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EEG Analysis of Brain Signals: A Review

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ABSTRACT: Electroencephalogram (EEG) is very useful in medical and research areas. EEG is an electrical phenomena that is companion with physiological process and it monitors the condition of the brain rather say electrical condition of the brain. The goal of my paper is to come out with a broad-gauge review about Electroencephalogram and to give an overview of how brain catalyzes a large amount of signal to be detected by EEG. We will get to know about EEG and its history. How the signals of brain are detected by this machine, EEG waveforms, EEG recording technique using electrodes, amplifiers along with filters, analog to digital converter and recording device.

Keywords: EEG, electrical activity, EEG waveform, pole-synaptic

I. INTRODUCTION

Before going into extended treatment about EEG let us first thoroughly familiar with the meaning of EEG. Electroencephalogram (EEG) examines and writes down the electrical activity of the brain and these vigorous actions are shown up as wavy lines on an EEG recording. Small, flat metal discs (electrodes) are connected to our scalp that notices the presence of electrical activities of our brain. Our brain cells convey through electrical impulses and are involved in some activity all the time, even when we are sleeping. An (EEG) electrophysiological monitoring method to record electrical behavior of the brain is known as Electroencephalography.

The history of EEG dates back to 1875. In 1875 a physician Richard Caton who was practicing in Liverpool, presented his research in the British Medical Journal. He wrote about his findings of rabbits and monkeys open cerebral hemispheres electrical phenomena. After that in 1890, a Polish physiologist Adolf Beck presented about his findings of electrical behavior of the brain of rabbit and dogs. The first animal EEG was published by Ukrainian physiologist Vladimir Vladimirovich Pravdich-Neminsky in 1912 whereas the first human EEG was recorded by German physiologist and psychiatrist Hans Berger in 1924.

EEG is done to meet out about the person’s physical or mental health problems. It not only finds about brain or nervous system related problems but it also finds about problem in spinal cord.

It watches brain activity, a medical health in which someone abruptly goes down into deep sleep while talking or engaged in some work e.g., narcolepsy. It also helps if a person is in coma and also finds out the chances of recovery. EEG also helps to diagnose epilepsy (this is the case of nervous system that that make a person faint abruptly and it also changes the person to become violent), and what type of abnormal state of fit is occurring. Less often, an EEG may be used to investigate other problems, such as a medical state that makes someone to be incapable to think in a clear manner or to understand what is real and what is not real (dementia), head injuries, brain tumors, inflammation of the brain (encephalitis) etc.

II. HOW BRAIN SIGNALS ARE DETECTED BY EEG?

Let us understand the procedure of brain signal generation. As we know that EEG scale the cumulative action or effect of electrical activity on the scalp, initially the pole-synaptic activity around the dendrites of the neuron. Neurons convey by passing an electrical signal by the processing of moving ions flowing in and out of the cell. First electrical signals are conducted from the dendrites to the cell membrane where the meet the axon hillock. Here the totality of all these charges is used by the axon hillock which is the gatekeeper of the neuron and decides whether or not the signal should be passed on to the axon terminal.

The axon hillock is the point where the totality of excitatory pole-synaptic potential and inhibitory pole-synaptic potential meet. If the totality of these potential reaches the threshold, signal passes. The neuron has the resting membrane potential of -70 mv.

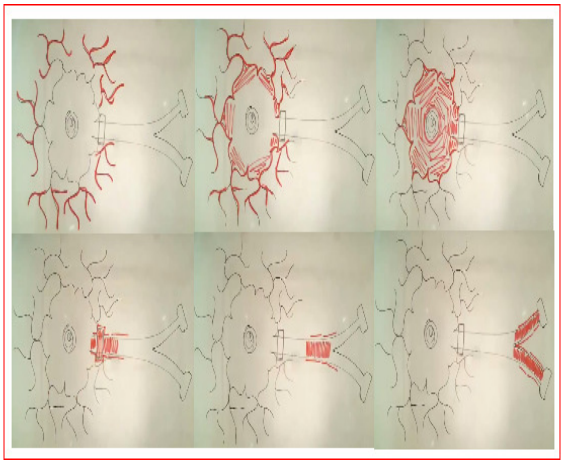

Fig. 1. Signal passing through axon hillock to axon terminal.

Voltage gated sodium channels will permit passage when the membrane capability becomes more positive or depolarize. When this occurs the sodium rushes into the cell, transmitting the depolarization down the axon. This occurrence is called an actual potential.

However the single electrical event is not big enough to be detected by EEG and action potential can cancel each other enter the pyramidal neuron. Pyramidal neurons are found in the most superficial layers of the brain and are specially aligned. Thus their activities are synchronous which produces a largest signal. It can be measured superficially from the scalp axons from neighboring neurons synapse with the pyramidal neurons.

Chemically gated ions on the pole-synaptic membrane opens in response to increase concentration of neuron transmitted that bind to the proteins. However when the depolarization began at one end of the neuron other end re-polarizes back to -70 mv. Thus creating a dipole at neuron and conducting a current.

It is important to retain in the memory that regardless whether an actual potential reaches or not, all pole-synaptic potential will contribute to the EEG signal. Every pole-synaptic signal potential causes the charge inside the neuron to change and the charge outside the neuron to change in opposition. The totality of the dipoles created by hundreds and thousands of neuron is what is detected by EEG.

To record EEG signals few types of equipment are used as EEG recording techniques:

- Electrodes with conductive media
- Amplifiers with filters
- A/D converter
- Recording device

III. EEG BRAIN WAVES

Let us get some knowledge about EEG brain signals. Brain waves are beget by the building blocks of our brain. Neuron is a key feature in brain signal production. Neurons convey knowledge of information with each other by electrical fluctuations. We can truly see these electrical transformations in the form of brain waves shown in EEG test.

Brain waves are studied in terms of cycles per sec or Hz (shortest form for that). Let us discuss about the frequencies of the brain wave activity. In the case of brain, frequency (Hz) is directly proportional to the brain activity. Various types of brain signals were investigated during 1930’s and 40 by the Researches. Myth-logically, these waves fall into four types that we will talk about later.

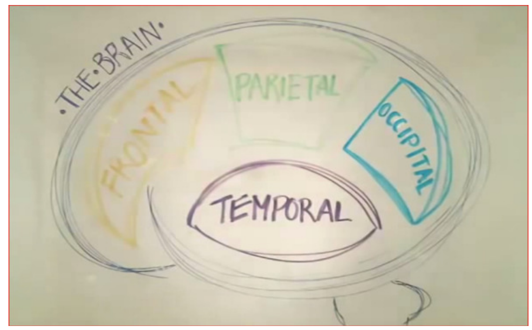

Fig. 2. Diagram of human brain.

Our human brain is an electrochemical organ with beget waves which proves that human beings never switch off their minds. Researchers have presumed that 10 watts of electrical power is generated by a fully active brain.

Before learning about brain waves let us be thoroughly familiar with arousal levels and what kinds of waves are used to show these arousal levels using examples.

Sleeping: In sleeping arousal large slow waves are seen.

Relaxing: In relaxing arousal the waves becomes faster.

Action: but in action arousal dense EEG pattern is seen and is characterized by low voltage and high frequency producing a fast wave.

An electrical fluctuation of a brain is graphed in the form of brain waves. There are four classes of brain waves as told earlier, compartmentalize from the most liveliness to the least liveliness.

- Beta (β)
- Alpha (α)
- Theta (Φ)
- Delta (δ)

-Beta (β) waves lies between 14-30 Hz. It represents arousal and has attributes of a strongly occupied mind. In beta range a person might be in functional chat. For example: a person making a conversation, or a teacher giving guidance in a class, or a talk show emcee when they are occupied in their work.

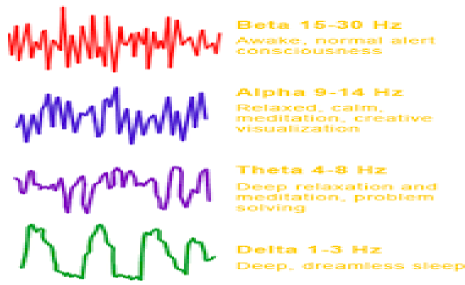

Fig. 3. Brain waves.

When a brain is in logical activities, it begets beta waves. These beta waves consist of relatively low amplitude and are fastest of the remaining. Or we can say that in beta waves amplitude and frequency are in a inversely proportional relationship.

-Alpha (α) waves ranges from 8-13 cycles per second. It describe as having a specified character of non-arousal, these are comparatively not quicker as beta waves and have larger amplitude. It happens to be found when a person is in comfort level, but watchful. During this state a person is awake but resting. An alpha state is described when a person takes relax after a tough day.

-Theta (Φ) wave ranges from 4-7 cycles per second. They are ordinarily of huge amplitude and bitty frequency. It considers sleep, deep relaxation like hypnotic relaxation and visualization. A theta brain wave state is described with a condition when a person is in a pleasant visionary imagination.

-Delta (δ) waves ranges from below 4 cycles per second and it is deliberated with the giant amplitude and crawled frequency. It occurs during sleep. Delta waves ranges below 4 Hz but it should never approach to zero Hz because that would show a lifeless brain condition. But, instance visionless sleep would reach to the lowest frequency. Gradually, 2 to 3 Hz. In this case frequency decreases and amplitude increases.

From Beta to Delta amplitude increases and frequency decreases i.e. ,

For amplitude $\beta<\alpha<\Phi<\delta$ whereas for frequency we can say that $\beta>\alpha>\Phi>\delta$.

There is also one additional wave Gamma (γ) wave which ranges from 30-50 or 60 cycles per second. Gama has the fastest frequency of brain of waves. Gama brain waves allow the brain to succeed in getting optimal interpretation; permit a person to be at their best both physically and mentally.

IV. CONCLUSION

Brain is an important part of our body. It produces some kind of electrical signals which shows the activity of our brain performing a test which is known as Electroencephalogram.

This paper described what EEG is and how the signals produced by brain are able to show the brain activities through brain graphs, types of brain waves and operations of these brain waves. Now a day's EEG is used in many areas of medical field, research areas, security system, illness, health related issues etc. So using our brain and with the help of science and technology EEG methods can be used in wide variety of areas.

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