

Life History of Brain

In the structure of the human frame, the brain is the most extraordinary organ. The functions of all its parts are, however, not quite understood but the knowledge we possess of the functions of the brain is of most superficial character and is quite incommensurate with the economy of this wonderful apparatus.

*Maharaj Sahab Pandit Brahm Sankar Misra
(Discourses on Radhasoami Faith, 1960)*

2.1 Introduction

The history of our quest to understand the brain is certainly as long as human history itself. Use this extensive timeline to meander through some of the high-lights (and low-lights) of this great journey of understanding. There are many evidences of ancient civilization which show that people were conducted surgery on head (Brain). In Hindu religion, Lord *Ganesh* had the head of elephant, Incarnation of Lord *Narsingha*, etc. Today due to fast progress of neuro-science, we are at the verge of understanding that how brain functions and what is the relationship between mind and brain, which may provide a basis for understanding consciousness.

At this juncture, let us discuss an episode from the Hindu Epic: “Ramayana”. It is said that demon king Ravana attained the status of the Gods in heavens. It is said that he used his enormous power in his spiritual battery to fly his airplane called Puspak, by which he abducted Sitaji to his palace in Lanka. In this regard, let us only confine ourselves to the fact of harnessing consciousness by the demon king Ravana to propel his plane, myriad millennium ago. This would indeed be a point to meditation to top one’s consciousness and explain methodology to harness consciousness in machine.

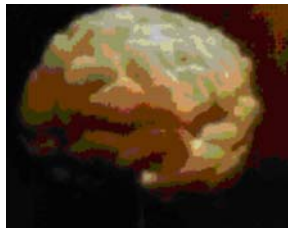
Plato hypothesized that the brain was the seat of the soul and also the center of all control. It is somewhat surprising that he came to this correct

conclusion in spite of the fact he rejected experiment and observation, and believed that true knowledge came only from pure reasoning and thought such as that involved in mathematics. It is also mentioned that our pleasure, joys, laughter and jests as well as our sorrows, pains, grief and tears every thing is closely controlled by the brain condition.

2.2 Development of Brain with Age

A baby's brain

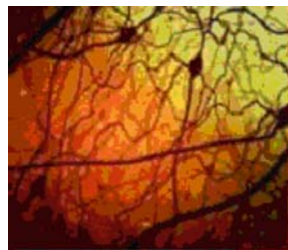
A baby's brain is a mystery whose secrets scientists are just beginning to unravel. The mystery begins in the womb – only 4 weeks into gestation the first brain cells, the neurons, are already forming at an astonishing rate: 250,000 every minute. Billions of neurons will forge links with billions of other neurons and eventually there will be trillions and trillions of connections between cells. Every cell is precisely in its place, every link between neurons carefully organized. Nothing is random, nothing arbitrary.



One way a newborn is introduced to the world is through vision. The eyes and the visual cortex of an infant continue to develop after birth according to how much stimulation she can handle. What happens to the brain when a baby is born with a visual abnormality? Infant cataracts pose an interesting challenge to scientists: How to remove the visual obstruction without compromising brain development.

Baby's brains are more open to the shaping hand of experience than at any time in our lives. In response to the demands of the world, the baby's brain sculpts itself. Scientists have begun to understand how that happens, but as Neurologist Carla Shatz says, "There's a great mystery left. Our memories and our hopes and our aspirations all of that is in there. But we only have the barest beginnings of an understanding about how the brain really works."

Child's brain



A child's brain is a magnificent engine for learning. A child learns to crawl, then walk, run and explore. A child learns to reason, to pay attention, to remember, but nowhere is learning more dramatic than in the way a child learns language. As children, we acquire language – the hallmark of being human.

In nearly all adults, the language center of the brain resides in the left hemisphere, but in children the brain is less specialized. Scientists have demonstrated that until babies become about a year old, they respond to language with their entire brains, but then, gradually, language shifts to the left hemisphere, driven by the acquisition of language itself.

Teenage brain

When examining the adolescent brain it is mystery, complexity, frustration, and inspiration. As the brain begins teeming with hormones, the prefrontal cortex, the center of reasoning and impulse control, is still a work in progress. For the first time, scientists can offer an explanation for what parents already know – adolescence is a time of rolling emotions, and poor judgment. Why do teenagers have distinct needs and behaviors? Why, for example, do high school students have such a hard time waking up in the morning? Scientists have just begun to answer questions about the purpose of sleep as it relates to the sleep patterns of teenagers.

A major challenge to the adolescent brain is schizophrenia. Throughout the world and across cultural borders, teenagers from as early as age 12 suffer from this brain disorder.

While adults spend about one third of their time sleeping, babies and toddlers sleep away half of their early childhood. It cannot be the terrible waste of time that it seems. Or can it be? Embarrassingly, scientists still cannot persuasively point out the biological function of sleep. Sex, eating, and sleeping constitute the triad of basic impulses of human beings. Yet, while the functions of the first two have been obvious for millennia, it is not clear why we crave to spend a third of our life in bed.

The first few hints for the function of sleep came from observations on animals. All mammals sleep, as do birds and even bees. One theory suggests that sleep is a simple protection mechanism, a way to keep animals quiet and still, so that they attract less attention, and thus are less noticeable to predators. This stillness is particularly important when the animal is most vulnerable, which for many animals, is during the dark of night. But comparing sleep patterns of different species suggests that this may be too simplistic explanation. Opossum, for example, sleep up to 20 h a day. Giraffes, Dolphins and whales also spend a very short time in sleeping. Some scientists even claim that dolphins let only half of their brain sleep at a time. Clearly, sleep is an opportunity to rest. Hence, many theorists have hypothesized that the main purpose of sleep is to enable the muscles and the brain to recuperate after a busy day. But measuring the electric activity of the brain unveils the shortcomings of this theory: A sleeping brain is far from dormant.

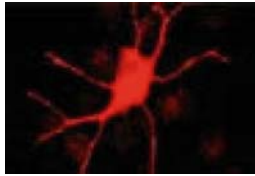
Adult brain

The adult brain is the apotheosis of the human intellect, but what of emotion? The science has changed the study of emotion: Emotion is now

considered integral to our over-all mental health. In mapping our emotions, scientists have found that our emotional brain overlays our thinking brain.

There is a critical interplay between reason and emotion. We are well aware of how brain malfunctions can cause pain, depression, and emotional paralysis. We must also understand that the brain affects positive emotional responses such as laughter, excitement, happiness, and love. “Brain systems work together to give us emotions just as they do with sight and smell. If you lose the ability to feel, your life, and the lives of people around you, can be devastated.” – Antonio R. Damasio

Aging brain



The latest discoveries in neuroscience present a new view of how the brain ages. Overturning decades of dogma, scientists recently discovered that even into our seventies, our brains continue producing new neurons. Scientists no longer hold the longstanding belief that we lose vast numbers of brain cells as we grow older. The normal aging process leaves most mental functions intact, and may even provide the brain with unique advantages that form the basis for wisdom. The aging brain is also far more resilient than was previously believed. Despite this, many people still suffer from the disease most associated with aging.

Mind illusion



Vision has only partly to do with the retina, lens, and cornea. Mostly it depends on the state of brain. It is a reason for optical illusions. The process of seeing begins with the presence of light, an image being formed on the retina, and an impulse transmitted to the brain, but there are many other factors that play a part in how we perceive visually. Our perceptions are influenced by our past experiences, imagination, and associations.

2.3 Technologies for Study the Details of Brain

It's an exciting time in the study of the human brain and mind. Much of this advance in knowledge is the result of technological advances in brain imaging. It seems that almost every time one hears about some neurological experiment or advance in human neuroscience, the term “brain scan” appears. There are five most important technologies that allowed scientists to peer into the workings and structure of the living human brain.

2.3.1 Electro Encephalo Graph (EEG)

The electro encephalo graph (EEG) deserves as one of the first and still very useful ways of non-invasively observing human brain activity. An EEG is a recording of electrical signals from the brain made by hooking up electrodes to the subject's scalp. These electrodes pick up electric signals naturally produced by the brain and send them to galvanometers which detect and measure small electric currents that are in turn hooked up to pens, under which graph paper moves continuously. The pens trace the signals onto the graph paper.

Although it was known in the nineteenth century that living brains have electrical activity. An Austrian psychiatrist named Hans Berger was the first to record this activity in humans, in the late 1920s. EEGs allow researchers to follow electrical impulses across the surface of the brain and observe changes over split seconds of time. An EEG can show what state a person is in – asleep, awake, and anaesthetized because the characteristic patterns of current differ for each of these states. One important use of EEGs has been to show how long it takes the brain to process various stimuli. A major drawback of EEGs, however, is that they cannot show us the structures and anatomy of the brain or really tell us which specific regions of the brain do what.

2.3.2 Computerized Axial Tomography (CAT)

Developed in the 1970s, CAT (or CT) scanning is a process that combines many two-dimensional X-ray images to generate cross-sections or three-dimensional images of internal organs and body structures (including the brain). Doing a CAT scan involves putting the subject in a special, donut-shaped X-ray machine that moves around the person and takes many X-rays. Then, a computer combines the two-dimensional X-ray images to make the cross-sections or three-dimensional images. CAT scans of the brain can detect brain damage and also highlight local changes in cerebral blood flow (a measure of brain activity) as the subjects perform a task.

2.3.3 Positron Emission Tomography (PET)

It is developed in the 1970s to scan or observe blood flow or metabolism in any part of the brain. In a PET scan, the subject is injected with a very small quantity of radioactive glucose. The PET then scans the absorption of the radioactivity from outside the scalp. Brain cells use glucose as fuel, and PET works on the theory that if brain cells are more active, they will consume more of the radioactive glucose, and if less active, they will consume less of it.

A computer uses the absorption data to show the levels of activity as a color-coded brain map, with one color (usually red) indicating more active brain areas, and another color (usually blue) indicating the less active areas.

PET imaging software allows researchers to look at cross-sectional “slices” of the brain, and therefore observe deep brain structures, which earlier techniques like EEGs could not. PET is one of the most popular scanning techniques in current neuroscience research.

2.3.4 Magnetic Resonance Imaging (MRI)

MRI technique was a major breakthrough in 1977 in imaging technology. In an MRI, the subject is placed on a moveable bed that is inserted into a giant circular magnet. It is a non-invasive technique that does not involve exposure to radiation. It is usually painless medical test that helps physicians diagnose and treat medical conditions. MRI uses a powerful magnetic field, radio waves and a computer to produce detailed pictures of organs, soft tissues, bone and virtually all other internal body structures. The images can then be examined on a computer monitor.

2.3.5 Magneto Encephalo Graphy (MEG)

It is a new technology that measures the very faint magnetic fields that emanate from the head as a result of brain activity. In MEG, magnetic detection coils bathed in liquid helium are poised over the subject’s head. The brain’s magnetic field induces a current in the coils, which in turn induces a magnetic field in a special, incredibly sensitive instrument called a superconducting quantum interference device (SQUID). Of all the brain scanning methods, MEG provides the most accurate resolution of the timing of nerve cell activity—down to the millisecond.

2.4 Brain Functioning

Animals, lizards, frogs, fish, even birds have brains. But none of these creatures demonstrate the same capacity for learning, language, emotion and abstract thought that distinguishes the human species. Neuroscientists learned plenty about the functioning of the brain. But they admit there are aspects of brain-power that remain among humanity’s most enduring mysteries. The brain performs a number of functions, many of which are related to the physical needs and actions of the body. For these functions, the brain can be thought of as the command centre of the human nervous system, much like the headquarters of a military unit. It receives information from its vast network of neurons throughout the body. Based on this information, it makes decisions and issues commands that stimulate muscles and give the body movement. Other brain functions are more like those of a university than a military headquarters. These functions give us the ability to read, write, talk and think about issues more broad than where the next meal is coming from.

2.5 Brain Structure

The brain is made of three main parts: the forebrain, midbrain, and hindbrain. The forebrain consists of the cerebrum, thalamus, and hypothalamus (part of the limbic system). The midbrain consists of the tectum and tegmentum. The hindbrain is made of the cerebellum, pons and medulla. Often the midbrain, pons, and medulla are referred to together as the brainstem. The “wrist” is the *brainstem*, connecting the brain to the spinal column, and the “fists” constitute the left and right hemispheres of the largest part of the brain, the *cerebrum*. It is associated with higher brain function such as thought and action. The cerebral cortex is divided into four sections, called “lobes”: the frontal lobe, parietal lobe, occipital lobe, and temporal lobe. Figure 2.1 shows the cortex. Different areas or lobes of the cerebral cortex shown in figure play specific roles in human thought and activity. For example:

The *frontal lobes* control behavior, intellect and emotion, talking, self-monitoring, speaking (word finding), smell, abstract thinking and reasoning.

Temporal lobe is responsible for long-term memory storage, hearing, speech and understanding of language.

Parietal lobe is associated with movement, sense of touch, differentiation between size, shape colour, spatial perception, and visual perception.

Occipital lobe lies at the back of the brain and does vision function in the brain.

The cerebrum has an outer layer of *grey matter* arranged in folds (wrinkled texture). This outer layer, the *cerebral cortex*, is just a few millimeters thick but because of its numerous folds constitutes 40% of the entire brain mass. Essentially this makes the brain more efficient, because it can increase the

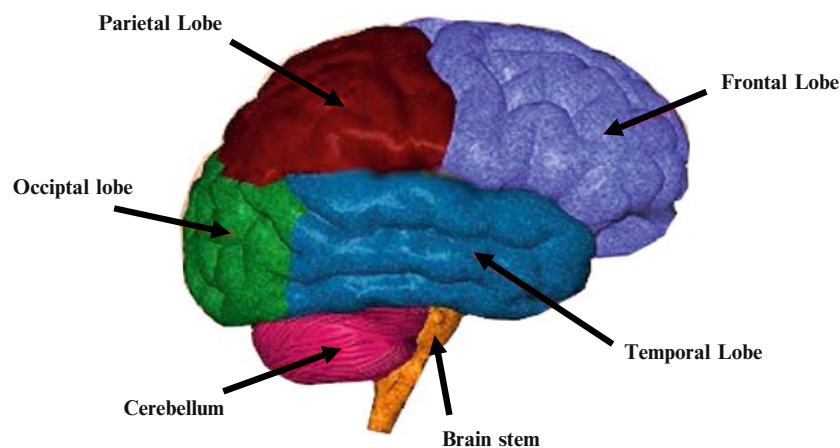


Fig. 2.1. Exposed view of brain

Table 2.1. Comparison between brain size and body size of human and different animals

Species	Brain length (cm)	Brain weight (g)	Body length (cm)	Body weight (g)
Camel	15	680	200	529,000
Dolphin		1,700	305	160,000
Human	15	1,400	100	62,000
Kangaroo	5	56	150	35,000
Baboon	8	140	75	30,000
Monkey	5	100	30	7,000
Raccoon	5.5	39	80	4,290
Cat	5	30	60	3,300
Rabbit	5	12	30	2,500
Squirrel	3	6	20	900
Frog	2	0.1	10	18

surface area of the brain and the amount of neurons within it. The outer cortex is divided into *gyri* (ridges) and *sulci* (valleys).

An obvious anatomical observation that one makes is that the brain is divided into two cerebral hemispheres. The size of these hemispheres is quite larger in humans than any other animal. The two hemispheres look mostly symmetrical yet it has been shown that each side functions slightly different than the other. In general, the right side of the brain controls movement in the left side of the body and the left side controls the right. However, there is some specialization. For example, language is more a function of the left hemisphere and recognition of shapes is more a function of the right.

The *cerebellum*, or “little brain”, is similar to the cerebrum and below to it, has two hemispheres and has a highly folded surface or cortex. This structure is associated with regulation and coordination of movement, posture, and balance.

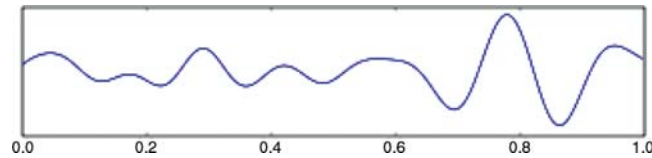
The limbic system, often referred to as the “emotional brain”, is found buried within the cerebrum. Underneath the limbic system is the brain stem. This structure is responsible for basic vital life functions such as breathing, heartbeat, and blood pressure. Scientists say that this is the “simplest” part of human brains because animals’ entire brains, such as reptiles (who appear early on the evolutionary scale) resemble our brain stem as given in Table 2.1.

2.6 Brainwaves to Study the State of Brain

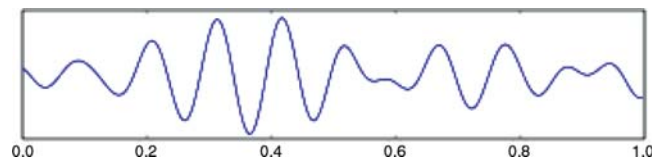
It is well known that the brain is an electrochemical organ. Researchers have speculated that a fully functioning brain can generate as much as 10 W of electrical power. Electrical activity emanating from the brain is displayed in the form of brainwaves. There are four categories of these brainwaves, ranging from the least activity to the most activity.

1. *Delta waves*

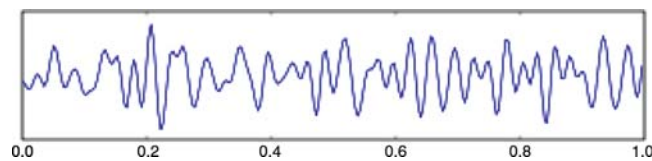
It is in the frequency range from 1 to 8 Hz. It is seen normally in babies and young children. It may be seen in drowsiness or arousal in older children and adults; it can also be seen in meditation.

2. *Alpha waves*

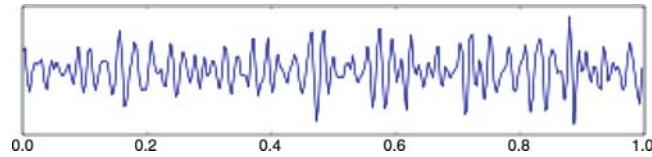
Alpha waves are shown when brain in non-arousal state. These waves are slower and higher in amplitude. Their frequency ranges from 9 to 14 Hz. A person who has completed a task and sits down to rest or meditates is usually in an alpha state.

3. *Beta waves*

When the brain is aroused and actively engaged in mental activities, it generates beta waves. These beta waves are of relatively low amplitude, and are the fastest of the four different brainwaves. The frequency of beta waves ranges from 15 to 40 Hz. Beta waves are characteristics of a strongly engaged mind. These brain waves are often associated with active, busy or anxious thinking and active concentration.

4. *Gamma*

It is the frequency range approximately 26–100 Hz. It represents binding of different populations of neurons together into a network for the purpose of carrying out a certain cognitive or motor function.



5. *Higher gamma waves*

It is the frequency range approximately 100–130 Hz.

Do you know?

1. *The brain* is the main switching unit of the central nervous system; it is the place to which impulses flow and from which impulses originate.
2. The spinal cord provides the link between the brain and the rest of the body.
3. The brain has three main parts:
 - a. The cerebrum
 - b. The cerebellum
 - c. The brain stem
4. The brain is a highly organized organ that contains approximately 100 billion neurons and has a mass of 1.4 kg and it is protected by a bony covering called the skull.
5. In order to perform the brain functions, it needs a constant supply of food and oxygen. If the oxygen supply to the brain is cut off even for a few minutes, the brain will usually suffer enormous damage. Such damage may result in death.

The cerebrum

1. The cerebrum is the control center of the brain. It is the largest and most prominent part of the human brain and 85% of the weight of a human brain is of cerebrum. It is responsible for all the voluntary (conscious) activities of the body.
2. It is the site of intelligence, learning and judgment. It functions in language, conscious thought, memory, personality development, vision, and other sensations.
3. The cerebrum takes up most of the space in the cavity that houses the brain (skull). It is divided into two hemispheres, the left and right cerebral hemispheres and a deep groove that separates the two hemispheres. The hemispheres are connected in a region known as the corpus callosum. The right and left cerebral hemispheres are linked by a bundle of neurons called a tract. The tract tells each half of the brain what the other half is doing.
4. The most obvious feature on the surface of each hemisphere are numerous folds. These folds and the grooves increase the surface area of the cerebrum. The ridges are called gyri, and the grooves are called sulcus.

5. The cerebrum, which looks like a wrinkled mushroom, is positioned over the rest of the brain. It contains thick layers of gray matter.
6. Each hemisphere of the cerebrum is divided into four regions called lobes. These lobes are named as, frontal, parietal, temporal, and occipital lobes.
7. Scientist have discovered that the left side of the body sends its sensations to the right hemisphere of cerebrum, and the right side of the body sends its sensations to the left hemisphere. The right hemisphere is associated with creativity and artistic ability and left hemisphere is associated with analytical and mathematical ability.
8. The cerebrum consists of two surfaces, one is folded outer surface called the cerebral cortex and consists of gray matter and second is the inner surface called cerebral medulla, which is made up of white matter.

The cerebellum

1. The cerebellum is the second largest part of the brain, and is located at the back of the skull. It coordinates muscle movements and balances the body.
2. This is a small cauliflower shaped structure, and well developed in mammals and birds. Bird performs more complicated feats of balance than most mammals.

The brain stem

1. The *brain stem* connects the brain to the spinal cord and maintains life support systems. It controls vital body processes.

2.7 Summary

The human brain is responsible for overseeing the daily operations of the human body and for interpreting the vast amount of information it receives. The adult human brain weighs an average of 1.4 kg, or about 2% of the total body weight. Despite this relatively small mass, the brain contains approximately 100 billion neurons. Functioning as a unit, these neurons make up the most complex and highly organized structure on Earth. The brain is responsible for many of the qualities that make each individual unique—thoughts, feelings, emotions, talents, memories, and the ability to process information. Much of the brain is dedicated to run the body, the brain is responsible for maintaining Homeostasis by controlling and integrating the various systems that make up the body.

- Our brain is more complicated than any computer we can imagine. There are 100 billion nerve cells in your brain, and every nerve cell has many connections to other nerve cells. In fact, your brain has more connections in it than there are stars in the universe!

- Sleep deprivation also decreases brain activity and limits access to learning, memory, and concentration. People who consistently slept less than 7 h had overall less brain activity.
- Stress negatively affects brain function. Brain cells can die with prolonged stress.
- Every time you learn something new your brain makes a new connection. Learning enhances blood flow and activity in the brain.

2.8 Bibliography and Historical Notes

An excellent up to date introduction to neuroscience can be found in Bear et al. (1996). Other interesting historical perspectives can be gleaned from (Arbib 1987, 1995, 2003; Kandel 2000; Kandel and Schwartz 1982). Bridgeman (1988) introduced the contemporary theories of behaviour and mind in lucid manner. The historical development of brain and mind are provided in accessible manner by Blackmore. For the detailed and advanced treatment on neurons and their working look (Koch 1999). Neurobiological aspects of memory are given in Dudai (1989).

2.9 Exercises

1. Explain the salient points of human brain development.
2. What do you mean by mind illusion?
3. Explain the different parts of human brain and also mention various functions performed by these part.
4. Summarize the functions of the major parts of the brain.
5. Summarize the functions of the cerebrum, brain stem, and cerebellum.
6. Describe how the brain is protected from injury.
7. Compare the brain size and body size of human beings and different animals.
8. Write in brief about the emotional brain of human being. Where does it locate?
9. What do you mean by brain waves?
10. What are the different categories of these brainwaves?
11. Which type of brain waves often associated with active, busy or anxious thinking and active concentration?

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