BRAIN IS THE ORGAN OF LEARNING

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ABSTRACT

The brain is the organ of learning, teaching, and memory. Though many professionals of teaching knew this fact, the lack of potential evidence to understand the process involved in learning hinders them from becoming successful teachers and learners. This paper aimed at magnifying the human brain as a learning organ and provided scope to know its parts and functions. The paper purposed to alert the learning and teaching communities to the available research studies to understand the kingpin of learning so that they can alter the content, context, and teaching and learning aids for optimal teaching and learning.

Index Terms: Human brain, anatomy of brain, learning neuron, and teaching and learning

1. Introduction

Learning is as natural as breathing and it cannot be stopped but only channeled. Learning is an understanding. When brain perceives confronting danger, it directs body to change its behavior in order to escape from the coming danger. Therefore, it is survival oriented. It is regulated by many factors such as motivation, environment, material, and teaching. A good teacher will organize all the possible factors of learning and orchestrate them to give everlasting learning experience to the students. Learning is an experience. The research showed that the experiences both good and bad will be remembered for a longtime, for example, first school and teacher, first day in the college, moments with friends, fights they were involved in, insults they faced and complements of the beloved. Though they were not consciously recalled, the students remember thousands of experiences, as they will be hooked to their emotions. Teaching and learning process strikes back to the centuries but the advent of technology and westernization in education policies through the process of teaching and learning to undesirable state of teaching for specific purpose i.e. obtaining ranks. The matter of cognitive development, culminating higher thinking levels, comprehensive approach, qualitative analytical skills, decision making are almost neglected. Now, the discoveries of neuroscience with the innovated technology, which enabled the scientists to understand the learning psychology of neurons in the brain and forming strong memories showed a new light to draw implications in the discipline of education.

2. Anatomy of Brain

Brain is defined by Ornstein and Thompson:

> There are perhaps about one hundred billion neurons, or nerve cells, in the brain, and in a single human brain the number of possible interconnections between these cells is greater than the number of atoms in the Universe (1984: p.21).

It is also defined in presidential proclamation:

> It is the most magnificent-- and mysterious--wonders of the creation. It is the seat of human intelligence, interpreter of senses, and controller of movements, this incredible organ continues to intrigue scientists and laymen alike (1990).

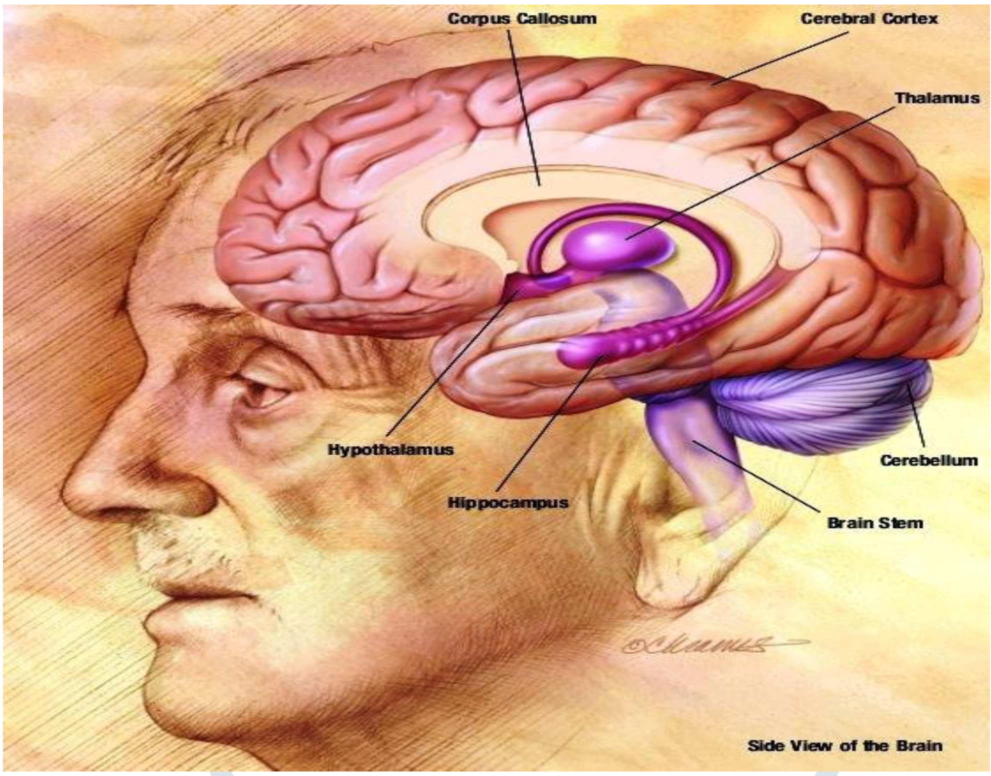


Image: 1

Human brain can be divided into three major parts at macro level: Brain stem, the limbic system (Thalamus, Hypothalamus, Hippocampus, and Amygdala), the cerebral cortex. These parts can be divided into specific areas with individual and complex roles to play. Some parts process the information from the senses while some of them deal with the aspects of emotional responses. Some of them are responsible for certain types of memory while others help to read cues from the people and make physical and emotional responses (Call & Featherstone, 2010).

2.1. Brain Stem

In the terms of evolution, brain stem is the oldest part, which is made up of three parts. They are; mid brain (upper part), the Pons (center part) and Medulla (lower part). The brain stem and cerebellum (which is usually developed in two years of birth of a baby and receives information from motor cortex to initiate a movement after computing muscles to involve. It is responsible for balance, posture, motor movements, and some concepts of cognition and referred to reptilian brain whose primary purpose is body's survival. It controls autonomic functions, which are not in our conscious control but essential for our survival (Wolfe, 2010). It regulates our life supporting mechanisms such as 'heart rate', 'breathing' and 'fight or flight' responses to perceived danger. High order of thinking could be derailed during the times of stress. So the child's stress level should be brought to absolute minimum for ideal learning environment (Call &Featherstone, 2010). Brain stem performs the functions by means of neural networks and fibers that are called reticular formation (RF) which occupies the core of brain stem. It adjusts heart rate, blood pressure, or breathing according the information passed to RF in every movement of body. Thus, RF system regulates several supporting systems along with controlling eyeball movements, pupil constriction, stomach reflexes, facial expressions, salivation, and taste. RF is well matured by the time of birth (Diamond &Hopson & Diamond, 1998). The RF neurons in thalamus and neurons from various sensory systems of the brain form reticular activating system (RAS) which keep our life-supporting systems functioning. It adjusts cells excitation according to information from input. Severe damage to the RAS causes life threat or permanent coma (Binney & Janson, 1990). It serves as an effective filter for the thousands of stimuli bombarding and allows the person to focus on a relevant stimuli. Another essential role of brain stems is production of many brain's chemical messengers. These chemicals will be produced by nuclei located in the brain stem and supplied to all parts of the brain.

2.1.1. Cerebellum

It is a two lobed and deeply folded structure overlaying on the top of the brain stem and just below occipital lobe on back of the brain. It is usually developed fully in two years of birth of a baby. It receives information from motor cortex to initiate a movement after computing muscles to be deployed. It is responsible for balance, posture, motor movements, and some concepts of cognition.

2.2. Limbic System

It is located between brain stem and cerebral cortex. It consists of several structures that manage our emotions and some aspects of memory. The lower structure of limbic system manages our basic emotional responses and higher structure manages intellectual responses. The former causes behavior like blushing or shaking against criticism the latter prepares a measured response to the criticism (Call, 2010). It occupies 20% of brain volume but it is responsible for sleep, attention, body regulation, hormones, sexuality, smell, and production of most brain chemicals (Jensen, 1998). This system consists of hippocampus, thalamus, hypothalamus, and amygdala.

2.2.1. Thalamus

It is located in the deep of the limbic system and above the brain stem; there are two walnut-sized, plum-shaped structures. They are responsible for regulating the perception and vital functions of the body. Thalamus works as a relay station between the sense organs and the cortex. Only one exception is olfactory system, which sends smell stimuli directly to the cortex (Wolfe, 2010).

2.2.2. Hypothalamus

It is located below thalamus in thumbnail-size. It is a crucial part of autonomic system along with the pituitary gland. It is responsible for regulating the temperature of the body according fluctuations. If the body gets hot, it improves perspiration rate to cool the body vice-versa. It also serves as a control center for the stimuli from eating and drinking. It signals when salt and sugar levels are high and regulate sex drive, sleep, pleasure, and aggressive behavior (Binney & janson, 1990). Increase in the rate of heartbeat, respiration and palms get sweaty against scared situation are functions of hypothalamus. It is one of the organs to control 'fight or flight' response.

2.2.3. Amygdala

It is located near thalamus and hypothalamus in two almond-shaped structures. It is also one of the organs to control 'fight or flight' response along with the emotions. Since it play major role in controlling emotion, it is also called psychological sentinel of the brain. It is composed of three divisions; one division links with olfactory bulb, another is linked to sensory association cortex and another is linked to brain stem and hypothalamus. All incoming sensory data except smell first relayed through the thalamus and sends to the appropriate cortex. At the same time, it sends information to amygdala for evaluation of emotions with co-ordination of hippocampus. If amygdala finds anything harmful, it triggers the hypothalamus, which sends hormonal message to the body and prepares the body for reaction by creating physical changes with increasing blood pressure, increased heart rate, and muscle contractions. Research stated that amygdala forms emotional memories, which can trigger responses without corresponding to conscious recollections to link responses to a particular event. This may be concerning to panic attacks and unreasonable phobias (Carter, 1998).

2.2.4. Hippocampus

The shape of hippocampus is like two paws curving towards each other. The absence of hippocampus makes us disable to remember immediate past. It not only holds immediate past but also dispatches the memory to the cortex where it will be stored in long-term memory (LeDoux, 1996). If an episode is fully decoded in long-term memory, hippocampus is no longer needed to retrieve it. Damage to hippocampus causes disability to remember immediate past and fail to encode new memories (Hilt, 1995).

2.3. Cerebrum and Cerebral Cortex:

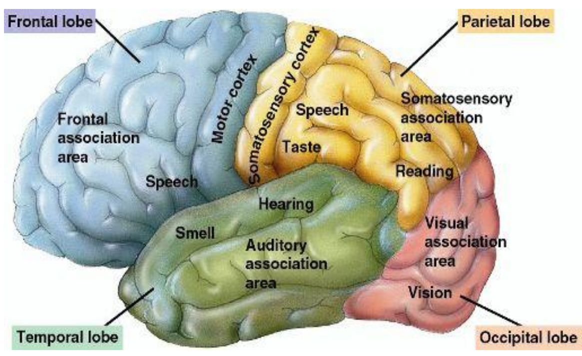


Figure: 3

A thin layer that covers the cerebrum is called cerebral cortex. It is the largest part of the brain and sometimes called 'thinking brain'. It resembles the bark of a tree and called "gray matter" of the brain. It is wrinkled and 1/32 and ¼ inch thick. It is made up of six layers of cells, their dendrites, and some axons. It is about ¾ of the brain's weight. The cerebrum is formed of four main lobes viz., occipital lobes, parietal lobes, frontal lobes, and temporal lobes.

2.3.1. Occipital Lobes

These are located in the lower back part of the brain. They have the primary brain centers for visual stimuli and called visual cortex. They have multiple sub-divisions, which of each of them has a role to process visual data coming into brain. The stimuli, which reach visual cortex, will be processed by primary visual area where millions of neurons gathered to process different aspects of vision. Then moves to visual association area where the present stimuli will be compared with information what was seen before and defined, if the matching is found. Different people focus on different aspects of a thing. The identification of an object is the output of coordinated functioning of various brain systems. Most of the times, brain is directed to focus on a particular stimulus over others. So tell the objective of an activity to the students to prepare them to focus on certain stimulus (Wolfe, 2010).

2.3.2. Temporal Lobes

They are located above the ears on either side of the brain and stretches from occipital lobes to the bottom of frontal lobes. These lobes are responsible for processing auditory stimuli. There are several subdivisions to correspond with hearing language and some aspects of memory. Hearing is important sense and it is vital for our survival. With this faculty, brain processes certain sounds and warns us to take proper care or safety measures. When the primary auditory region is stimulated, sensations of sound are produced. Besides this, the auditory association area has links to primary regions and other parts of the brain to process the sound and cause perception. At the conjunction of occipital, parietal and temporal lobes, there is a Wernicke's area in the left hemisphere and it is critical to speech. Comprehension and putting words in correct syntax are the basic functions of this area while speaking (Wolfe, 2010).

2.3.3. Parietal Lobes

Plates like structures on the top of both hemispheres of the brain are called parietal lobes. They consist of two parts, anterior and posterior, which have different and complementary roles. The anterior part, immediate behind of motor cortex contains somatosensory cortex. Somatosensory cortex receives information through touch, temperature from the environment, sensations of pain, pressure from the skin and positions of our limbs. Its surface contains the areas to represent each part of the body. The good portion of this area is allocated to interpret the messages from more sensitive parts. For instance, lips, tongue, and throat have the largest number of receptors. Posterior part of the parietal lobes analyzes and integrates continuously the received information and gives us a sense of spatial awareness. Brain is informed about the location of each part of the body and its relation to its surroundings. The ultimate role of parietal lobes is to maintain focus or spatial attention. When attention shifts from location to location, much activation can be seen in these lobes. If it is less meaningful stimuli, attention wanes (Wolfe, 2010).

2.3.4. Frontal Lobes

These lobes cover the largest portion of the cerebral cortex. They are located in the front part of the brain and stretched to the top of the head. Our frontal lobes are rapidly expanded over the past 20,000 generations. They perform more complex duties such as moving the parts of the body at will, thinking about past, planning for the future, focusing our attention, reflection, making decisions, solving problems, and engaging in conversation. Moreover, these lobes allow us to have awareness of thoughts and actions consciously. Functions of these lobes fall into two main categories: sensory motor processing and cognition. At the back of frontal lobes, there is a strip of cells stretches across the top of the brain. This strip is known as motor cortex. Almost all-neural activity to make muscular movement originates in the motor cortex. Like in somatosensory cortex, each part of the body, that is from toe to lips have corresponding area in this cortex. The muscles that carry more precise and fine-motor movements than other muscles are allocated a large area in the cortex. For instance, the areas that govern the fingers, tongue, and lips are much larger than muscles of back.

The front of the motor cortex is extremely important because it contains Broca's area. It is usually located in the left hemisphere of the supplemental motor area. This part enables us to speak. Broca's area is connected to Wernicke's area in the temporal lobes with the bundle of nerve fibers called "arcuate fasciculus." This link is very important because formation and appropriation of words first take place in Wernicke's area and relayed to Broca's area to be translated into corresponding sounds and then passed to motor cortex for vocal production (Ackerman, 1992). The following image will show the both areas in brain.

2.3.4.1. Broca's and Wernicke's Areas:

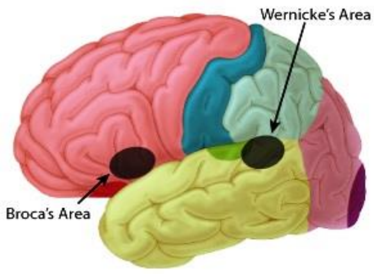
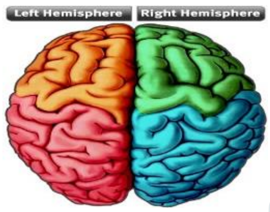


Figure: 4

2.3.5. Prefrontal Cortex

It is located in front of the secondary motor zones. It is a silent area because it is free from processing sensory data and governing movements. It is sometimes referred to association cortex. In this cortex, information will be synthesized from both inner and outer sensory worlds. Here object will be associated with names. It is responsible for highest forms of mental activities. Research findings stated that a part of prefrontal cortex is critical for emotional self-regulation (siegel, 1999). The Orbito-frontal cortex (because it is near to eye socket) is responsible for regulating and evaluating emotional impulses that come from lower centers of the brain. It deserves to be considered for attention and study. Thus Broca's area, arcuate fasiculus, Wernicke's area and motor cortex work together to make us speak a coherent sentence.

2.4. Right and Left Hemispheres



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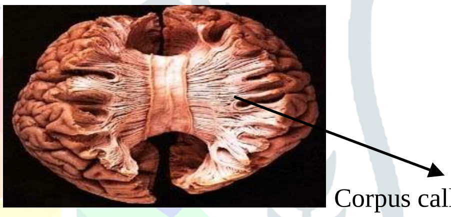

Figure: 6

The view from the top gives our brain resemblance of walnut with seemingly identical two halves. The role of left and right hemisphere has been debated for centuries. The thing what scientifically studied and confirmed true is that the right side of the body is governed by left hemisphere and left side of the body is governed by right hemisphere. The two hemispheres are connected by four-inched long bundle of fibers, which is composed of 300 million axons, the appendages of neurons that are responsible for sending information to other cells, is called "corpus callosum." Roger Sperry, a neuroscience researcher contemplated that cutting corpus collasum might prevent electrical activity that passes from one hemisphere to another is come to be true (Ornstein, 1997).

The studies on specialization of split-brain showed that each of the hemisphere is specialized in what they do (Gazzaniga & Bogen & Sperry, 1962). From these studies it is believed that most of the people(95%)are left brain learners because left hemisphere is dominant for language and speech while the roles reversed in some left-handed individuals (Wolfe, 2010). The issue of context is very important because our understanding of what we read or hear depends on the context, which it occurs. Unless the listener compute the context through the body language, intonation of speaker or the preceding sentence in a narrative , the sentence remains meaningless. Right hemisphere not only decodes external information and helps us for over all understanding what we hear or read but also assembles the whole view of the world (Ornstein, 1997).

Robert Ornstein in his extensive studies on normal people used EEG that validates the findings from the studies on split-brain patients. It is observed that when writing a letter, the left hemisphere showed more beta activity. The opposite was true when a person arranging blocks (1997). So finally it is understood that the two hemispheres work in coordination and share each other's information. For instance, left hemisphere allows producing speech while right hemisphere gives intonation for the speech. The educators must recognize that the left hemisphere process the text while right hemisphere provides context. Since they work together, the educators must teach to both hemispheres. It is in the sense that content must always be connected to the context along with the help to see how the information is useful to their lives (Wolfe, 2010).

3. How Brain Learns

The cells that constitute central nervous system (CNS) compose the brain and the spinal cord. They regulate most of the functions of the body along with endocrine system. There are two types of cells. They are neurons and glial cells. Neurons can be found in both brain and spinal cord. Brain contains 90% of glial cells and 10% neurons. Human beings have 100 billion neurons. Many brain cells are lost every day through attrition, decay, and disuse. In spite of the debate on the number, it is estimated that we lose the brain cells from 10,000 to 1, 00, 000 per day (Howard, 1994).

3.1. Glial Cells

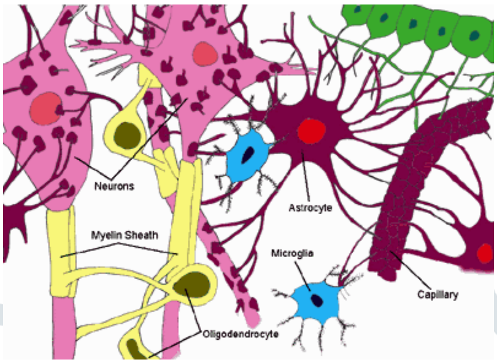

Figure: 7

The term "glial" has derived from Greek word "glue". They are about 1000 billion and they serve as glue to put brain together. These cells outnumber neurons in 10: 1 ratio. The process of formation of neurons and neural networks depends completely on glial cells. They do not take part in the process of learning as they have no cell body but they support learning indirectly. These cells are responsible for development of fetal brain and some of these cells are called radial glia that can travel ahead of neurons and form temporary scaffolding for neurons to climb. The special adhesion molecules of glial guide neurons as they migrate to the predetermined place in the cortex. Their functions include formation of the blood-brain barrier, transport of nutrients, regulation the immune system, and removing the dead cells (Jensen, 1998).

3.2. Communication among neurons

Though the neurons are only 10% of all the cells in the brain, they are essential for functioning of brain. Neurons communicate each other through both electrical and chemical signals. They consist of compact cell body, dendrites, and axons. They process the information through converting chemical and electrical signals back and forth. A new discovery by neuroscientists disclosed that brain generates new neurons in the hippocampal dentate gyrus and olfactory system. Many become survive and functional. These neurons are highly correlated with memory, mood and learning. This process can be controlled by every day behavior of the people and enhanced by exercises, reducing stress and good nutrition (Kempermann & Kuhn & Gage, 1997). The normal functioning of neurons involves continuous firing, integrating and generating information.

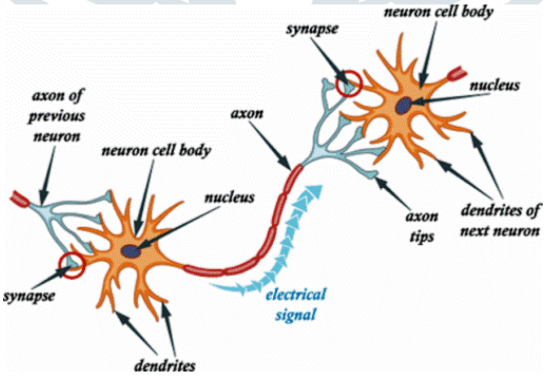

Figure: 8

Each neuron has a cell body with dendrites and axon, a string like structure extends to connect to the dendrites of the cell body of other neuron. Axon splits itself repeatedly. Each neuron not only receives information but also passes the information to other cells. Information always goes in one direction that is from cell body to down the axon to the synapse but not in reverse (Jensen, 1998).

Axon is responsible for both conducting information in form of electrical impulses and transport chemical substances. If the axon is thicker, it conducts faster. Every axon will be myelinated. Myelin is fatty substance that is formed around well-used neurons. It not only speeds up the electrical transmission but also controls any other interference nearby. Proper myelinated axon conducts electrical impulses at the speed of 120 meters for second or 200 miles an hour. More connections turn the communication effective. The number of synaptic reactions arriving from all the dendrites of the cell body will determine the time to fire itself. Dendrites are branch-like extensions that grow outward from cell body when environment is well enriched (Jensen, 1998).

3.3. The Process of Learning

With the received input, each cell body works as a small electrical battery. Changes in the voltage influence the power to transmit signals for dendrites. The body of the cell sends electrical discharge to axon and stimulates the release of the stored chemicals into the synaptic gap, which is the space between axon terminals and tip of the dendrites. When the tip of the dendrites receives neurotransmitters (electrical signals changed into chemical signals) and turns them again into electrical impulses (Jensen, 1998). According to the change in the potential difference, the axon generates action potential. So the change in potential difference of dendrites causes stimulation of target neuron (Restak, 1994). The chemical signals conducted down to cell body of the postsynaptic neuron then cell body changes chemical signal into electric signals. Thus, one cycle is completed.

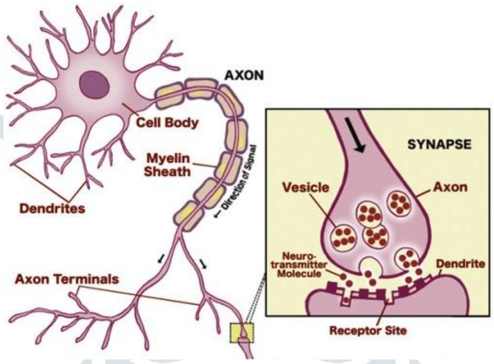

Figure: 9

3.4. Sound Learning

Learning and memory are two sides of the same coin, without one, we cannot find the value of other. The evidence of learning is that the information stored in the memory. Donald Hebb (1949), Canadian psychologist rightly postulated before 50 years that the learning occurs when cell needs less input in the second attempt to be activated. When a cell is repeatedly stimulated electrically, it excites nearby cell. A little later, if a weaker stimulus is given to nearby cell, its ability to get excitement will be enhanced. When synapse is altered, it causes Long-term depression (LTD). Then the chances of firing of cell are very less. Quick learning cannot be promoted by trial-and-error method (Seigfried, 1997). Therefore, the receiving capacity of a cell can be determined by previous stimulation and shows us that the learned cells change their behavior (Jensen, 1998).

4. Conclusion

The paper presented the role of brain in learning and teaching and focused on the internal parts of the brain to find the function of each of them in the process of learning and teaching. The paper showed the learning procedure between two neurons, which gives implications to alter the priorities of the teaching community in terms of selecting content, context, and aids for teaching and learning process.

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