude showed that subjects in tense. Thus the subject's executional attention level is determined by analyzing the different components of EEG signal.*

**Key words:** EEG signal, Alpha wave, EMOTIV EPOC, Beta wave

on a candidate's state of mind is studied using different EEG signal given that the human brain produces different electrical activity due to the different genre of music.

In some situations, music is quite essential to human well-being. It is known to have therapeutic effect in the management of pain and some types of mental disorderliness. However, for some people music is a companion and an antidepressant. Sleep and mental health go hand in hand, with different psychiatric disorders associated with sleep (Scott, Webb, & Rowse, 2017). Some psychiatric disorders associated with sleep disorderliness include



Major Depressive Disorder, Bipolar Disorder, Generalized Anxiety Disorder, Post-Traumatic Stress Disorder.

People who do not have psychiatric illness but suffer from insomnia are more likely to develop a disorder like depression later in their life (Sleep and Psychiatric Disorders, 2019). Difficulties with sleep can make psychiatric disorders worse by making the person confused or frustrated, as well as more sensitive to pain and other medical problems.

The emerging view is that relationships of psychiatric disorders with sleep are complex and marked by bi-directional causality. For example, the longstanding view that treating some psychiatric conditions improves sleep is complemented by recent evidence suggesting that treating sleep disturbances can have important effects on the outcome of managing psychiatric conditions. Further, contrary to the prevailing view, some sleep disorders increase the risks of developing episodes of psychiatric disorders (Andrew D. Krystal, 2012).

### **Related Work**

The Renaissance period (1450-1600) brought about the classification of the texture of music into soprano, alto, tenor, and bass voice. Instrumental music continued to be of secondary importance to composers, whose approach to writing for instruments was usually the same as that for voices.

Nigeria has been blessed with a few well trained organist-composers since the arrival of Christianity around the 1840s. The schools built by European missionaries and the colonial administration had a great impact on the emergence of the 'Nigerian organ school.' The incentive to become professional organist-composers was further propelled and inspired through the private lessons given to talented Nigerian church musicians at an early age. The musicians had their formative



periods at the mission schools, church choirs, and under organ playing apprenticeships (Sadoh, 2004).

Prior to the arrival of European missionaries in the middle of the nineteenth century, Nigerian music was predominantly a religious or a social event. The concept of music as a purely contemplative tradition was not general. Although there were examples of traditional musical performances which took place outside specific social or religious contexts, music was regarded as an integral part of social or ritual events. An example, of this is the Igbo Ofala (yam eating festival) music which can only be understood by relating the music to the extra-musical context of the Ofala festival. (Bando H, 2001.)

Since musical practices in traditional Nigerian Society are strongly tied to religious, social and political activities, the introduction of Christianity and European culture to Nigeria was bound to have a significant impact on Nigerian musical culture. In the mid-19th century, the Anglican Church established several Churches around the country which employed congregational hymns in worship. The hymns became popular musical themes in Nigerian society especially when Priest Josiah Ransome-Kuti (Grandfather of Fela Kuti) began to compose hymns in Yoruba language. He was invited to London in 1922 to record an album because of the popularity. (Carroll J, 2015)

Two streams of popular music, based on social status, existed at this time. Choral Music and Classical music became the favourite of wealthy, educated Nigerians in the late 19th and early 20th century. For the less wealthy, traditional music remained favourite. This changed with the advent of Brass Bands. Originally of the colonial police and army, they gained cross-over appeal when they adapted traditional tunes, exposing them to a larger audience. Civilian Brass Bands were soon formed, the most popular was the Calabar Brass Band (aka Lagos Mozart Orchestra).



## **Music Therapy**

Music therapy is a developing aspect of medicine which uses medicine to treat certain ailments. This includes to lower blood pressure, make the body calm and lessens pain. Music has also been said to augment cognitive skills and enhance creativity reasoning. Studies have shown impressively over the past 15 years that rhythmic entrainment of motor function can actively facilitate the recovery of movement in patients with stroke, Parkinson disease, cerebral palsy, or traumatic brain injury. There is strong physiological evidence that rhythmic sounds act as sensory timers, entraining brain mechanisms that control the timing, sequencing, and coordination of movement. Recovery of speech functions can also be facilitated with music (Thaut, 2005).

Sound waves are heard and pronounced in different ways, and this has an impact on the behaviour of the neurological system. The auditory, frontal and motor cortex are some of the different cortical structures involved in the processing of this information. Several frontal regions are known to be involved in music processing, such as the motor and premotor cortex in rhythm processing, and the middle frontal gyrus in musical mode and time processing. In general, the medial prefrontal cortex is strongly associated with emotional processing (Gomes *et al.* 2017).

Patricia Gomes et al studied the effect of the brain wave to different music to elicit different sets of emotions. This was seen in the brain electrical activity. To do this, a list of four songs were selected specifically to elicit joy, sadness, fear and anger. These was tested on a group of people between the ages 18 and 25 years. It was noticed that Music 1 induced joy because it presents relatively fast pacing and dance rhythm, without great jumps in melody. Music 2 selection for sadness was made due to its very slow tempo characteristics, minor



harmonies and a constancy in the melodic and dynamic scope. Music 3 was selected for fear and Music 4, which was selected to induce anger, exhibit faster time with speed ups, harmonious or dissonant chords, rapid changes in dynamics, and great melodic contrasts, many of which are sudden and unexpected (Gomes *et al.* 2017).

Another study was carried out on the music genre preference and tempo alter alpha and beta waves in humans (Hurless, et al., 2013). This was done by monitoring the electrical impulses of the brain with electroencephalograph (EEG) and event related potential (ERP), and analyzed with Fast Fourier Transform (FFT). Two genres were used (rock and jazz) and three tempos were examined (slowed, medium/normal, quickened). It was observed that when participant listened to their preferred genre of music, the alpha wave increased. These alpha waves were not significantly affected by tempo. Beta waves, on the other hand, increased in amplitude significantly when the tempo was increased. This study indicates that genre preference and artificially modified tempo do affect alpha and beta wave activation in non-musicians listening to music.

Based on the frequency ranges, brainwaves are classified into five categories:

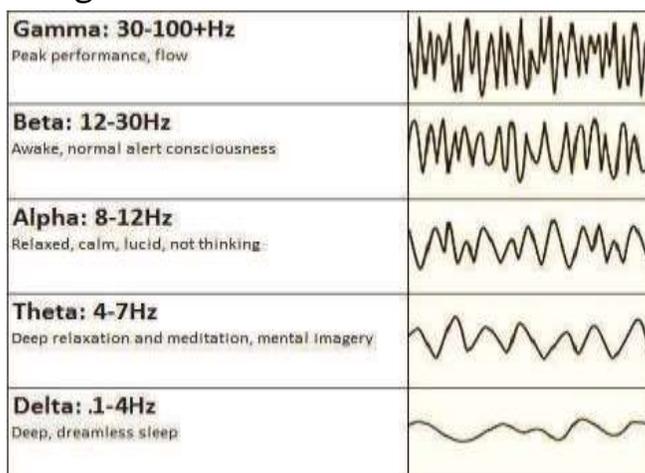


Fig. 1. The waveform of brainwaves (C. Tallon *et al.*, 1999)



## Propose Methods

In this study, MATLAB was used to develop the transfer function between the EEG features corresponding to the difference equation in discrete and continuous form. EEGLAB (v4.x) is an interactive MATLAB toolbox for processing continuous and event-related EEG data using independent component analysis (ICA), time/frequency analysis, and other methods including artifact rejection.

The EMOTIV EPOC is placed on head the subjects and electrical activity of the brain were recorded to the computer through an EMOTIV PRO software.

Subjects were made to sit down on a comfortable chair in a dimmed Computation Laboratory of University of Lagos at a distance of 100cm from the monitor. They were asked to close their eyes for 30 seconds in order to take baseline readings before actual recording commenced and lasted for five minutes. All musical excerpts were delivered from YouTube through a HP Laptop using a Wireless Bluetooth Speaker S9 with a sound pressure level of 60DB.

The recordings were stopped after each genre of music to allow the subject for stretching and repositioning.

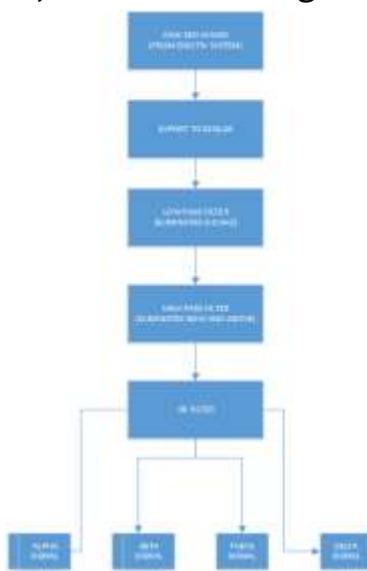


Fig 2: A block diagram showing steps of preprocessing of EEG signals

## Experiment 1

Experiment was designed to record proper EEG data while subjects are listening to the music from the musical dataset, 2 candidates, participated in the experiment. one of the participated candidates was a male and one was a female.



Before the experiment informed consent was presented to candidates and experiment was explained. The subjects were informed to sit in a comfortable position, keep their eyes closed and not to move during the experiment. EMOTIV device was placed on the forehead of the subjects and contact quality was 78%-85%.

Subjects was presented to listen to eight music excerpts as the first five minutes of the selected songs were presented.

### ***Experiment 2***

Experiment was designed to record varieties of EEG data for candidates that are about going to bed and listening to music from the musical dataset, 4 candidates, participated in the experiment. Two of the participated candidates were males and two also were females

Before the experiment informed consent will be presented candidates and experiment will be explained. The subjects will be informed to sit in a comfortable position, keep their eyes closed and not to move during the experiment. EMOTIV device will be placed on the forehead of the subjects and guaranteed that all of the electrodes were working properly.

Subjects will be presented to listen eight music excerpts as the first two minutes of the selected songs were presented. Firstly, three excerpts from common songs dataset will be presented in the order of the genre of music. Timeline of the presentation will be tabulated. Secondly, three excerpts from the songs they had chosen will be presented in the order of the genre of music

### **Experiments and Results**

The following results are from the experiments run on the two candidates, listening to 8 genres of music. The results from the 5 channels of the emotiv were obtained but since the channels of



interest are channels 8, 9, 10, 11, 12. Only results obtained from the listed channels are presented below

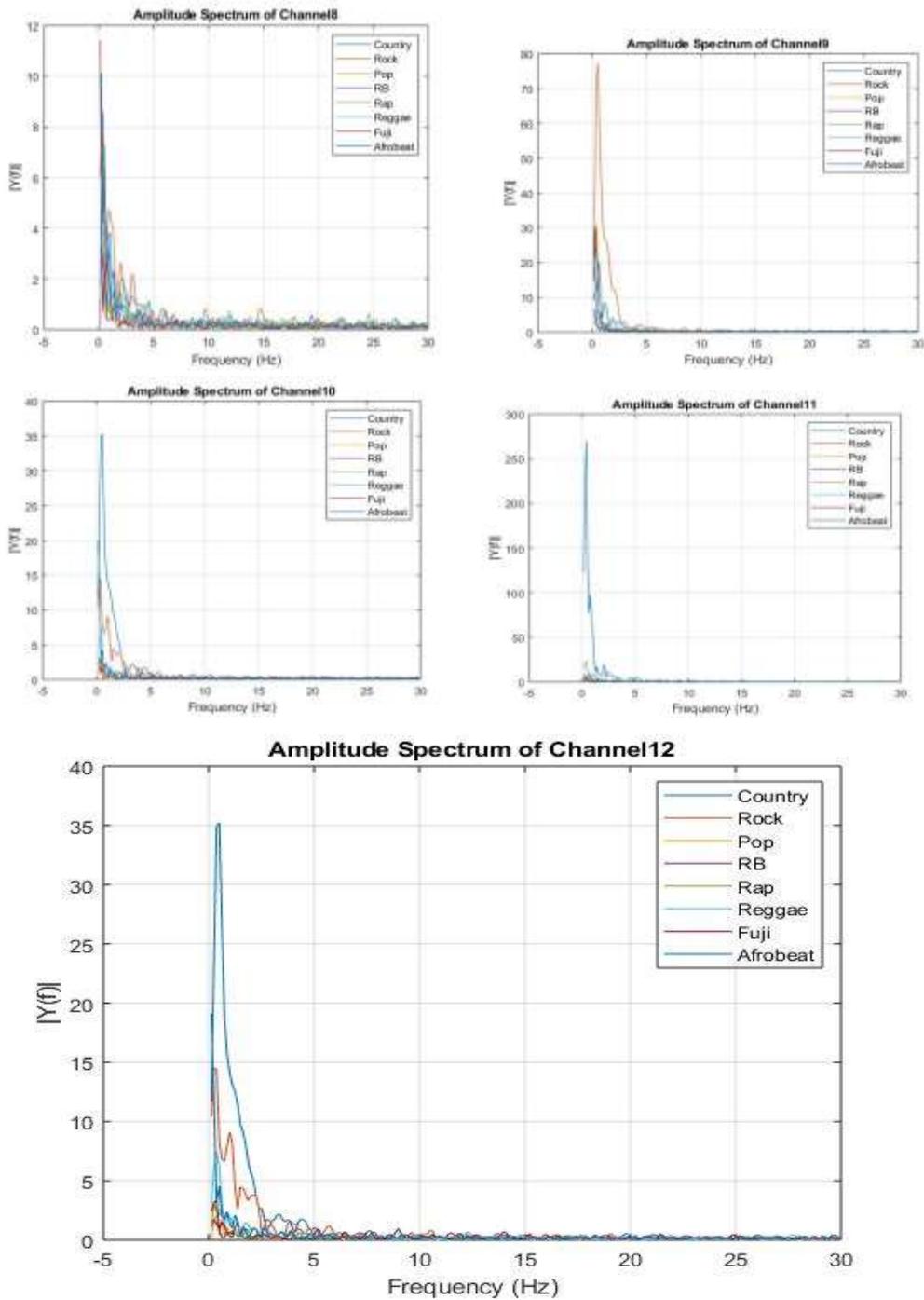


Fig. 3a-d. amplitude spectrum of Channels



## EEG signal that is sleeping with or without different genre of music

The following results are from the experiments run on the two candidates, listening to 8 genres of music when about going to bed. The results from the 5 channels of the emotiv were obtained but since the channels of interest are channels 8, 9, 10, 11, 12. Only results obtained from the listed channels are presented below

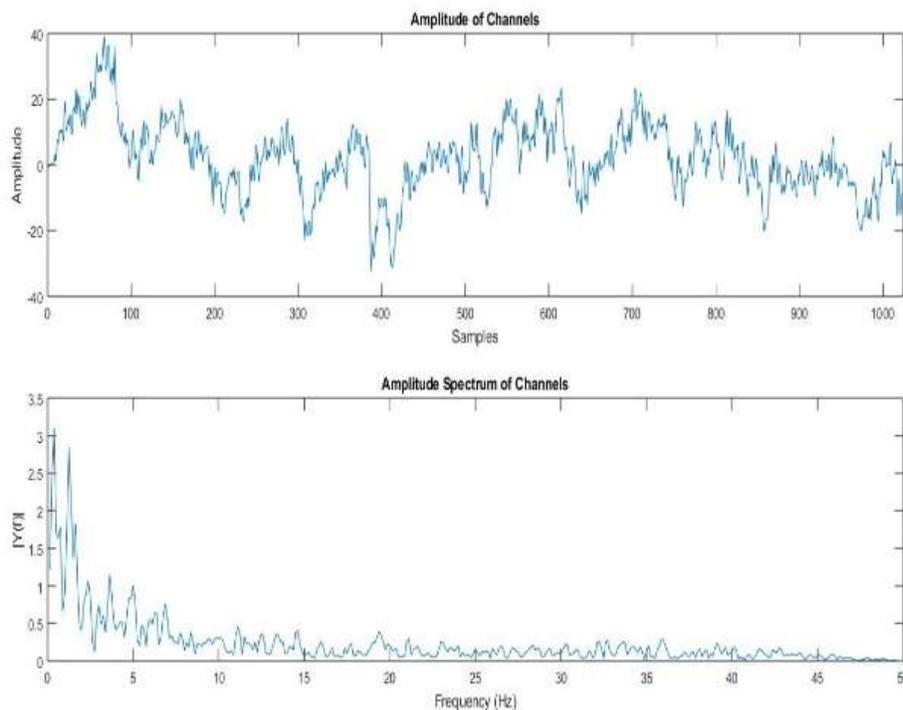


Fig. 4. Graph of the Base line

### Conclusions

Our research, which conducts an empirical analysis using EEG is an effective study on the different music genre will provide a strong knowledge base to design better stress therapy methods using music. Powerful EEG signal acquisition protocols for different music genre and well-structured algorithms for EEG signal analysis is the basis for this.



It is noted in our results that Rock music takes preeminence when awake. R and B can be seen as the optimum genre of music that induces sleep in a person.

## References

- Andrew D. Krystal, M. M. (2012). PSYCHIATRIC DISORDERS AND SLEEP. *National Institute of health Neurol clin*, 30(4), 1389-1413.
- Bando, H. (2001). MUSIC THERAPY AND INTERNAL MEDICINE. *Asian Medical Journal*, 44(1), 30-35.
- C. Tallon-Baudry and O. Bertrand, "Oscillatory gamma activity in humans and its role in object representation," *Trends in Cognitive Sciences*, pp. 151-162, 1999.
- Carroll, J. (2015). Pinker, Dickens, and the functions of literature. *Philosophy and Literature*, 63-68.
- Gomes, P., Pereira, T., & Conde, J. (2017). Musical emotions in the brain-a neurophysiological study. *Neurophysiol Res*, 1(1), 12-20.
- Hurless, N., Mekic, A., Peña, S., Humphries, E., Gentry, H., & Nichols, D. (2013). Music genre preference and tempo alter alpha and beta waves in human non-musicians. *Impulse: The Premier Undergraduate Neuroscience Journal*, 1-11
- Sadoh, G. S. (2004). *THE ORGAN WORKS OF FELA SOWANDE: A NIGERIAN ORGANIST-COMPOSER*. Louisiana: Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College.
- Scott, A. J., Webb, T., & Rowse, G. (2017). Does improving sleep lead to better mental health? A protocol for a meta-analytic review of randomised controlled trials. *BMJ Open*, 016873, 7.
- Sleep and Psychiatric Disorders*. (2019, Feb 23). Retrieved from WebMD: <https://www.webmd.com/sleep-disorders/guide/psychiatric-disorders>
- Thaut, M. H. (2005). The Future of Music in Therapy and Medicine. *ANNALS NEW YORK ACADEMY OF SCIENCES*, 1060, 303-308.