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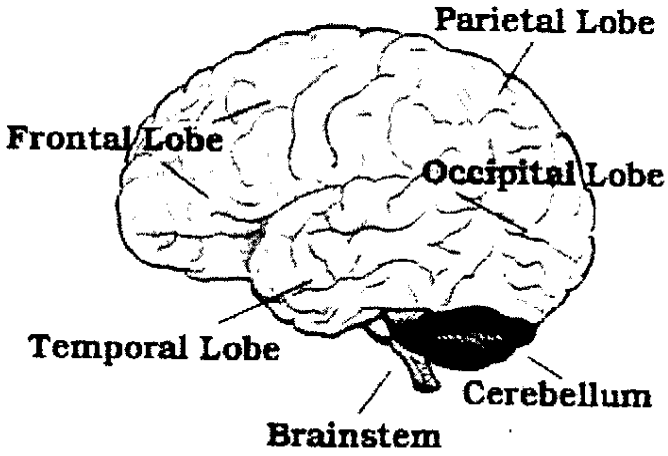

Functions of the Frontal Lobe

- Initiation
- Motivation
- Planning
- Self-Awareness
- Planning Complex Movements
- Behaviour
- Emotions
- Word Formation

Functions of the Occipital Lobe

- Visual Processing of Words
- Vision

Functions of the Temporal Lobe

- Language Comprehension
- Intelligence
- Auditory
- Memory
- Naming of Objects

Functions of the Parietal Lobe

- Somatic Sensory
- Spatial Co-ordinates of Body and Surroundings

Functions of the Cerebellum

- Coordination of Voluntary Movement
- Balance and Equilibrium
- Some Memory for Reflex Motor Acts

Functions of the Brainstem

- The Main "Highway" for the Vast Quantities of Information Flowing Between the Brain and the Rest of the Body

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Brain Neurology: Building A Brain From The Bottom Up

One way of looking at the parts of the brain and what they do is to consider the brain from the lowest and most primitive parts up to the highest and most advanced pans. This basically follows the evolution of the brain: the simplest lower parts evolved first and the highest and most complex parts evolved most recently.

We will look at the brain as composed of six basic parts of generally increasing complexity from the bottom up: BRAIN STEM, CEREBELLUM, THALAMUS, BASAL GANGLIA, LIMBIC SYSTEM, AND CORTEX.

Brain Stem: Arousal And Basic Life Functions

WHERE IS IT?: When the spinal cord enters the skull through a hole in the bottom called the FORAMEN MAGNUM, it becomes the BRAIN STEM. The spinal cord and BRAIN STEM merge into one another. The BRAIN STEM is basically a small enlargement of the spinal cord. It is about the size of your little finger and rests at the very base of the brain, supporting it like a stem for a flower. There are three parts to the BRAIN STEM from the bottom up: the MEDULLA, the PONS, and the MIDBRAIN.

WHAT DOES IT DO?: The BRAIN STEM is the oldest and deepest part of the human brain, having evolved more than five hundred million years ago -- long before there were humans on earth. Scientists sometimes call it the "Reptilian Brain" because it resembles the simple brain of a reptile.

The BRAIN STEM has two main functions: (1) BASIC LIFE FUNCTIONS through the respiratory and cardiac centers in the lower part, the MEDULLA, and (2) AROUSAL through the RETICULAR ACTIVATING SYSTEM that stretches throughout the BRAIN STEM. The RETICULAR ACTIVATING SYSTEM alerts the thinking part of the brain, the CORTEX (located at the very outside of the brain), like a telephone bell, letting it know that information is going to arrive.

The 12 pairs of CRANIAL NERVES also originate and exit from the BRAIN STEM. The sensory and movement pathways to and from the brain and spinal cord pass through the brain stem.

: The BRAIN STEM can be injured by trauma, disease, or stroke. When injured, alertness and arousal may be reduced or cranial nerve deficits may be seen. Also, there can be impairment in movement and touch sensation in the body and breathing and heart rate can become disturbed. After severe brain trauma, death often results from brain swelling that compresses the MEDULLA of the BRAIN STEM causing respiratory and/or cardiac

Cerebellum: Balance And Coordination

WHERE IS IT?: The CEREBELLUM lies underneath the lower back of the skull, just under the CEREBRAL HEMISPHERES and right behind the BRAIN STEM. It has a right and left hemisphere. It is convoluted on the outside with bulges and valleys. It is about the size of two large plums. It has many connections with the BRAIN STEM and other parts of the movement system of the brain.

WHAT DOES IT DO?: The CEREBELLUM has two main functions: (I) BALANCE of the body and (2) COORDINATION of body movement. Through its

connections with the motor system, the CEREBELLUM influences the body's ability to stand upright, walk, and coordinate fine and gross body movements.

WHAT HAPPENS WHEN IT'S INJURED?: The CEREBELLUM can be injured by trauma, disease, and stroke. When injured, difficulties in coordination called ATAXIA can be produced where individuals may not be able to touch their noses or perform coordinated movements. Balance may also be affected, and there may be difficulties in standing upright or walking.

Thalamus: Relaying And Processing Sensory Information

WHERE IS IT?: The THALAMUS sits just above the top of the BRAIN STEM more or less in the center of the brain. There are two of them: a right and a left, each about the size and shape of a large grape. Specific areas of the THALAMUS have direct neural connections with the rest of the brain and spinal cord.

WHAT DOES IT DO?: The THALAMUS has two main functions: (1) it is the great RELAY CENTER for incoming sensory information to the brain. and (2) it performs PRELIMINARY SENSORY PROCESSING of incoming information. Specialized areas in the THALAMUS receive sensory information from visual, hearing, and touch (pain, temperature, and position sense) sensory pathways. These areas then relay the information to the cortex to be perceived and analyzed.

WHAT HAPPENS WHEN IT'S INJURED?: The THALAMUS can be injured by trauma, disease, or stroke. The deficits after injury to the THALAMUS depend upon what specific area is injured. If the visual receiving and processing areas are injured, visual field deficits can result. If the touch perception areas are injured, there can be difficulties in feeling touch and, sometimes, acute pain syndromes.

Basal Ganglia: Starting And Controlling Of Movement

WHERE ARE THEY?: The BASAL GANGLIA are a collection of small gray areas or clusters of neurons located deep within each of the CEREBRAL HEMISPHERES on either side of the THALAMUS in sort of a ring shape.

WHAT DO THEY DO?: The BASAL GANGLIA have two main functions: (1) CONTROL OF INVOLUNTARY MOVEMENT and (2) INITIATING VOLUNTARY MOVEMENT. Involuntary movement is the resting type of postural movement and body position that is in control when no voluntary movement is present. This is movement that you don't plan or think about like sitting in a chair or letting your arm rest on the arm of a chair. The BASAL GANGLIA are also heavily involved in the initiation of voluntary movements like walking and talking.

WHAT HAPPENS WHEN THEY'RE INJURED?: The BASAL GANGLIA can be injured by trauma, disease, or stroke. When injured, movement disorders usually result. A major disease of the BASAL GANGLIA, PARKINSON'S DISEASE, results in stiffening and slowing of voluntary movements, involuntary or "resting" tremors, and poor initiation of movement. Parts of the BASAL GANGLIA are also involved in the higher planning, organizing, and analyzing of behavior.

Limbic System: Emotions And Memory

WHERE IS IT?: The LIMBIC SYSTEM is a ring-like collection of several brain structures in the deep areas of the CEREBRAL HEMISPHERES that is adjacent to, but somewhat larger than the BASAL GANGLIA. The deep parts of the TEMPORAL LOBES and FRONTAL LOBES of the CEREBRAL HEMISPHERES are connected to the LIMBIC SYSTEM.

WHAT DOES IT DO?: In humans, the LIMBIC SYSTEM has two main functions: (1) MEMORY and (2) EMOTIONS. Areas of the LIMBIC SYSTEM like the HIPPOCAMPUS ("sea horse"; it is shaped like one) are involved in storing new experiences into memory so that this information can be recalled at a later date. Other areas of the LIMBIC SYSTEM like the AMYGDALA ("almond"; it's shaped like one) are involved with the production of feelings or emotions.

The LIMBIC SYSTEM evolved between two hundred million and three hundred million years ago. It has sometimes been called the "Mammalian Brain" because it is most highly developed in mammals and is responsible for some of the key differences between mammals and reptiles: ability to learn, complex emotional expressions of love and guilt, raising of young in social settings, and regulation of internal body stability. The LIMBIC SYSTEM is particularly involved in the emotional reactions that have to do with survival: sexual desire and self-protection through fighting or escaping.

The HYPOTHALAMUS is a very important pan of the LIMBIC SYSTEM. About the size of a large pea and lying just under the THALAMUS, the HYPOTHALAMUS has been called the "Brain within the Brain" because of its involvement in so many functions. It is involved in the regulation of eating, drinking, sleeping, waking, body temperature, chemical balances, heart rate, hormones, sex, and emotional expression, among other things.

The connections between the LIMBIC SYSTEM and CEREBRAL CORTEX are most important in producing higher adaptive human behavior. The LIMBIC SYSTEM produces the emotional states that motivate and flavor behavior. The emotions and memory traces of the LIMBIC SYSTEM are constantly influenced by the cognitive "thinking" processes of the CEREBRAL CORTEX. Thoughts act to create emotional states which, in turn, create behavior.

WHAT HAPPENS WHEN IT'S INJURED?: The LIMBIC SYSTEM can be injured by trauma, disease, and stroke. Depending upon what part of the LIMBIC SYSTEM is injured, numerous problems in internal body regulation and higher behavior can result. Injury to the HIPPOCAMPUS can result in severe memory deficits. Injury to the AMYGDALA can result in extreme and inappropriate emotional states. Injury to the HYPOTHALAMUS can result in the inability to control the body's temperature, fluid levels, hem rate, and sleep cycles.

Lobes Of The Cerebrum: Thought And Control Of Behaviour

When looking at the brain from the outside, most of what can be seen are the two large circular globes that form the CEREBRUM. The CEREBRUM is divided into a RIGHT CEREBRAL HEMISPHERE and a LEFT CEREBRAL HEMISPHERE. Each of these CEREBRAL HEMISPHERES is responsible for the opposite half of the body. The lei~ side of the brain controls movements and receives information ~om the right side of the body, and the right side of the brain does the same for the left side of the body.

The extreme outside layer of the CEREBRAL HEMISPHERES is the CEREBRAL CORTEX, or CORTEX, for short. The CORTEX is the highest evolved and most complex part of the human brain, even though it is only about one-eighth of an inch in thickness. The CORTEX has two main functions: (1) inner speech or THOUGHT that analyze incoming information to the brain and (2) the CONTROL OF BEHAVIOR, including the planning, organization, initiation, and monitoring of behavioral actions.

The CEREBRAL HEMISPHERES are connected to each other by a large band of nerve fibers called the CORPUS CALLOSUM. This allows the RIGHT and LEFT CEREBRAL HEMISPHERES to communicate with each other in an efficient

manner. Via the CORPUS CALLOSUM, the two CEREBRAL HEMISPHERES interact to produce most of our complex human behaviors.

CEREBRAL CORTEX: THE "BARK" OF THE BRAIN: The CEREBRAL CORTEX is the outside one-eighth of an inch of the CEREBRAL HEMISPHERES of the brain, sometimes called the GRAY MATTER because of it's gray, mottled appearance. The word CORTEX comes from the Greek for "bark", which aptly describes it's location on the outside edge of the cerebral hemispheres. The CORTEX has more neurons than any other brain structure. This area is where the cell bodies and dendrites of the cortical neurons are located and where the higher mental processes take place. Utilizing the CORTEX, the outside world is perceived, our thoughts are organized, our individual experiences are stored in memory, speech is produced and understood, scenery is seen, and music is heard. Although it is known what certain areas of the CORTEX do, we actually know very little about how it actually works and it is still one of the great mysteries of science. For example, it is still unknown exactly how memories are stored in the CORTEX, how these memories are retrieved, or how new ideas occur.

The Left And Right Cerebral Hemispheres: Language And Spatial

In nearly all fight-handed individuals and most left-handed individuals, the LEFT CEREBRAL HEMISPHERE is specialized for language, including reading, writing, listening, and speaking. The RIGHT CEREBRAL HEMISPHERE, in most individuals, is specialized for non-language or spatial abilities like recognizing p,,771es, knowing directions, drawing pictures, and solving p,,771es.

THE BACK THREE LOBES OF THE BRAIN: INPUT: The outside surface of the CEREBRAL CORTEX is folded into numerous convolutions so that only about thirty percent of the CORTEX is visible from the outside on the bulges or GYRI. Seventy percent is hidden within the folds of the brain, called SULCI.

: While the rear three lobes of the brain are concerned with receiving and analyzing information, the frontal lobe of the brain is concerned with the OUTPUT of all planned voluntary behavioral actions.

Temporal Lobe: Hearing

WHERE IS IT?: The TEMPORAL LOBE is a large, thumb-shaped extension of the CEREBRAL HEMISPHERES located near the temples of the head. It lies at the side of the brain below the FRONTAL and PARIETAL LOBES. The back of the TEMPORAL LOBE borders on the OCCIPITAL LOBE, which is at the extreme rear of the CEREBRAL HEMISPHERES.

WHAT DOES IT DO?: Much of what is known about the functions of the TEMPORAL LOBE comes from studying people who have had some sort of brain damage in this area of the brain. In both CEREBRAL HEMISPHERES, the top of the TEMPORAL LOBE has a small area about the size of a poker chip that is responsible for hearing (the AUDITORY CORTEX). The TEMPORAL LOBE is also involved in perception and memory.

The TWO TEMPORAL LOBES do two different things. The LEFT TEMPORAL LOBE is specialized for the comprehension of language, including listening and reading. The RIGHT TEMPORAL LOBE is specialized for comprehending music.

WHAT HAPPENS WHEN IT'S INJURED?: The TEMPORAL LOBE can be injured by disease or trauma, but is most often injured by a stroke in the MIDDLE CEREBRAL ARTERY which provides blood and nourishment to the TEMPORAL LOBES. Injury to the LEFT TEMPORAL LOBE can produce a disorder of

language called WERNICKE'S APHASIA where there is (1) an inability to comprehend what someone is saying and (2) an inability to read. Injury. to the RIGHT TEMPORAL LOBE can produce an inability to recognize and appreciate music.

Occipital Lobe: Seeing

WHERE IS IT?: The OCCIPITAL LOBE is in the extreme rear of the CEREBRAL HEMISPHERE at the back of the head. The VISUAL *CORTEX*, where vision is perceived, is located on the inner inside surface of the OCCIPITAL LOBE where it is hidden and well protected.

WHAT DOES IT DO?: The OCCIPITAL LOBE is devoted entirely to vision and is often called the VISUAL CORTEX. Visual information is sent from the eyes through the THALAMUS to the VISUAL CORTEX in the OCCIPITAL LOBE, where it is perceived and analyzed for color, shape, position, and movement. As in all sensory pathways, information from one side of the body goes to the opposite side of the brain. Information seen in the left visual field in both eyes projects to the opposite RIGHT OCCIPITAL LOBE and information seen in the right visual field in both eyes projects to the opposite LEFT OCCIPITAL LOBE.

WHAT HAPPENS WHEN IT'S INJURED?: The OCCIPITAL LOBE can be injured by disease or trauma, but is most often injured by a stroke causing loss of blood flow or bleeding. Damage to the OCCIPITAL LOBE can result in disorders of perception, called AGNOSIA (not knowing), such as impaired color vision or the inability to recognize objects. Even blindness can result, if the injury is severe enough. Injury to RIGHT OCCIPITAL LOBE can result in an inability to see in the left visual field, called a LEFT HOMONYMOUS HEMIANOPSIA, Injury to the LEFT OCCIPITAL LOBE can result in an inability to see in the right visual field, called a RIGHT HOMONYMOUS HEMIANOPSIA.

Parietal Lobe: Touch Sensation

WHERE IS IT?: The PARIETAL LOBE (Latin for "forming the sides") is located on the upper sides of each CEREBRAL HEMISPHERE, above and in front of the OCCIPITAL LOBE, above the TEMPORAL LOBE, and behind the FRONTAL LOBE.

WHAT DOES IT DO?: The PARIETAL LOBE is responsible for perceiving, analyzing, and assembling touch information from the body. It is also in the PARIETAL LOBE where visual, auditory, and touch information combine to make sense of the world. The LEFT PARIETAL LOBE is also believed to be the area where letters come together to form words and where words are put together in thoughts. The RIGHT PARIETAL LOBE is responsible for understanding the "spatial" nature of the world, including recognizing faces and shapes, being aware of body states and deficiencies, and knowing directions.

WHAT HAPPENS WHEN IT'S INJURED?: The PARIETAL LOBE can be injured by disease, trauma, or stroke. When the PARIETAL LOBE is injured, the inability to recognize touch sensation from the opposite side of the body can result. For example, injury to the RIGHT PARIETAL LOBE could result in the inability to know when the left side of the body was touched or moved. Injury to the RIGHT PARIETAL LOBE could also result in AGNOSLA ("not knowing") such as not being able to recognize familiar objects touched by the hands. Injury to the LEFT PARIETAL LOBE could result in not knowing the meaning of words and the inability to do arithmetic calculations.

Frontal Lobe: Organizing And Controlling Actions

WHERE IS IT?: The FRONTAL LOBE is located in front of the brain just behind the forehead. It is in front of the PARIETAL LOBE and just above the TEMPORAL LOBE. It is the largest and most recently evolved of the four lobes of the CEREBRUM.

WHAT DOES IT DO?: The FRONTAL LOBE provides "executive" control over much of the brain's higher functions. The FRONTAL LOBE is concerned with the output of behavior and contains the neurons connected to the brain stem and spinal cord that control voluntary movement. The RIGHT FRONTAL LOBE controls movements of the left side of the body and the LEFT FRONTAL LOBE controls movements of right side of the body. The FRONTAL LOBE plans, initiates, and controls all purposeful actions.

Through complex connections to all parts of the brain, the FRONTAL LOBES are also involved in controlling attention and concentration, abstract and complex thinking, decision making, mental flexibility, higher judgment and reasoning, and emotional responses. The LEFT FRONTAL LOBE also contains an area called BROCA'S AREA which is responsible for producing speech and language output such as speaking and writing.

WHAT HAPPENS WHEN IT'S INJURED?: The FRONTAL LOBES can be injured by disease, trauma, and stroke. When a FRONTAL LOBE is injured, weakness (hemiparesis) and even total paralysis (hemiplegia) can result on the side of the body opposite to that lobe. Injury to the FRONTAL LOBES often results in distractibility, difficulty concentrating, inflexible thinking, simplistic or "concrete" thinking, the inability to plan or think ahead, poor judgment, and inappropriate emotional behavior. This is sometimes called a FRONTAL LOBE SYNDROME. Injury to the LEFT FRONTAL LOBE can result in injury to BROCA'S AREA a disorder of language called BROCA'S APHASIA where the individual has difficulty communicating with others through speaking and writing. Such individuals may not be able to speak or communicate at all or may be able to say only a few simple words even with a great deal of effort.

Interacting Parts Of The Brain

Most higher, complex behavior is the result of the interaction of many different parts of the brain. In particular, the "higher" thought processes of the cortex can powerfully influence functions of the brain done by "lower" brain areas. Below are a couple of common examples.

FRONTAL-BRAIN STEM CONNECTIONS: THOUGHTS AND AROUSAL: The frontal lobes of the brain are responsible for controlling and regulating much of the brain's activities. The Reticular Activating System, or RAS, of the Brain Stem is responsible for arousing and alerting the brain. However, these two parts of the brain often interact to regulate alertness. For example, when an individual has been awake for 24 hours without sleeping, the RAS will usually become inactive so that the individual can sleep. However, if the individual is driving home from a long trip and needs to say awake, the thought processes of the frontal lobes (e.g., "I have to stay awake!") can influence the RAS to keep functioning and, therefore, keep the individual awake. In this way, thoughts influence arousal.

FRONTAL-LIMBIC CONNECTIONS: THOUGHTS AND EMOTIONS: Again, the frontal lobes of the brain are responsible for controlling and regulating brain activity. Emotions are complex states or "feelings" that are produced by the Limbic System. There are direct neuron pathway connections between the Frontal Lobes and Limbic System. Thoughts generated in the Frontal Lobe of the Cortex travel down to the Limbic System to influence the production of emotional states. For

example, an individual sees a rattlesnake in front of him and thinks, "This is a rattlesnake – he will bite me -- I'm scared!" These thoughts impact the Limbic System to produce an emotional state of fear. This, in turn, results in fearful avoidance behavior in the individual.

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