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Function of Human Brain, from a Fecondary School Student's Perspective - a Review

Shreesha Sadagopan[1], Sampath Santhanam Ethiraj[2], Hemavathi Santhanam[3], Y. Lakshmisha Rao[4], B.V. Murlimanju[4]

[1]Lord Dorchester Secondary School, 61 Queen St, Dorchester, ON NOL 1G2, Canada
[2]Medical Director, Parkview Randallia Hospital, Inpatient Units, Adjunct Faculty Parkview Internal Medicine Residency Program, Volunteer Associate Faculty, Internal Medicine Clerkship, Indiana University School of Medicine, The United States of America
[3]Faculty of Science, Saint Mary's University, 923 Robie Street, Halifax, Nova Science, Canada
[4]Department of Anatomy, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, India

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ABSTRACT

Introduction: this review article explores the lobes of the brain, along with the different structures present in them such as the sulci, gyri, etc., with their functions, to provide a gentle introduction to a beginner-level reader, who wants to wet their feet in shallow waters before deep diving into the subject. It begins with a note on the basic organization of the brain, peeking into each of those divisions, cerebrum and its lobes, cerebellum and the brainstem while introducing the gyri, sulci and cortices. Further, a brief explanation of some important functional systems like limbic system and basal ganglia, and way to protect the brain is provided.

Keywords: Brain Stem; Cerebrum; Cerebellum.

Introduction

Cerebrum controls essential body functions like movement, coordination, speech production and comprehension, and body temperature regulation. The right and left hemispheres are connected to each other through a large, C-shaped structure, called the corpus callosum connecting both hemispheres. Corpus callosum is mainly formed of white matter and bundle of nerves. Each lobe performs and/or controls specific functions. Contrary to the popular belief that each half of the hemispheres controls specific functions (such as feelings, creativity, logic, emotion), both hemispheres are involved in these functions' regulation. The lobes are separated by deep ridges called sulci. Frontal lobe (FL) is situated behind the forehead. This lobe is covered by the frontal cortex and both, the lobe, and the cortex get their names due to their position. The frontal cortex also contains parts of the motor cortex called primary motor and secondary motor cortices. It is important for processing and interpreting somatosensory input and assembling input from other senses and converts it to a form the brain can use for other purposes. It is also involved in proprioception, by sensing the location, movement and action of parts of the body. Damage to this lobe may cause hemispatial neglect, which is the ignorance or lack of awareness of one hemisphere. The parietal lobe houses the brain's primary somatosensory cortex, a region where the brain interprets inputs like nociception, proprioception, and sense of touch from other parts and areas of the body. Its role in basic attention to language and social cognition has also been recognized[1]. Occipital lobe is situated at the back of the head. Damage to this lobe can cause difficulty with locating, recognizing and perceiving colors, shape, movement among a slew of other problems and inconveniences. The occipital face area is specialized for the perception of faces. The only cortex located in occipital lobe is the primary visual cortex whose functionality is to receive information from the eyes, compartmentalize them, and integrate the visual information[2]. The temporal lobe of the human brain, located just behind the ears is where auditory information is processed, along with the encoding of new memories. Further, the posterior part does language processing, intelligible speech and processes verbal mental arithmetic. The inferior temporal gyrus has been found to be involved in the writing of non-alphabetical languages, through a Japanese fMRI experiment. The fusiform gyrus is primarily concerned with the higher functions of vision. A few of such are object recognition, shape perception, motion detection etc[3]. The parahippocampal gyrus plays a chief role in memory encoding and retrieval. The cerebellum is located at the back of the head. The name cerebellum originates from Latin, which means, "Little brain". This part of the brain was previously thought to have been the coordinator of muscle movements but has been found to be crucial in several types of motor learning.

Brainstem connects the cerebrum, basal ganglia, diencephalon, cerebellum and spinal cord with each other. This part of the brain also has a critical role in the regulation of cardiac and respiratory function.

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It also controls various other roles, like regulation of central nervous system and sleep cycle. One important area in the brainstem is the substantia nigra, which is an important relay station for the motor system.

Limbic system

Limbic system helps in processing emotions and memories. It regulates all the functions needed for basic survival, such as thirst, hunger, regulating the fight or flight response among other functions. The hippocampus encodes new memories and associates them with sense. This is also one of the few parts of the brain where neurogenesis takes place, hence the hippocampus is also important in brain plasticity. The amygdala, an almond shaped structure, plays a median role in emotional response. This structure also attaches emotions to memories and determines how well or robust a memory will be stored. The hypothalamus also helps in maintaining the homeostasis of body. The limbic system also includes the fornix, cingulate gyrus, corpus callosum, pineal gland etc.

Basal nuclei

Basal nuclei manages the signals responsible for motor control, executive functions, behavior and emotions. It mainly consists of striatum, putamen, caudate nucleus (CN), globus pallidus (GP), subthalamic nucleus (STN) in the cerebral hemispheres; substantia nigra in the cerebellum; and the pons. The CN, putamen and nucleus accumbens act as the input nuclei receiving signals from the cortical, thalamic and nigral regions. The external segment of globus pallidus, subthalamic nucleus and substantia nigra pars compacta form the intrinsic nuclei. The internal segment of globus pallidus and SN pars reticulata are output nuclei that pass the signals from basal ganglia to the thalamus, which, in turn relays the signals to the cortical regions in the frontal lobe[4].

Insular cortex

The insular cortex, also known as the island of Reil, is a lavishly connected structure that serves as a cortical hub, is involved in multimodal sensory processing, interoception, emotional counsel of social behavior among other functions[5]. Its name emanates from Latin, meaning "island". In medical literature and text, the insula or insular cortex has been described as a separate or the "fifth" lobe, even being described as a part of other functional and structural groupings in the brain. This cortex is principal for risk-reward behavior processing, gustatory and sensorimotor processing, auditory and vestibular functioning, along with other jobs and responsibilities. It is because of this structure, people have awareness of the body, their self, and are able to perceive pain. Damage of any kind to this structure can cause neurological morbidity, and even mortality. Injury to the insula has also been associated with cardiac arrythmias. Anatomically, it dorsally separates the parietal and frontal lobes from the temporal lobe.

Meninges

The brain is protected from collisions, clashes, strikes, bumps, crashes etc. by 3 outer layers, called meninges. They are dura mater, arachnoid and pia mater, in that order. The dura mater, a thick and tough covering, covers the inner portion or dome of the skull and is itself divided into two layers, the periosteal layer and the meningeal layer. The inside of the cranium of the skull is lined by periosteal layer of the dura matter and then the meningeal layer. The space present in between the periosteal and meningeal layer allows for arteries and veins to supply blood, to and from the brain. The arachnoid mater, however, unlike the dura mater, is a thin weblike connective tissue that does not contain nerves or blood vessels. This layer contains cerebrospinal fluid or CSF, directly below it. The CSF cushions the central nervous system (CNS), and continually circulates around the related structures (brain and the spinal cord) to remove impurities and to provide protection. The arachnoid mater is below the dura mater, and the pia mater separates it from the brain. The last layer of protection for the brain, the pia mater, is situated right above the brain and is rich with blood vessels. Diseases such as meningitis, that affect these layers can prove to be fatal if not diagnosed and treated at the early stages as they compromise the safety of protective layers of the brain and in turn, the brain itself.

Conclusion

The human brain is complex. A broad overview of the human brain is bound to look somewhat big and brimming with information but in reality, it is not. Nature has assigned different responsibilities to different structures of the brain based on their placement in the brain, their strengths, weaknesses, the structures that surround them, among the other factors. The study of the brain can, therefore, become much comprehendible if studied in depth at the level of each structure, area, region, lobe of the brain.

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Corresponding author
BV Murlimanju
E-mail: flutemist@gmail.com