Detection and Analysis of EEG Signals Before and After Meditation

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Abstract: **Stress is associate degree inclination of ardent or physical strain. It will emerge out of any occasion or believed that causes a private to feel thwarted, irate, or anxious. Typically, the strain is positive that is simply for the well-being of an individual and alerting the soul able to avoid danger. once stress shows its presence in a very negative method, one will feel mental, physical or emotional imbalances. These days there square measure varied techniques to scale back stress – physical exertion, popping up or by alternative relaxation therapies like being attentive to music, sleeping, meditation.etc. The intake of drugs has many side effects and is followed only in extreme cases. In this proposal, meditation is considered. Meditation is one method of reducing stress without side effects. There area unit numerous strategies for determinant the strain level victimization physiological data. One such method is Electroencephalography (EEG). EEG signals are obtained and then the different components like alpha and beta signals are obtained from the brain then these signals are analyzed to verify the current mood of the person. In this proposal, the different types of EEG signals are analyzed in Brainstorm. Brainstorm is used because it provides various processing techniques for processing an EEG signal. In Brainstorm, the alpha and beta components of a stressed and relaxed brain are compared. It is observed that in a relaxed brain, amplitude of alpha waves is more and amplitude of beta waves is less when compared to amplitudes of alpha and beta waves respectively. Using the MP45 and the SS2LB electrodes, EEG signals before and after meditation is acquired. After recording the EEG signals, the alpha and beta components are obtained and observed in Biopac student lab (BSL) 4.1. In BSL 4.1, it is observed that content of alpha waves has increased and beta has decreased after meditation while compared to that before meditation. So conclusion could be made that the brain goes to the relaxed state after performing meditation.**

Keywords: **Electroencephalography, Brainstorm, MP45, Biopac student lab.**

1. Introduction

Electroencephalography (EEG) is Associate in Nursing electrophysiological checking technique to record electrical action of the mind. it's usually non -invasive, with the terminals placed on the scalp, albeit obtrusive anodes area unit currently and once more utilised, as in electrocorticography. electroencephalogram estimates voltage variances occurring due to ionic current within the neurons of the neural structure.

Clinically, electroencephalogram alludes to the account of the cerebrum's free electrical movement over some stretch of your time, as recorded from totally different cathodes attack the scalp. Analytic applications by and huge spotlight either every now and then connected potentialities or on the ghastly substance of electroencephalogram. The previous examines potential vacillations time fast to an incident, as an example, 'upgrade beginning' or 'catch press'. The last investigations the type of neural motions (prevalently referred to as "cerebrum waves") that may be seen in electroencephalogram flags within the return space.

Stress is usually recognized as a state during which a private is predicted to perform an excessive amount of beneath sheer pressure and during which he/she will solely marginally trot out the stress. These demands may be psychological or social. it's proverbial that psychosocial stress exists in way of life, that has resulted in poor quality of life by touching people's emotional behavior, job performance, mental and physical health Stress is that the body's reaction to a project or demand. In short bursts, pressure is positive, like as soon as it enables to avoid risk or meet a point in time. but as soon as strain lasts for an extended time, it need to damage the health. After you have got chronic stress, your frame remains alert, albeit there is no risk. Over time, this puts you in threat for health issues, including: High force per unit place, cardiopathy, Diabetes, Obesity, Depression, Skin issues, like inflammatory sickness or skin disorder, catamenial issues.

Meditation is that the technique of non-stop specialise in one object for a protracted quantity of your time. it is a delicate, sensitive technique that doesn't need any pressure or stress on the mind. The result you advantage out of the apply is redoubled attention and focus. Normally, mental and physical pressure motive redoubled degrees of the strain secretion hydrocortisone. This produces numerous of the dangerous consequences of pressure, just like the discharge of inflammation-selling chemicals referred to as cytokines. These results will disrupt sleep, sell despair and anxiety, boom pressure in keeping with unit location and make contributions to fatigue and cloudy thinking. In partner degree eight-week study, a meditation vogue known as "mindfulness meditation"

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reduced the infection response due to stress.

2. Tools

A. Brainstorm

Brainstorm is an open-source application which is used to analyze the brain recordings like EEG, MEG, ECoG, fNIRS. etc. Electroencephalography (EEG) measures the scalp electric potentials produced by electrical activity in neural cell assemblies and Magnetoencephalography (MEG) measures the magnetic induction outside the head. Electrical brain activity is directly measured through MEG or EEG. When compared to PET or fMRI, higher temporal resolution is obtained by EEG and MEG. The rich and intuitive graphic interface of Brainstorm is the main advantage for physicians and researchers because no programming knowledge is required for using Brainstorm. A rich interface is provided by Brainstorm to display and interact with MEG/EEG recordings. This rich interface will include several displays topographical mapping on 2D or 3D surfaces as a function of time. The interface also helps to manipulate clusters of sensors. Brainstorm dedicates a user interface to perform the decomposition of EEG or MEG sensor data in time/frequency domain. The interface also helps to perform the source time series decomposition. Brainstorm is proficiently designed to store and compute the transformed data. Analysis of the data can be done as instant measurements, or the data can be grouped into spectral bands of interest.

B. Biopac

A wide range of tools is provided by BIOPAC® to record, display, and analyze the surface EEG and implanted EEG signals from the human brain. Several hardware solutions are provided by BIOPAC®. These hardware solutions allow a person to record EEG data from single channel or up to thirty-two channels. The main components are BSL system, MP45 data acquisition system and SS2LB. The BSL system is an integrated solution. Data from various parts of the human body can be recorded by using the BSL system. BSL is not only a data recorder, but also comes with full hardware, software support along with guided lessons with step by step instructions. The main part of BSL package is the MP45 unit. An internal microprocessor is present in the MP45 unit which controls the acquisition of data and the communication of sensor with the computer. The MP45 converts the input signals into digital signals and these digital signals can be processed by the computer. There are analog input channels, and one analog channel can be used as a trigger input. The MP45 must be connected to the PC (Personal Computer). It should also be connected to the transducers, electrodes, and the input/output devices.

3. Methodology

A. EEG signal processing in Brainstorm

Brainstorm is open-source tool that has lot of features to analyze the brain waves weather it is EEG or MEG signals that are obtained. Here is the flow-chart to analyze the EEG data in brainstorm.
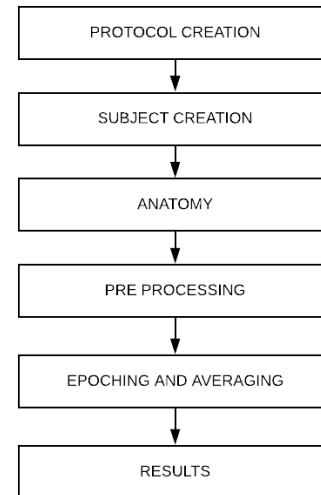

Fig. 1.

First, create a protocol and then add the subject and all its details like electrode position, anatomy of the brain etc. To estimate the power spectrum density (PSD) of the data on all the channels, the raw-data link option is dropped in Process1 and the process Power spectrum density (Welch) is selected in the frequency option. The estimates of above power spectral density will be saved in a separate file which is attached to the original data. The above PSD estimates can easily be reviewed for all the channel types in a graphical form. The data can be further analyzed by importing into Matlab. Contamination from the power line also can be removed easily with the help of notch filters which is centered at 50 Hz and its harmonics. Some extra processing like removal of eye blinks and correction of heartbeat artifacts can be done if needed when subject during recording didn't perform well during recording. We can view the time series graph from each electrode and also we can see the signals from different channels individually. Various types of filters like the band pass, band stop and notch filters are used for processing. The different operations to be performed are named as process and the processes are added to the pipeline editor.

B. Biopac Student Lab 4.1

Experimental Setup includes Turning ON Computer while MP45 is in the ready state, connecting SS2LB electrode to the Channel 1. Position the electrodes on the scalp. While positioning the electrodes certain guidelines to be followed:
1. The placement of the scalp electrodes can vary slightly and it may depend on the instructor's or Subject's preference.
2. The electrodes are kept on the head on only one side.
3. The third electrode which is the ground electrode is placed

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above the Mastoid region which is the region behind the ear.

4. The Subject should be seated and relaxed. The room should be quiet so that the subject can be relaxed.
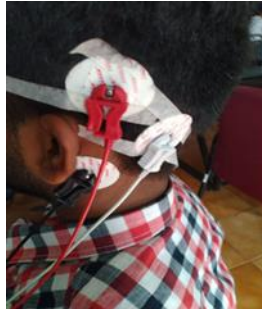

Fig. 2. Electrode placement

At first the subject brain data is recorded without performing Meditation then the subject performs Meditation for half an hour; then again the electrodes are placed as mentioned before in this chapter then data is recorded.

After the data is recorded the analysis of each obtained raw EEG data is done by clicking review raw data. There one is able to see voltage peak-peak, area, integration, calculation, etc., as per need one can analyze these EEG data using Biopac Student Lab 4.1. The Application provides user with in-built feature of dividing brain waves into Alpha, Beta, Gamma, etc. Then we get the separated signal components in the different bands with channels named CH40 to CH43. Portions of the graph can be selected by using the I-beam tool. The obtained graphs can be exported to excel sheets for further analysis.
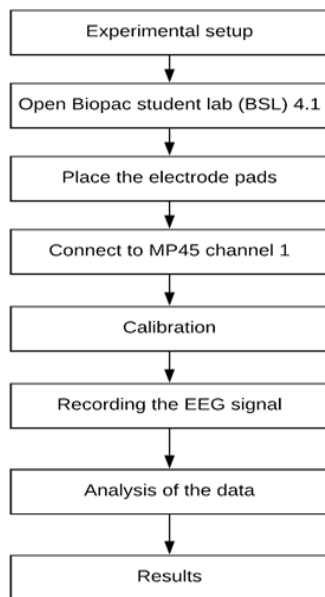

Fig. 3. Flowchart of EEG signal processing in Biopac Student Lab 4.1

The above flowchart shows the brief procedure to obtain the data using the SS2LB and MP45 Data Acquisition sensor and analyze the data in Biopac Student Lab 4.1.

4. Results and Discussion

The time series graph through different channels obtained from different electrodes is given below. The amplitude of the alpha waves increases after meditating which can be seen from figure 4 and figure 5. The amplitude of the beta waves decreases which after meditating which can be seen from figure 6 and figure 7.
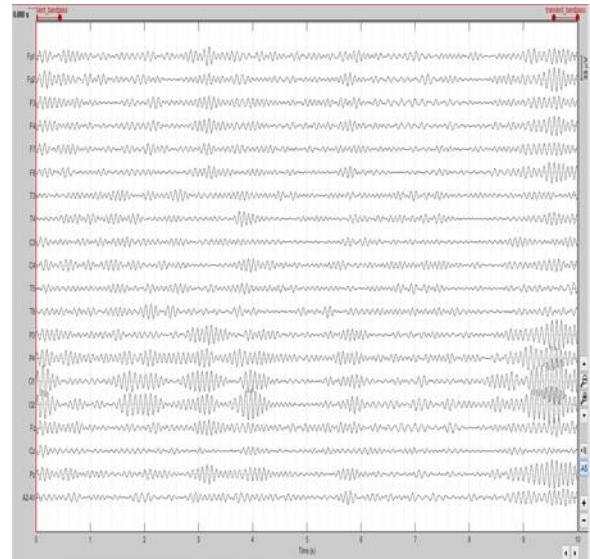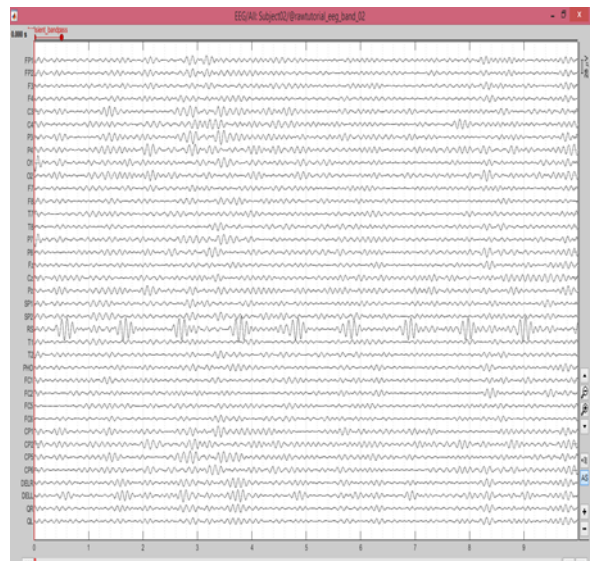

Fig. 4. Alpha waves when stressed

Fig. 5. Alpha waves when relaxed

The Real time data which is obtained from SS2LB electrodes is plotted as shown in figure 8 and figure 9. The alpha waves component of EEG signal becomes dominant after performing Yoga (Meditation) which can be observed by seeing the two figures and the comparison of the area of both the waves before and after meditating shows the dominance of alpha waves

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quantitatively. Area is considered because both positive and negative components should be added and not subtracted.
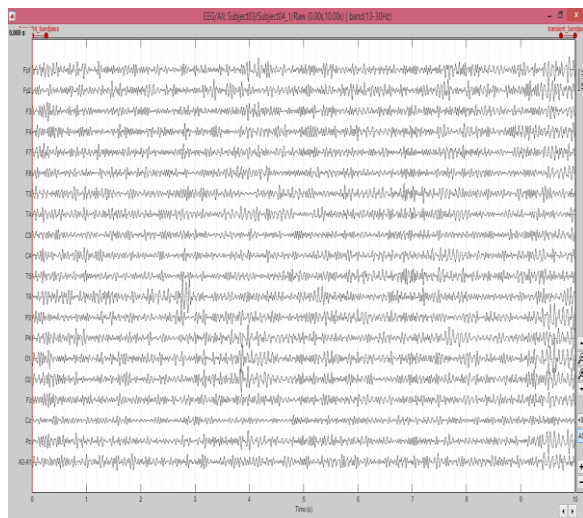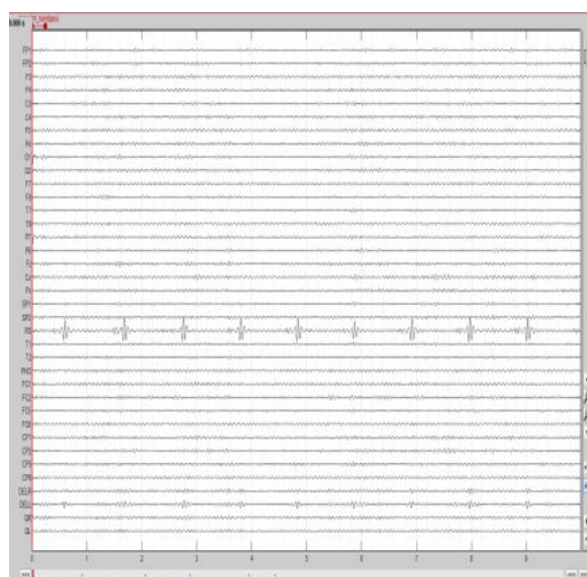

Fig. 6. Beta waves when stressed

Fig. 7. Beta waves when relaxed

Table 1
Amplitudes of the alpha and the beta waves before and after meditating

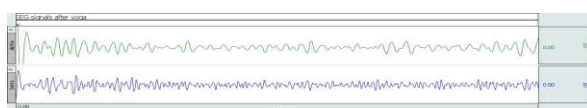| Name of the waves	Alpha waves	Beta waves
Highest amp when stressed (μV)	14	16
Highest amp when relaxed (μV)	18	12

Fig. 8. Alpha and Beta waves before yoga

Fig. 9. Alpha and Beta waves after yoga

5. Conclusion

These days' stress is one of the most important issue and there is no specific age group for experiencing stress. Around 60% of the student's experience stress due to the pressure of academics and it is irrespective of grade, age, gender or any other personal factor. Many people suffer from depression and commit suicide. So it is very important to give solution to this problem. Medication is one such solution but with it is at the cost of certain side effects. Hence other methods like Meditation and Yoga are reliable as they help to maintain our health in addition to zero side effects.

In this proposed research, the EEG signals ((brain waves) before and after performing yoga are analyzed. In Biopac student lab 4.1, it was seen that before meditation, the area of alpha wave is 2.096518 uVsecs while area of beta wave is 3.480528 uV-secs and after meditation, it was seen that the area of alpha wave was 11.885859 uV-secs while area of beta wave was 3.274762 uV-secs. So, in the given proposal, it has been proved that yoga (meditation) is a solution which affects a person's mental health with creation of certain vibrations during breathing which leads to the change in frequency of the brain waves in a positive manner.

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