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Changes in Asymmetry of Brain Wave Rhythms during Different Emotions

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Abstract: The electrical activity of brain obtained in form of electroencephalographic signals are significant in describing different parts of brain. These electrical activities may alter during different state of emotions. This article deals with the changes in asymmetry and various brain rhythms like alpha, beta and theta during distinguished states of emotions. The study reveals that for happy emotion the asymmetry index comes out to be higher or more positive as compared to that of sad ones.

1. Introduction

Human brain is the most sophisticated organ. It comprises of billions of neuron cells which get activated when the subject undergoes different states of emotions. The pilot study revolves around observing the changes in brain wave rhythms during happy and sad emotions. Previous researches have suggested that emotional states are closely related with physiological electroencephalographic signals [1-2]. The electroencephalographic signals are acquired from the scalp of the individual by biopac system MP150. The electrodes is placed in accordance to the international 10-20 system [3]. The study focusses on observing the effects on various parameters of EEG while the subject is made to go through two different states of emotions- happy and sad. The aim is to compute the asymmetry index. This pilot study shall be concentrating on testing this parameter of healthy engineering students. Also, the previous researches carried out shall be verified along with some new outcomes.

1.1 Literature Survey

Electroencephalographic signals are significantly affected by distinguished stated of emotions of a human being.

Panagiotis C. Petrantonakisused frontal brain asymmetry for recognizing emotions. Asymmetry index was computed to in order to evaluate the asymmetry. This approach was applied on three channels of EEG for emotion recognition [1].

Irene Winkler et. al. considered the asymmetry index. The researchers studied the problem of classifying the EEG signals utilizing the "frontal EEG asymmetry" phenomenon. This was done while presenting pictures to the subjects related to different emotions. It was suspected that brain activity is related to emotions. Also, left frontal activity indicates a positive or approach-related emotion, whereas higher right frontal activity indicates a negative or withdrawal-related emotion. The degree of activation is concluded from the spectral power in the alpha band, with lower values in alpha power being associated with a higher degree of activity. Alpha asymmetry indices were then computed by subtracting the natural logarithm of left-sided alpha power from the natural logarithm of right-sided alpha power (Asymmetry Index = ln[right alpha] - ln[left alpha]). Assuming an inverse relationship between alpha power and cortical activation, a more positive asymmetry index reflects a greater relative left hemispheric activity [2].

Ian H. Gotlib, CharanRanganath and J. Peter Rosenfeld made their research on physiological activities in the prefrontal region of brain to relate depression and cognitive functioning. They evaluated the asymmetry in prefrontal region using power in the alpha band. According to the research, left frontal hypo activation is related to depression [4].

1.2 Problem Definition

According to the previous researchers, there is a strong correlation between brain waves and emotional state of a being. Keeping their work under consideration, the pilot study aims at verifying what has been proved previously. The present research takes healthy engineering students into account to verify the changes in EEG rhythms during tasks involving two different emotions, that are, happy and sad. For this purpose, asymmetry indices of each subject are calculated, hence their effects are studied.

1.3 Hypothesis

As per the literature survey done, it has been assumed that the left frontal activity indicates a positive or approach-related emotion, whereas higher right frontal activity indicates a negative or withdrawal-related emotion. Also, a more positive asymmetry index reflects a greater relative left hemispheric activity hence giving rise to positive emotions.

1.4 Proposed Method

Any cognitive enhancement technique involves application of suitable intervention. Pre and post-intervention cognitive assessment is made to confirm the cognitive enhancement achieved, if any. The protocol proposed for this research involves the following:

(a) Selection of Participants

10 healthy engineering students contributed in the study. All the participants shall be engineering students from undergraduate or postgraduate level**.** Before the experiment, all participants shall be given a detailed, written summary of the experimental procedures. None of the participants shall have any neurological or psychiatric disorders or previous head injury that might affect the experiment. It shall be confirmed that all subjects had normal or corrected normal vision and normal hearing. All experiments shall be conducted in the Laboratory of Thapar University.

(b) Preparation of participant for EEG

Participants shall sit on a comfortable armchair in the front of monitor. They shall be explained about complete procedure, that is, hardware (EEG system), data acquisition, and all the tests to be carried out, as a result of which subject shall become familiar with the experiment. The scalp of subject shall be prepared by light abrasion to remove dead cells.

(c) Baseline data acquisition

The EEG data as the baseline shall be taken by making the subject seated calmly for 2 minutes with eyes opened and no movements in the body. EEG data is recorded using BIOPAC MP150 system having 10 channels. The electrodes are placed according to international 10-20 system. EEG data is acquired while the person watches the videos during pre and post-intervention procedures. The sampling rate at which data is acquired is 500 Hz.

(d) Statistical analysis of data

Statistical analysis of data shall be done using one tail paired type t-test. The t-Test shall be used to test the null hypothesis that the means of two populations are equal. For testing statistical significance of data either one tailed or two-tail test shall be computed. Depending on whether one trend is considered in extreme or both trends are considered equally likely one tail or two tail test shall be considered respectively. Type of t-Test, that is, whether it is type one, type two or type three shall depend on whether data is paired, homoscedastic or unequal respectively. It shall return the value of “p” i.e. probability associated with the t-Test.

(e) Signal Processing and feature extraction

The pre and post data required shall be analysed and then compared to observe the changes due to training. The raw data acquired shall be filtered initially. The frequency range shall be selected between 0.5 to 30 Hz as this covers almost whole range of an EEG signal. This shall be followed by Independent Component Analysis (ICA) of the signal. ICA shall be used for finding underlying factors or components from multivariate (multi-dimensional) statistical data [5-6].The eye artifacts and muscle artifacts shall be removed from the resulting signal. This procedure shall be carried out using EEGLAB toolbox [7]. The final data thus obtained shall be analysed using frequency analysis. This frequency analysis shall be done using Wavelet transform [8]. Different ranges of EEG signal- alpha (α), beta (β), theta (θ) shall be computed by programming in MATLAB [9]. Power of all the components shall be calculated individually to compute the asymmetry index.

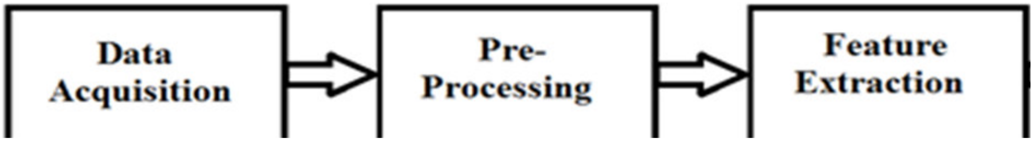

Figure 1: Flow chart for signal processing

For computing physiological results, the parameters like asymmetry index shall be computed and then compared. Alpha asymmetry indices can be computed by subtracting the natural logarithm of left-sided alpha power from the natural logarithm of right-sided alpha power (Asymmetry Index = ln[right alpha] - ln[left alpha]). A more positive asymmetry index reflects a greater relative left hemispheric activity [10-12].

2. Results and Discussion

The outcomes of the study are shown in this section.This section shows the values of asymmetry indices while the subject watches videos of different emotions. Alpha asymmetry indices can be computed by subtracting the natural logarithm of left-sided alpha power from the natural logarithm of right-sided alpha power (Asymmetry Index = ln[right alpha] - ln[left alpha]). A more positive asymmetry index reflects a greater relative left hemispheric activity.

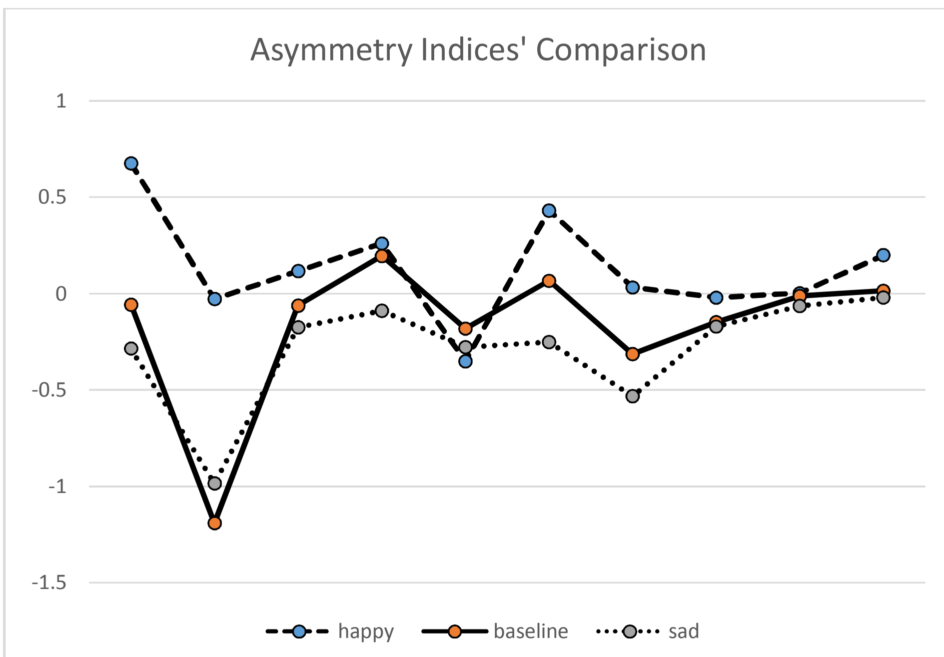

Figure 2: Comparison of asymmetry indices

From figure 2 it is inferred that for happy emotion the value of asymmetry index is more than that of baseline and sad emotion. Also, the value of sad emotion is less than that of baseline. Hence, the result is as expected. It is also computed statistically using single tailed paired t-test. Result of t-test for happy emotion is p=0.018458 and for that of sad is p=0.020359.

3. Conclusion

It can be concluded that with positive emotions energies and asymmetry indices get positive. Thus, even if an individual is indulged in any other task (except for watching videos) where these parameters increase, it can be inferred that the task gives the individual some positive emotions.Hence, it has been verified that for happy or positive emotions, asymmetry indices become more positive as compared to the sad or negative ones.

3. Proposed Work

This is a pilot study carried out on 10 subjects. In near future, it is scheduled to study the effects on around 30 subjects. Also, it is planned to provide some sort of intervention to the subjects like odor, meditation, music, etc. and pre and post interventions calculations can be made.

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