EEG IMAGING APPLICATION ON POSITIVE EMOTION OF AFFECTIVE NEUROSCIENCE

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ABSTRACT: This research paper explored the brain electrical activities of human positive emotions through Electroencephalography (EEG) device. Modern day EEG device has made it possible to record and analyze the electrophysiological pattern of the brainwaves. Brain reactions to certain situation and environment affect human physical body and produce physiological or emotions effects. However, the correlation of human emotion and its electrophysiological is still poorly understood. Although many scientific research has been carried out, it is still remain a big challenge as the physiology and psychology of human and living being cannot be quantify directly. The previous study investigated the positive emotion of the affective neuroscience. Despite being important for many functioning in humans, it is far less researched compared to negative emotions. This study elaborates its findings by investigating the relation between positive emotion with EEG frequency and its cognitive relation to the brain lobes. Human subjects participated for this experiment and were assigned to watch several stimulus videos while wearing the Emotiv Epoch to record their brainwaves. The results show that different positive emotions generate different spatial patterns. The spatial patterns and frequency bands for joy, inspiration and serenity particularly shows distinguishable difference compared to other positive emotions.

KEYWORDS: *Positive Emotions; Physiology; EEG Signal*

1.0 INTRODUCTION

The study of emotion of affective neuroscience is growing multidisciplinary field that links electronics, psychology and cognitive science in order to analyze the real emotional state of the human being through its correlation with the brain activity using EEG. There are two main areas of the brain correlated with the emotional state of humans which is the amygdala and the pre -frontal cortex. In spite of the fact that there is no agreement about a conceivable lateralization of the amygdala, its activation is more correlated with negative feelings than positive [1]. Through research, it is found that human emotions and personality have a strong involvement in the frontal lobe [2]. However, there remain gaps in the level of methodological knowledge between mapping the brain electrical connectivity and human psychological emotions. Therefore, the aims of this study are to identify the differences of frequency band when the subject is given with difference stimuli and to analyze the EEG frequency of positive emotion and its cognitive relation in the brain lobes via brain mapping.

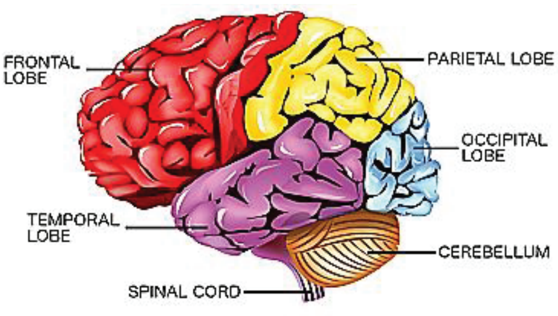


Figure 1: The overview of the brain lobe [3]

Figure 1 shows the overview of the brain lobe. The frontal lobe is located at the front of the brain and it is responsible for logical thinking, expressive language, higher level cognition, and motor skills [3-6]. The majority of the cerebrum's dopamine-sensitive neurons are located in the frontal lobe. Dopamine is a cerebrum chemical that helps bolster emotions of reward and motivation.

Electroencephalography (EEG) is the non-invasive medical imaging method that reads electrical activity produced from the brain nerves system through the scalp. From the ionic current flows between the neurons in the brain, the EEG can measure the signal in form of voltage [7-9]. The classifications of the brainwaves are as shown in Table 1 [10-11].

Table 1: Classification of brainwaves

Brainwaves Type	Frequency	Description
Gamma	>27 Hz	Still not entirely understood
Beta	12-30 Hz	Concentration, Beware
Alpha	8-12 Hz	Relaxation, Encouraged
Theta	4-8 Hz	Deep relaxation
Delta	0.5-3Hz	Sleep very well, deep meditation

Positive emotion is describe as any feeling that lack negativity, discomfort, or pain. There are ten common positive emotions; awe, serenity, joy, gratitude, inspirational, amusement, hope, pride, love, and interest [12-15]. There are fewer positive emotions and they tend to be less distinguishable from negative emotions as positive emotions have similar facial patterns, subtle or no autonomic response, and remembering them is often undifferentiated as it is hard for humans to remember if they are content or joyful compared to negative emotions [5].

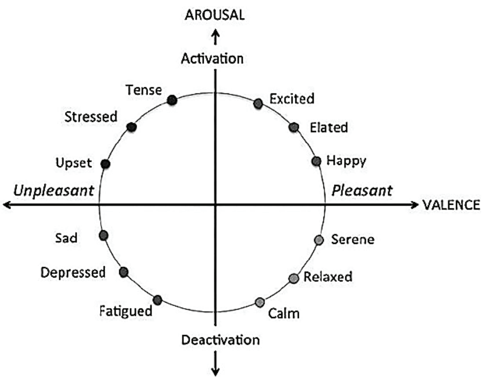


Figure 2: Psychophysiological emotional map based on valence [18]

However, positive emotions can be differentiated and measured according to the brain waves of humans when they are experiencing the emotion using the psychophysiological emotional map based on valence and arousal of the brain [16-17]. Brain processes valance and arousal differently. Valance codes emotional events as positive or negative while arousal inspires a fight-or-flight response, that, evolutionary, boost our survival. High arousal is associated with excitement or agitation, while low arousal is associated with the calming and soothing. High valance is associated with positive emotion and vice versa. The location of the brain activation during this emotion can be observed referring to the psychophysiological emotional map as shown in Figure 2.

2.0 METHODOLOGY

2.1 Subject

Four people have participated as subjects. The subjects are between the ages of 23 to 24 and consist of both female and male. They are all free from any medication and diseases.

2.2 Hardware

In this experiment, the Emotiv EPOC with 16 electrodes is placed on the subject's head as shown in Figure 3. It consists of 14 channel electrodes that record the data from the brainwave and 2 reference electrodes. This device is used to record the raw data during the experiment session.

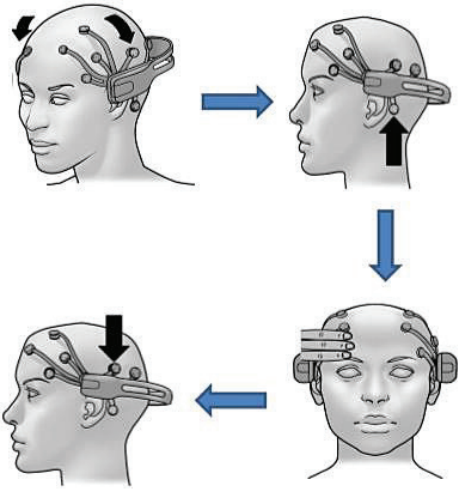


Figure 3: Applying the emotiv on subject's head [18]

2.3 Data Acquisition

The experiment was conducted inside a closed room. Several videos were displayed on a monitor for 8 seconds per video. Each video was taken from online YouTube video to represent the different positive emotions in order to record different spatial patterns for each one. The positive emotions represented from the videos are joy (Figure 4), inspirational (Figure 5) and serenity (Figure 6). While Figure 7 represented as negative emotion that works as a benchmark to differentiate the brain activation lobe between positive and negative emotion of the subjects.

Figure 4: Video for joy [19]

Figure 5: Video for inspirational [20]

Figure 6: Video for serenity [21]

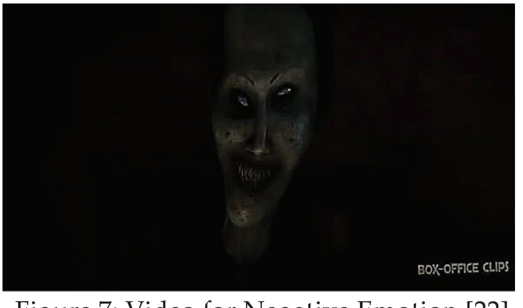


Figure 7: Video for Negative Emotion [22]

2.4 Data Analysis

After record the subjects brainwaves, the raw data of the brainwaves are obtain using the Emotiv testbench and saved in .pdf format. The EEGLAB toolbox in MATLAB software is used to extract the data. The data are then analyzed to get the channels spectra and maps where the spatial patterns of the EEG spectral power in different frequency bands during experiment are obtained. The raw data signal was computed using FFT power spectral density (PSD) [23-25] which is the common applied for EEG data analysis.

3.0 RESULTS AND DISCUSSION

The brainwave data in this research is illustrated using brain heat map and channel spectra. The graph represents the power spectrum density against frequency of each channel as shown in Figure 8. The frontal part of the lobe is associated with emotion and the right part of the frontal lobe is associated with positive emotion. Hence the electrodes used for this experiment are the frontal electrodes (F7, FC5, F3, AF3, AF4, F4, F8 and FC6). The frequency bands of emotion can be observed using theta until beta (4~25 Hz). In the Figure 8, the right hemisphere was the most concentrated with activity during watching the joy. The highest power spectrum of frequency band is 8~12 Hz depicted in alpha band.

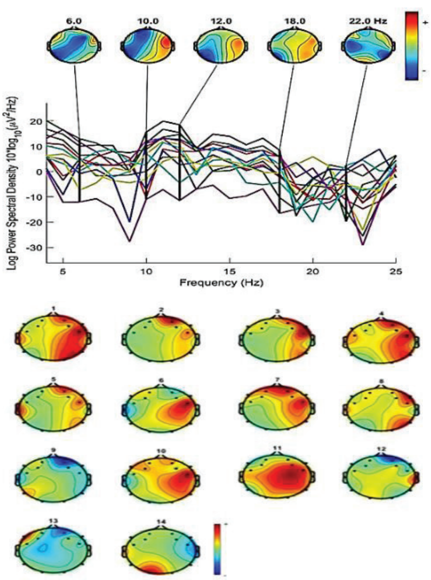


Figure 8: Channel spectra and 2-D activation map of joy

The research continues with the inspirational video of the inspirational that can be observed in Figure 9 that the right hemisphere of the frontal lobe is activated and the frequency band of the activation is around 12~25 Hz represented by beta wave.

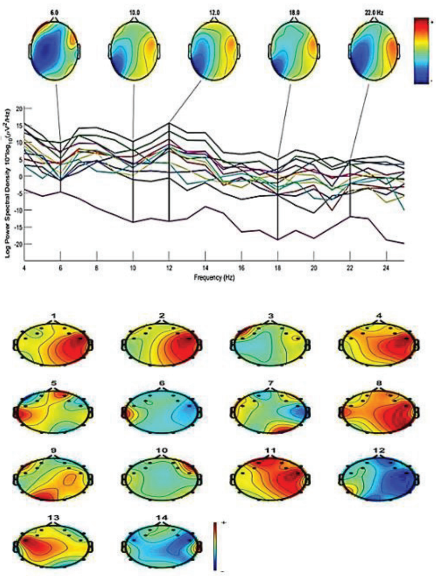


Figure 9: Channel spectra and 2-D activation map of inspirational stimulus

Meanwhile, in Figure 10, the serenity brain activation shows the right hemisphere of the brain indicates the positive emotion and very low value which confirmed that the subject is calm according to the psychophysiological emotional map (valence and arousal of the brain). The frequency of the serenity in the range of 4~8 Hz occurred in theta wave.

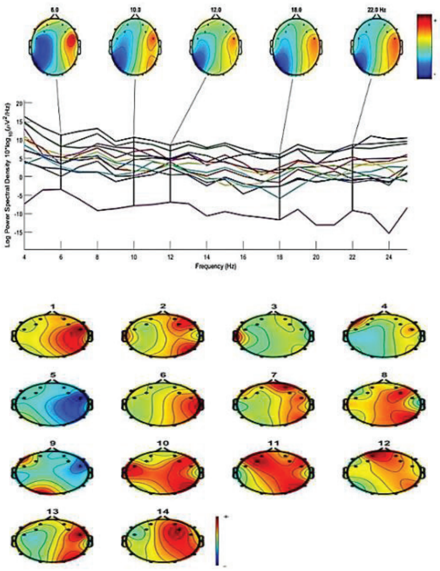


Figure 10: Channel Spectra and 2-D activation map of serenity stimulus

Negative emotion is observed during fear that the brain activation is on the left hemisphere as shown in Figure 11. The negative emotion and its frequency band in the range of 12~30 Hz (beta wave).

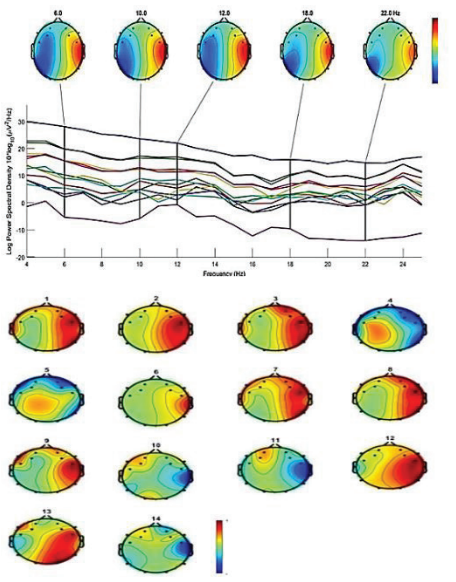
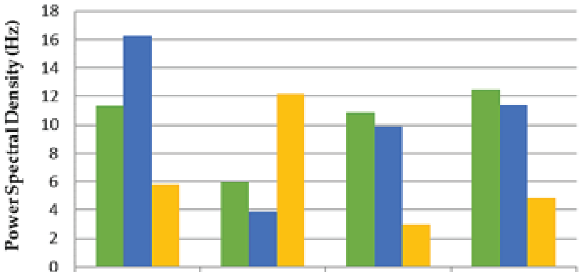


Figure 11: Channel spectra and 2-D activation map negative emotion stimulus

Figure 12 shows the frequency band against the power spectral density of the entire stimulus. It can be seen clearly that the power spectral density showed some differences with the stimulus. The difference showed the range of frequency from 14~24 Hz occurred in Beta wave. The brain activation of all subjects is dominant in alpha wave depicted that the brain was in a deep relaxation state during the experiments. The results from the graphs are different between the channel spectra and maps because these results are the average of all subjects.



	Joy	Negative Emotion	Inspirational	Serenity
Theta	11.32768355	5.997982905	10.82952486	12.44823675
Alpha	16.23592307	3.862562239	9.906919198	11.40504538
Beta	5.804624791	12.18549606	2.981536551	4.839404934

Figure 12: The average data in theta, alpha and beta waves

4.0 CONCLUSION

This research showed the difference of the positive emotions through the frequency and the power spectrum of brain activation. Differences in the brainwaves particularly alpha waves and asymmetry between the brain's hemispheres are associated with emotions. According to the valence and arousal dimension of the emotional map, a relative right activation indicated that the person is experiencing with the positive emotions like happiness, serenity and relaxation while a relatively left activation is associated with negative emotions such as stress, tense, sadness and depression. Further research on emotion and affective neuroscience will allow researchers to have greater understanding of human attitude and personality that is affected by their emotion. In addition, EEG research on affective neuroscience may also positively contribute to the electrophysiology industries as a commercial device in understanding human behavior such as emotion engineering and emotion intelligence.

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