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Editorial

Human Brain: Mystery Revealed?

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The human brain was a mystery baffling the ordinary peasant as well as philosophers of yore. It was mystified further when theology and religion tried giving interpretation and meaning to various cognitive functions of the brain, adding more complexity to the complex nature of the brain. Today, in the era of scientific inventions and technological advancement, brain and neural activities are explored and understood to a greater extent. However, the famous philosophical dictum of René Descartes (1596 - 1650) cogito ergo sum that differentiates animals and human beings, the awareness of one's own self, the origin of human consciousness is not explored. Brain still remains a mystery that needs to be explored continuously.

Today the human brain is the most complex organ in the whole body. Human brains consist of billions of neurons that control simple survival to complex cognitive functions. The development of the human brain is a slow and steady process of millions of years of evolution; from a simple animal brain that focused merely on the survival needs to a sophisticated conscious mechanism that can execute more complex cognitive functions. To explore the mystery that surrounds the brain, therefore, scientists take a multidisciplinary approach that comprises of fields like primatology, palaeontology, anthropology, archaeology, history, biology, biogeography, neurology, psychology, phrenology, natural sciences and many more. As far as psychology is concerned, there are many subfields that are closely associated with neurology and the brain related studies; for example, biopsychology, neuropsychology, cognitive psychology, evolutionary psychology, developmental psychology, and psychiatry to mention a few. Scientists from these fields closely associate with other fields and explore the depths of the brain and its neural network to help people in their concerns related to psychopathology, personality, cognition, feelings, emotions, and overall human behaviour.

The study of human evolution plays a vital role in understanding the development of the human brain, from primates to *Homo sapiens.* The endocast is a popular technique used by scientists to study the evolutionary development of the brain by measuring the cranial vault in braincases. The size and shape of the braincase help scientists to understand the nature of the primitive and modern brain. As a result, scientists understand that in the process of human evolution, brain size tripled and thus complex higher functionality emerged. Since the time of *Homo erectus,* some distinct skills appeared in humans that separated them from primates. These necessitated major adjustments to life situations, like, making simple tools, migrating to fertile and inhabitable places; social identity and networks also contributed to the brain expansion (in size). Thus, external conditions, environmental habitats, social interactions, and other extended activities play a vital role in the evolution of the human brain.

The brain of the early humans was similar in size to those of our immediate ancestors the chimpanzee, with subtle differences in the temporal cortex. Modern-day chimpanzees have a less white matter in the cortex, fewer connections between nerve cells leading to fewer cognitive functions. Early humans, on the other hand, had a more white matter in the cortex area that resulted in more connections between nerve cells and a greater ability to process information. The human brain evolved both in size and function in the course of time, and the average weight of an adult chimpanzee brain is 384g whereas that of a modern human brain is 1,352g.

Homo sapiens, the modern day humans, evolved some 200,000 years ago. The *Homo habilis* that inhabited sub-Saharan Africa approximately 2.33 to 1.4 million years ago had a brain size of 640 cm^3. The *Homo heidelbergensis* found across Southern and Eastern Africa and Europe had the brain size of 1,250 cm^3. In contrast, *Homo floresiensis* (an extinct human species discovered on the Indonesian island of Flores, Indonesia in 2003) had a smaller brain, half a size of its presumed immediate ancestor, *Homo erectus* (900 cm^3). *Homo Neanderthal* (an extinct species that co-existed with *Homo sapiens* in Eurasia some 45,000 - 40,000 years ago) on the other hand had a larger brain (1500 cm^3 with an average weight of 1,497) than the average modern human brain (1260 cm^3). Therefore, it is not only the size but the complexity of functions as well that differentiate *Homo sapiens* from other human ancestors. *Homo sapiens* coexisted with Neanderthals in

Europe for thousands of years and the higher complexity of *Homo sapiens* brain functions that gave them an edge over their counterparts in survival supremacy. Although Neanderthal had sophisticated hunting skills and comparatively bigger brains, the superior cognitive and communicative skills of *Homo sapiens* made life easier for them to survive. Anthropologists who studied the skeleton of Cro Magnon man who lived some 28,000 years ago and prepared a replica of the brain using the endocast technique found that it is about 15 - 20% larger than our present brain. Over the past 20,000 years, the human brain has decreased from 1,500 cm^3 to 1,350 cm^3 all over the world [1,2]. Anthropologists attribute this to the body size of modern-day humans, and the various environmental conditions and lifestyles. Some scientists also look positively that shrinking brain will make the brain more agile, sharper, and quicker to react due to the proximity of neurons.

From pseudoscience to science

In the 18th century, phrenology was considered a breakthrough progress in the field of neurology and was used as a powerful diagnostic tool of brain anatomy. Phrenology went to the extreme idea of a compartmentalized brain, each part dedicated to a single function or, different functions situated at a particular part of the brain. Franz Joseph Gall (1758 - 1828) was one of the strong proponents of this concept. According to these theorists, identifying skull bumps provided them with comfortable insight and precision in understanding personality and behaviour. Though popular, a few centuries ago, this concept has lost its charm today due to modern technology based brain studies. There is no established scientific evidence today to count the bumps on the skull, as claimed by Gall and his followers, to correlate it with the neural activity of the brain inside. Today's sophisticated brain studies pushed phrenology to the realm of pseudoscience. However, it has contributed to the modern day understanding of mental phenomena, cerebral localization, and neuroscience.

Myth and Mystery

There is a popular myth among people that humans use only 10 percent of their brains. Functional magnetic resonance imaging (fMRI) measures the brain activity based on the blood flow and oxygen intake during different human activities gives a different picture. Neuroanatomists have mapped different structures of the brain with the help of fMRI, relying on the changes in blood flow and oxygen consumption. When a particular human activity takes place, scientists know for certain, from which part of the brain the particular activity has originated and what are the other parts of the brain involved in the activity. Similarly, computational neuroscience, specifically, computational neuroanatomy helps scientists to reconstruct brain and neural networking. Moreover, it uses various mathematical, statistical and computational methodologies together with visualization, modelling, and simulation techniques to understand, how the brain converts sensory information from its environment into human behaviour. However, one shortfall that modern science faces today in brain studies is regarding the functioning of the brain in a specific way and that still remains a mystery.

New pieces of evidence

As a part of human development, there are significant and sensitive phases in the early childhood during which certain skills and functions are more efficiently performed by easily establishing neural connections in the brain than at a later period. One such activity is language learning. When the brain is young, there is a lot of flexibility to learn new things as it is easy to create new neural networks. As people grow and more the one use these established neural pathways, the neural connections become deeply embedded and hard to be removed. This is the reason why people are stuck in their childhood, younger days behaviours or habituated thought patterns and lifestyle. Therefore, it needs psychotherapy to remodify this neural networking. As we reach adulthood in the late twenties, we have so many existing pathways that our brain relies upon, it becomes hard to break free of them and the brain always looks for lazy, easy shortcuts rather than learning new pathways or establishing new neural connections.

New pieces of evidence show that the brain is capable of forming new connections at any point in time and has the potency to develop new neurons throughout the lifespan. This does not mean we can learn anything at any time. In a study among mice, scientists identified that pheromones trigger new neurons. Pheromones are chemicals produced to attract the same species. They are often found in urine or sweat. Study on mice sheds more light on this issue on what happens in the brain and the kind of chemical as well as neurological changes are produced in the brain [1]. Urine releases sex pheromones that help rats to recognize and choose their mates to stimulate new neurons. Pheromones trigger the hypothalamus, to release of hormones that cause the new neurons. Based on this and similar concepts, many neurologists suggest some remedies to keep the human brain alive and agile even in old age [3]. By initiating activities that are not used frequently can stimulate the brain to grow new neurons and establish new neural networks and pathways. Thus, an opportunity is created to have new neurons in the brain. Swart [4] suggests that learning a new language, musical instrument, and other complex activities can keep the brain agile and active.

Mystery yet to be explored

In spite of all the recent developments in the neurosciences, the human brain still remains a mystery in certain aspects. Although some major philosophical questions like, freewill and freedom to act are not fully understood by brain studies, some basic brain functions are also not clearly understood. One such basic activity is sleep. Why do we sleep and what exactly happens in the brain neural network during sleep still remains a mystery. Thalamic reticular nucleus (TRN) is the structure in the brain that is known for relaying signals to the thalamus and then the brain's cortex, oscillating brain waves that lead to sleep. This oscillation induces decreased arousal. Neuroscientists are not conclusive rather infer that the TRN happens in the brain in order to consolidate new memories and exchange information with each other. This sharing of information among different areas of the brain during sleep facilitates programming our long-term memories from fragments that are received and stored. Neuroscientists have discovered that during sleep only a small region of the brain is less alert, while the rest of the brain remains awake and active. What induces sleep is understood by scientists, however, what exactly happens during sleep is not fully understood.

Human consciousness is yet another important aspect that has not been fully explored in brain function. Conscious awareness is the landmark of the human brain that gives us a unique identity, thoughts, feelings, opinions, and preferences that place us above animals as far as brain functions are concerned. However, neuroscientists are not able to explain how ordinary sensations are translated into mental images leading to subjective cognitive preferences.

Conclusion

Brain studies are slowly moving from myths to reality. A lot of breakthroughs have been done through various sophisticated methods and techniques. Brain studies shed more light on human activities and its correlates in the brain, mainly the "what and where" it happens. However, "why and how' it happens is not understood yet fully and thus brain still remains a mystery and cogito ergo sum remains an

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