

Wireless Physiological Monitoring Systems by using Neurofeedback-Biofeedback Systems

Prof. Abhinav V. Deshpande

Abstract— This paper presents the different methods of monitoring the physiological parameters of human body like ECG, EEG, EMG, BVP, EOG etc. in order to measure the state of human brain, heart, eyes, muscles and blood volume pulse etc. so that the correct activity of human body in terms of electrochemical activity and the corresponding body mechanism can be observed and the predictions about the current diseases which are occurring in the body or the onset of future ailments that may disrupt the life of ordinary human being can be predicted and the danger that may be caused to human being can be prevented. The different lobes of human brain are described in this research article and the various parameters of chemical activities which are occurring in different parts of the brain are described along with their standard numerical values so that the basic concepts of human physiology can be understood and the process of neurofeedback and biofeedback architecture can be understood.

Index Terms— ECG, EEG, Wireless, Physiological, EOG, EMG, Human Brain.

I. INTRODUCTION

The different electronic terms that are used in neurofeedback and biofeedback systems are given as below:

1. Amplitude:

A measure of the “strength” of an electrical signal normally measured in volts or amperes.

2. Bandwidth:

The range within the limits of a band. The width of a bandpass filter is generally taken as the limits between which its decrease in amplitude is not more than 3.0 decibels greater than its average decrease in amplitude throughout its passband. BINARY A term used to indicate a signal which has only two allowable states, (e.g, “1”=on “0”=off) having voltage levels of approximately 5 and 0 volts.

3. Bipolar:

A term which implies the use of a differential amplifier, two active electrodes and a ground electrode.

4. Filter:

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Prof. Abhinav V. Deshpande, Assistant Professor, Department of Electronics & Telecommunication Engineering, Prof. Ram Meghe Institute of Technology & Research, Badnera, Amravati, India, Mobile No. 9370270054.

A selective network, or circuit, which passes alternating currents of desired frequencies and substantially reduces all others.

5. Frequency:

The number of recurrences of a periodic phenomena, such as alternating current or voltage, per unit time. Frequency is commonly measured in Hertz (Hz), the number of times per second that a periodic waveform is repeated.

6. Impedance:

The total opposition of a circuit to the flow of an alternating current. The unit of measure is the Ohm.

7. Monopolar:

It implies the use of an amplifier which is having only one active input with respect to a neutral or ground connection. This type of design does not reject artifact as well as a bipolar system.

8. Root-Mean-Square (RMS):

The effective value of an ac quantity which is independent of waveform. It is mathematically denoted as the square root of the average of the squares of the instantaneous amplitudes which are taken over a cycle of that quantity.

II. INTERNAL STRUCTURE OF THE HUMAN BRAIN:

The major parts of a human brain are indicated as follows:

1. Frontal Lobe:

The frontal lobe is involved in planning problem solving, decision making, memory, organizing, impulse control, behavior and emotion control. The damage to the frontal lobe may cause impulse, language, memory, social and sexual behavior, emotions etc.

2. Parietal Lobe:

The parietal lobe is involved in Sensory controls like pain, touch, hot/cold), integration of sensory information. The parietal lobe damage may affect to inability to recognize or locate parts of body.

3. Occipital Lobe:

The occipital lobe is involved in the perception of shape and colors, visual information receiving and processing. The damage to the parietal lobe may affect the inability to recognize or locate parts of a body.

4. Temporal Lobe:

The Temporal Lobe is involved in Memory, Sound recognition, Processing of sound, production of sound.

The damage to the temporal lobe may cause defects in the process of hearing, language, senses (inability to recognize person's face)

5. Cerebellum:

The cerebellum is mainly involved in the Movement, Balance, Coordination. The damage to the cerebellum may cause Movement balance and coordination.

6. Brainstem:

It controls the heart rate, breathing, blood pressure, swallowing etc. The damage to the cerebellum may cause Movement balance and coordination.

7. Temperature:

It measures the surface temperature at the peripheries. The measured temperature by the sensors which are placed on the ring fingers. The unit of temperature is degree Celsius.

8. EMG:

It measures the electrical activity in muscles which is measured by attaching surface EMG sensors on the muscle group. The unit of EMG is microvolts.

9. SC/GSR:

It measures the skin conductance or Galvanic Skin Response (Sweat Gland Activity) at the peripheries. It is measured by placing the SC/GSR sensors ring and index fingers or palm. The unit of SC is Microsiemens and the unit of GSR is Kiloohm.

10. Heart Rate:

The heart rate is measured by using ECG or BVP. The unit of Heart rate is Beats per minute.

11. Respiration:

It is measured in terms of respiration rate and is measured by attaching the respiration sensor around the chest/abdomen. The unit of respiration rate is breaths per minute.

12. Neurofeedback (EEG):

It measures the electrical activity in the brain. The unit of EEG is microvolts.

13. Delta (0.5-3Hz)

It signifies the sleep rate, complex problem solving. The higher delta amplitudes indicate learning disabilities, Brain injury, eye movements/eye blinks.

14. Theta (4-7 Hz)

It signifies Day dreaming, Creativity, Internal Focus, Trance state, Thought. The high amplitudes of theta indicate learning disabilities, slow reaction time, depression, day dreamers, ADD/ADHD.

15. Alpha (8-12 Hz):

It signifies relaxed attention, readiness, alertness.

16. SMR (12-15 Hz, 15-22 Hz):

It signifies thinking, Focus, Sustained Attention, Problem Solving. The high amplitude of SMR indicates Right side anxiety, Left Side Depression, OCD, Sleep Disorders.

17. Beta (23-55 Hz):

It signifies the fast cognitive processing, Hyper vigilance.

The high amplitude Beta indicates epileptic auras, Cortical irritability, Over thinking, OCD.

18. Gamma (35-42 Hz):

It signifies Binding Rhythm.

III. STANDARD VALUES OF MODALITIES:

The standard values of modalities are given as below:

1. EMG:

5-10 microvolts

2. ECG:

This is the heart rate (70-80 bpm)

3. EOG:

This is a measure of eye movement which is used for artifact control.

4. EEG:

It depends on the person.

5. SCP:

It is a positive or negative from zero which is too complicated to explain in this article.

6. SC/GSR:

It depends on the measure of the conductance that should be below 5, 10, 20 is high which depends on the humidity in the room.

7. RSP:

It is of the order of 5-10 per minute.

8. Temperature:

It is usually 91 F to 93 F.

9. HR:

It is of the order of 70-80 beats per minute.

10. RSP rate:

It is of the order of 10-12 breaths per minute for the kids or teenagers. It is 6 breaths per minute in case of adults.

11. EEG:

Theta: A training is required if the amplitude is above 10.

Alpha: The more is better for relaxation.

SMR: The more is better for focus and attention.

Beta: The value of Beta should be below 15.

In case of ADD/ADHD, the value of Theta is high and the value of SMR is low, so training is required for lowering the value of Theta or increasing the SMR.

Theta (Slow brain creativity/Day Dreaming/Brain Storming):

The value of theta should be high for creative people. The value of Theta should be low for analytical low.

Alpha (relaxed attention):

The value of Alpha should be high for general relaxation.

SMR (Active Brain): The SMR should be high.

Beta: The value of Beta should be very high and the value of Beta amplitude signifies the level of anxiety.

The theta beta ratio is found to be 1:1 which indicates that the person is normal. If the theta : Beta ratio is found to be 3:1 then the person is suffering from ADD/ADHD.

The ECG or HR or BVP (HR) is found to be 80. The value of SpO2 should be greater than 97 and if the value is found to be less than 97 then the person needs immediate medical attention. The EMG should be always lesser. If the value of SMG is more in muscular areas, then it can go upto 4000.

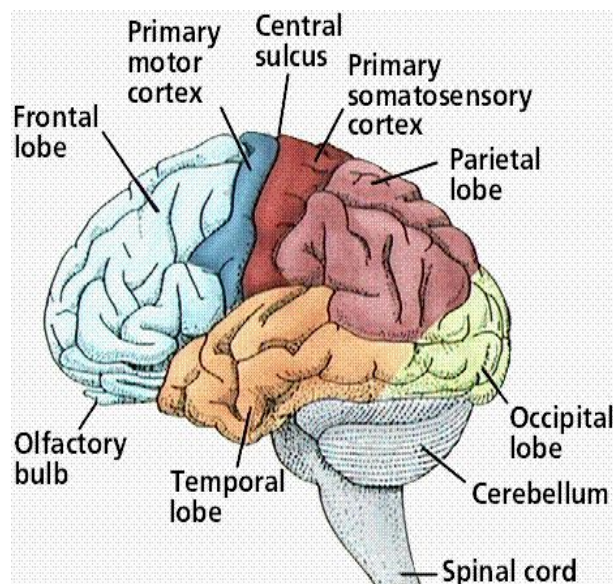


Figure 1 Internal Structure of Human Brain

IV. AROUSAL CONTROL FOR TRACK AND FIELD:

Issac Asimov noted in the “relativity of wrong” that there are no absolute rights and wrongs and that all theories are wrong. The experienced coaches know that

1. one method or theory may work for some athletes but not for all athletes, or

2. what works for a time period with one athlete may not work with the same athlete at a later time period.

Progress is made when we as coaches and scientists recognize a good concept and refine and extend it more subtly, usually through advancement of instruments or measurements. This I believe is the case of the concept of ‘arousal’. Several theories of how and why arousal works have been around for decades and coaches have applied these concepts to millions of track and field trials. But newer instruments or measurements are available to help ‘refine’ the arousal level of athletes.

3.1. What is Arousal?

Arousal is the physiological change, typically the central and autonomic nervous systems, that occurs when demands are made upon the person, be they:

1. physiological such as exercising.

2. psychological such as nervousness prior to competition.

3. behavioural such as interacting with others or even

4. small physiological changes to environmental events such as temperature, air pressure etc.

Most changes occur under subconscious processing but some are readily observable or felt by the athlete. Arousal is often used synonymously with activation but anxiety is not the same.

1. Anxiety refers to a mind state of uneasiness about undefined threats or worries and usually increases arousal.

2. Anxiety has also been associated with the level of self-confidence of the athlete.

Fear is identifying the upcoming threat and typically has high levels of arousal associated with such. Fear comes when the athlete knows he/she is not prepared for the level of performance required and when the outcome of failure is important to the person. What is important for the coach/athlete is to know that arousal control is a complex system of neural networks within the brain that control which systems respond and the intensity of those systems. To appreciate this complexity, imagine taking several transparent road maps and stacking them off centre upon one another, noting the myriad of possible routes. This explains why it is so difficult for an athlete to consistently fine tune how, when and to what degree he/she responds.

Arousal is controlled by:

1. conscious mechanisms.

2. pre-conscious mechanisms (with training or instruments can be made conscious) and

3. subconscious mechanisms.

The state of arousal affects one’s:

1. Thoughts

2. Feelings and

3. Performance

The daunting task of training the ultimate control system the brain, has resulted in most coaches and athletes reverting back to training the body for performance with hopes the mind will follow. Fortunately, the human brain has flexibility and learning embedded within its structure and may indirectly learn what is required for sport performances. However, newer research has shown that with specialized knowledge

and equipment, the brain can be trained for specialized functions such as attention or arousal control.

Why should coaches and athletes care about arousal?

Arousal affects one's:

1. Perception
2. Attention
3. Reaction time
4. Speed and strength of movements, and
5. Decision-making abilities

In short, the quality of performance is affected in both practice and competition by the level of arousal.

V. CONCLUSION:

In conclusion, biofeedback and biological monitoring are useful in creating readiness for self-exploration, reducing therapeutic resistance and enabling the patient to recognize mind-body linkages. The display of physiological signals enables therapist and patient alike to identify maladaptive and stereotypic responses to stress, and to retrain more flexible and adaptive responding. Biological monitoring during the course of psychotherapy can provide a "window into the soul"-alerting both patient and therapist to attune to specific topics and life situations which activate somatic threat and distress reactions.

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Prof. Abhinav V. Deshpande

My name is Prof. Abhinav V. Deshpande. I have done M.Tech. in Electronics Engineering from G.H.Raisoni College of Engineering, Nagpur in the year 2012 with a CGPA of 7.90 on a scale of 10.00. I am presently working in Prof. Ram Meghe Institute of Technology & Research, Badnera, Amravati in the Department of Electronics & Telecommunication Engineering as an Assistant Professor. I have published 6 research papers in reputed International Journals and 1 research paper in International Conference. I have also published a book in Saarbrücken, Germany which is published by Lambert Academic Publishing Company House (LAP). I am a Life Member of ISTE, Associate Member of IEI, Student Member of IEEE, Associate Member of IET, Associate Member of UACEE.