# Study of Brain Anatomy and EEG Characterization

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**ABSTRACT**

*Human brain at any given time results in effective and optimized delivery of numerous tasks. It functions as a compelling multitasking machine, due to the complex structure of the human brain. Thus, before measurement of brain variables it is vital to learn the brain structure of the human and its functioning to address any issue and its respective solution. Human brain communicates to other body organs with the help of nerve cells. Synapses are the mean of communication among around 100 billion nerve cells. The brain cells control the functions of the various organism and the signal propagates through the Central nervous system (CNS). It controls, supervise the functions of the human body and interprets information. The important features of brain are memory, emotion, creativity and intelligence.*

## INTRODUCTION

Eight- cranium bones (occipital, sphenoid, frontal, temporal 2, Parietal 2 and ethmoid) structure protects the brain. At the root of the nose a square bone called ethmoid bone is present which is joined at suture lines. It forms part of the cranium, and having many perforations through which the olfactory nerves pass to the nose. Skull is formed by such structure. Posterior fossa, middle fossa and anterior fossa are '3' different areas of skull. The communication between brain and rest of body is made through all the arteries, veins and nerves which come out from a hole that exist at the skull base, called Formina or Foramen Magnum. It is similar to computer's hardware wires which come out from the back side.

There are three brain regions where synapses and dendrites meet remodeling:

The primary memory region (hippocampus),

1. Emotional related region (amygdale), and

2. Region deals with higher cognition, planning, personality, and proper social (Prefrontal cortex).

These three areas communicate with mediate cognitive factors and each other. It also responses to HPA axis to traumaor, self-regulation to aggression, fear as well as turning on and off the autonomic functions.

**Medial prefrontal cortex**: Baseline metabolic activity of Medial prefrontal cortex (MPFC) is highest among these brain regions at rest. Functional imaging study decreases from the baseline across a wide variety of goal-directed behaviour such as loss of synapses, shrinkage of dendrites, impulses help shut off the trauma response, mood, self-regulatory behaviours, working memory, and decision making.

**Hippocampus**: It's a part of the brain very important for remembering things. The process through which new neurons (cells of the nervous system) are generated by neural stem cells is slowed or halted when synapses die off, when support for shrinking neurons is provided, and when the trauma response is blocked (Hippocampus).

**Amygdala:** It is the brain area which concern to increased synapses, increased volume and activity hypertrophy of neurons, increases heart rate, turning on trauma hormones for preparing emergency, fear, and detecting anxiety.

Acute and chronic trauma both affect the hippocampus, the amygdala, and the prefrontal cortex, and all of these regions show structural plasticity. Certain neurons in the basolateral amygdala are responsible for memory storage and the fear response to previously neural inputs by associating them with unpleasant stimuli (BLA). Neurons in the medial amygdala have less spine density after chronic trauma, while those in the hippocampus and cerebellum show an increase after chronic immobilisation trauma. This occurs as a result of CRF's production of tissue plasminogen activator, but trauma has no effect on BLA because it operates autonomously. Anxiety-like behaviour increases as a result of the trauma. As a result, circuits in the amygdale become disorganised and dysfunctional as a result of trauma.

## STRUCTURE OF BRAIN AND ANATOMY

Neurons, cells and blood vessels configure the brain. Neurons in the brain are having very complex structure, topology, shape and size. Sensory neurons present in visual cortex or auditory cortex is one type whereas motor neurons are present in the cerebellum or motor cortex. Inter-neurons integrate two regions of brain. It enables communication between sensory neuron, motor neuron and CNS. However, there are tens or hundreds various types of neurons present within sensory and motor areas. The mast cell changes the gut-brain axis. Structure of brain and its activity is highly complex. Fig.3.1 shows a simplified structure of brain.

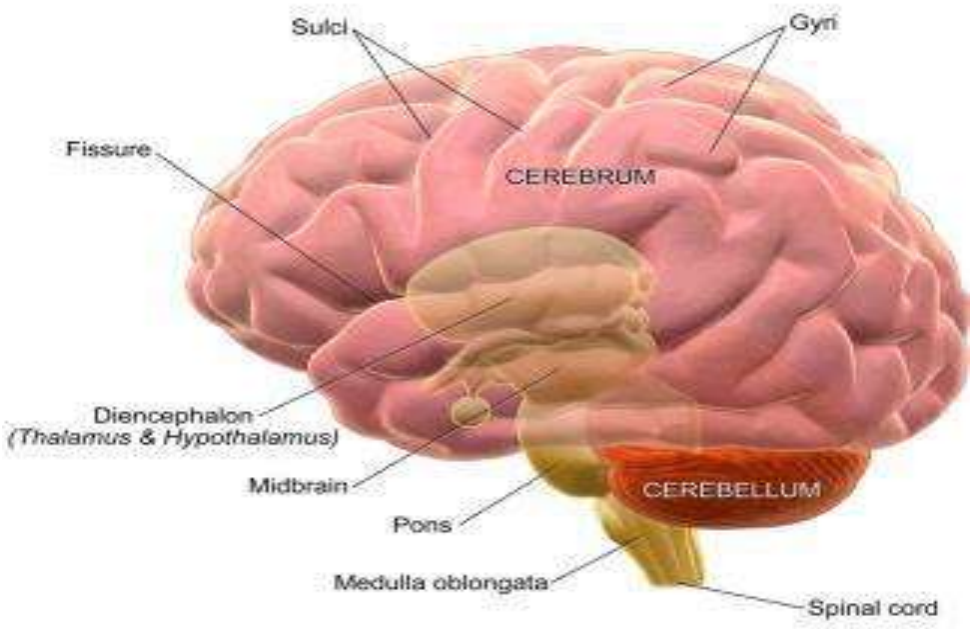


**Fig. 1: Simplified structure of Brain**

**Cerebrum:** Human brain's largest area is occupied by cerebrum. It is superior to the brain stem and cerebellum and envelops the diencephalon. It mainly performs controlling and regulatory functions like creativity, reasoning, emotions, learning, touch, hearing and vision. The surface of the cerebrum is made of intricate layer of gray matter, called cerebral cortex. This area contains majority of neurons, near to 70 percentage of one hundred billion nerve cells, and carry out the complex functions and covered by skull. Fig.4.1 shows the brain parts, based on the

simplified structure [184]. Spinal cord and brain is connected by brainstem. It controls and regulates the survival functions of brain. The three regions of brainstem are:

1. Midbrain,
2. Pons, and
3. Medulla oblongata

Grey and white matter is the colours of the three regions. The structure is like net configured known as the reticular formation. The body muscle is toned by such structure and carry out functions of on / off such as consciousness and sleep.

Medulla oblongata superior side is connected to the Pons whereas inferior side is connected to spinal cord. Basically, medulla oblongata is a cylindrical shaped of nervous tissue and comprises of white matter. It acts as bidirectional channel over which nerve signals propagate in ascending direction to the brain It contains mostly white matter over which nerve signals propagate in descending direction to the spinal cord and in ascending direction to the brain. Grey matter area of medulla is responsible for homeostasis process. Cardiovascular centre is present in medulla. The required oxygen need to the tissues of body is met by heart rate, oxygen level of the body, and blood pressure are regulated and monitored by it. Swallowing reflexes, coughing, sneezing and vomiting are also coordinated by this region.

Cerebrum is divided by a deep furrow into two hemispheres:

1. Left hemisphere and
2. Right hemisphere.

The corpus callosum transmit message from one side to other in form of signal, is a heap of filaments which attach the two hemispheres of the brain. Opposite side of the body is regulated by each hemisphere. This conveys that if right part of the body is weak or paralyzed, then a disease is identified in the left hemisphere. Responsibility of writing, arithmetic, and voice comprehensive is assigned to left hemisphere, whereas musical skill, artistic and creativity are the responsibility of right hemisphere. There are four lobes of each cerebrum hemisphere. The four lobes convey the information of surrounding environment and perceptual interpretation.

1. Frontal lobe
2. Parietal lobe,
3. Temporal lobe, and
4. Occipital lobe.

Motor functions and problem solving and judgement are carried out by frontal lobe. The body position, handwriting, and sensation are managed by parietal lobe, hearing and memory is managed by Temporal lobe, whereas, brain visual processing system is managed by occipital lobe. Cerebrum cortex carries out the higher functions of thought and action. Cerebrum area represents the 4 – lobes, shown in fig. 2.

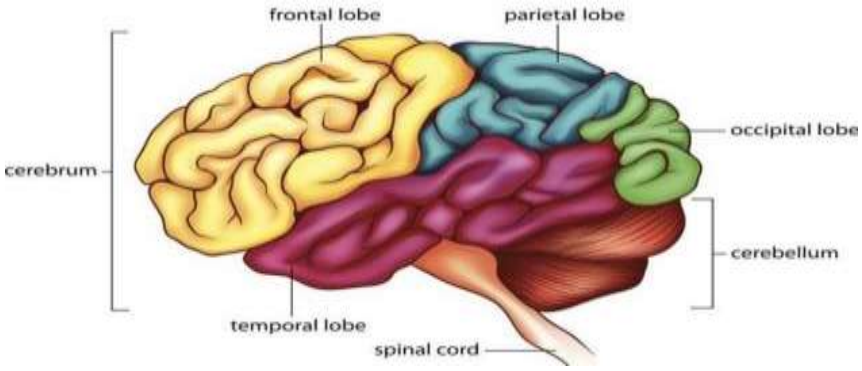


**Fig. 2: 4-lobes of the cerebrum area**

**Cerebellum:** Inferior to the cerebrum and posterior to the brainstem is being present the cerebellum. Cerebellum's outermost part is called Cerebellar cortex. It is folded gray matter and wrapped tightly. Cerebellum gets processing power from this folded matter. In the deep of cerebellar cortex, there is a white matter in form of tree shaped, called Cerebellar cortex. Rest of body parts and the brain are connected via Cerebellar cortex to processing areas ( present in cerebellar cortex). It is commonly called 'tree of life'. Motor functions are controlled by it.Speech,walking, writing, muscle activities, and posture, etc. are the motor functions [185].

**Diencephalon:** The area position and location lying in the anterior and superior to the midbrain is called the diencephalon or interbrain. Pineal glands, hypothalamus, and thalamus are major area of interbrain [186]. Thalamus is located in between the ventricles fences and inferior to the lateral ventricles. The cerebrum memory centers route the sensory information for processing. These define learning function of thalamus. The hypothalamus is located between superior to the pituitary gland and inferior to the thalamus. It is the control center for brain as it regulates some of the vital activities like hormone production, blood pressure, hunger, heart rate, body temperature, and thirst. Sub-part found posterior to the thalamus, the pineal gland is a very small gland positioned in epithalamiums. Sleep inducing hormones, melatonin is also produced by this gland.

Brain can be divided into 3 different areas, shown in fig 3:

1. The Forebrain,
2. The Midbrain, and
3. The Hindbrain.

Pineal gland, hypothalamus, thalamus and cerebrum are surrounded by the **forebrain**. Some of important functions of it are the initiation of reasoning, memory, speech, language and complex movement. The outermost part of the cerebrum records the brain activity which make use of electrodes as sensors and placed on the scalp.

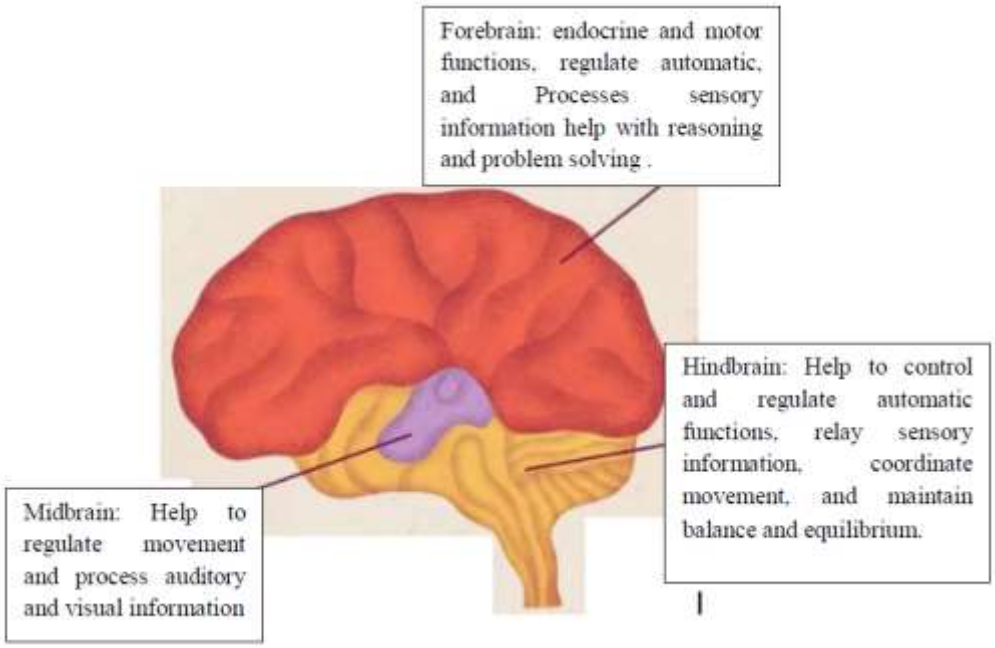


**Fig. 3: Major parts of brain**

1. **The Midbrain** is situated between the interbrain and the hindbrain near the centre of the brain and made up of only a small part of the brainstem. It connects the spinal cord and the forebrain.

2. **The Hindbrain** constitutes of pons, cerebellum, and rest of brainstem. The cerebellum co-ordinate all kinds of movements. Regulation and control of sleep and arousal, and relay signals from the cortex to assist in the control of movement is carried- out through the pons function. Midbrain to spinal cord is connected by the medulla oblongata. Muscle tone, blood circulation, and breathing are performed and control by the medulla oblongata. Pons enforce the neuron signals to travel across the cerebellum via bridge. Pons, cerebellum and rest of the brain stem get the information of these signals. The three areas of brain are presented in fig. 3.3.

**Brain Memory**

Brain's electrical signal needs memory for extraction of information from it besides storing, and control function of signal. The memory is evolved from the special nervous cells. Like the microcontroller, every information or data are evoked from the memory for desired function to achieve. Cerebral cortex area is hub of distributed memory of brain. It is classified into three types:

1. Memory for sensory,

2. Memory for short-term, and

3. Memory for long-term.

(i**). Memory for sensory** is the storage of impression of stimuli or information of physical senses. It keeps this information for very short period. It can enable to forget the sensory information or forget it depending upon the importance of information. The various stimuli are music, visually compelling image, etc. Fig. 3.4 shows the sensing area in brain for physical parameters.

(ii). **Short-term memory** is working memory to enable the sensory signal information to be stored as it is sensed. Fig.3.4 shows the area in the brain of short memory. It is just a temporary storage arrangement of information, before processing further. Maximum 7-itema can be stored at a time for 10 seconds to a minute.

(iii). **Long-Term Memory** is set in action after the pre-processing information through short term memory is passed to it. Here, the brain carries out more processing related to analysis, planning, decision making, etc. The chances of loss of vital information are less here over passes of time. Fig. 3.5 shows the brain's memory block diagram.

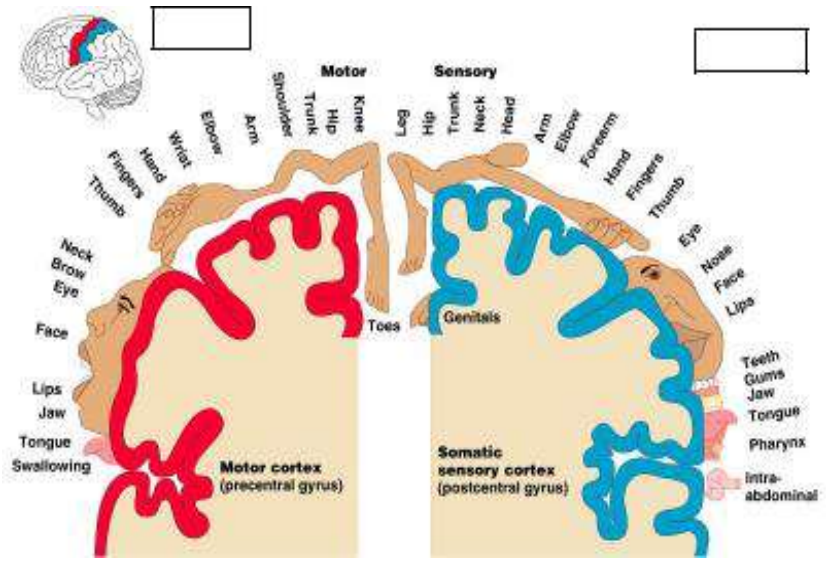


**Fig.4: Physical senses area in Brain cortex**

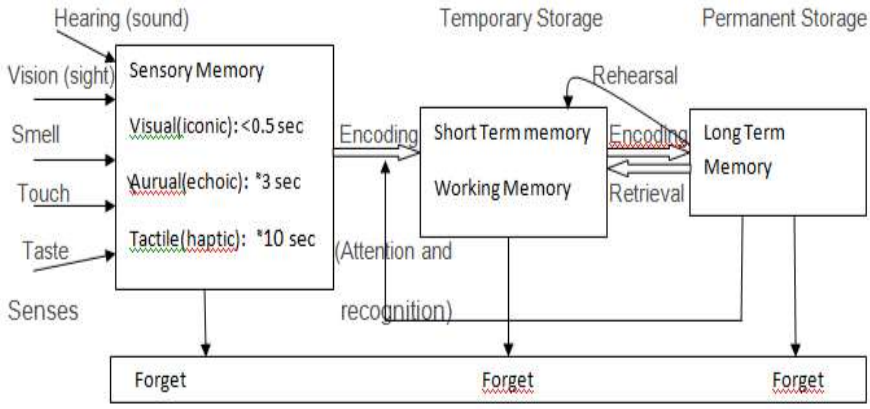


**Fig. 5: Brain- memory block diagram**

Hippocampus is the area of the brain which carries out the activities related to learning and memory. It is the space of brain responsible for depression and sensitive to trauma. Poor recollection may be due to volume reduction of hippocampal. The person can find difficult to concentrate on tasks due to deep thoughts characteristic of the trauma. The brain uses this area for continuously thinking about same sad or dark event and utilizes the resources of neural which memory or other events could have used.

Tissues and cells are part of brain. They are very tender and need protection from physical movements such as physical jerks, and head movement. These requirements are met with colourless cerebrospinal fluid (CSF), secreted by the choroid plexus, present in various portion of brain and spinal cord meets this requirement.

## CONCLUSION

Brain is one of the intelligent regulating and decision-making systems of the body. Monitoring, regulation and control of all organisms are made by brain. Brain memory stores the processed information which is obtained after assembling of the messages. Movement of arms, legs, speech, thought, creativity, memory, emotion, etc. all activities are control by brain. Skull house provides protection to it. Central nervous system of brain comprises of spinal cord, the set of nerves, and peripheral nervous system (PNS). Memory stores the information of each and every event of daily life and meets the requirements of functions to be carried out such as breathing, blinking of eyes, etc. Spinal cord, nose, ear, face, brain, receive the information via nerves pathways.

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