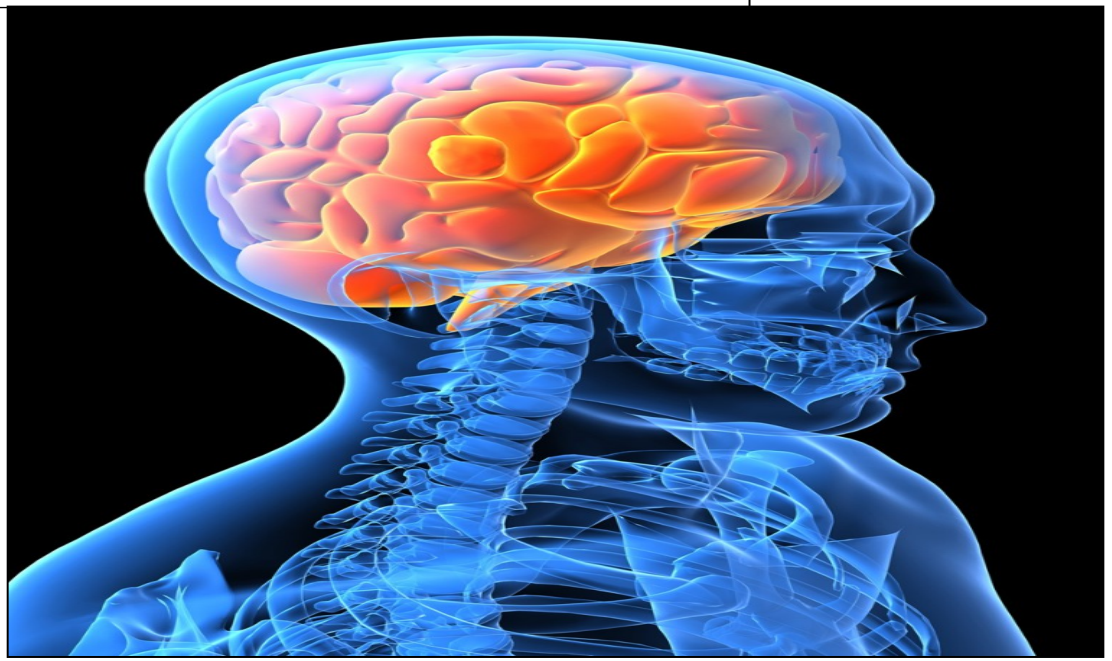
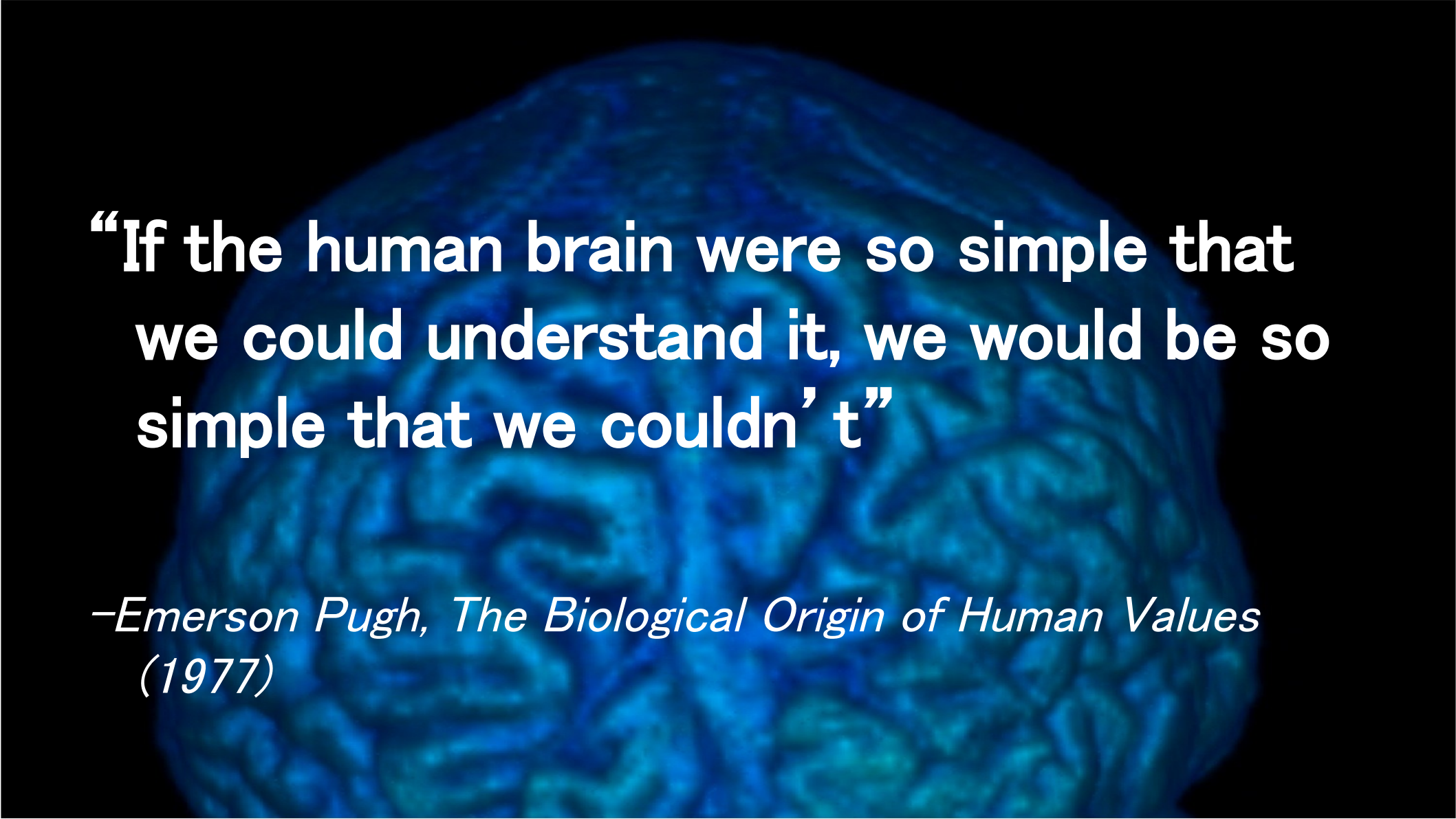
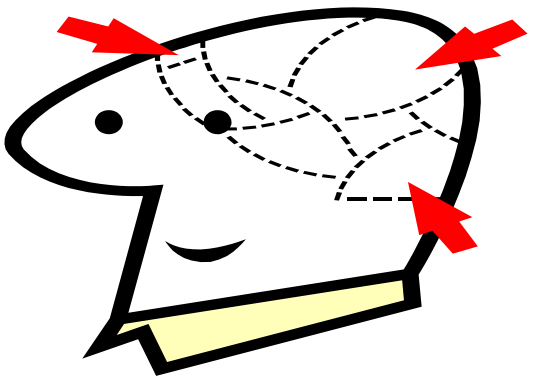
The Brain




“If the human brain were so simple that we could understand it, we would be so simple that we couldn’t”
–Emerson Pugh, The Biological Origin of Human Values (1977)

The Brain

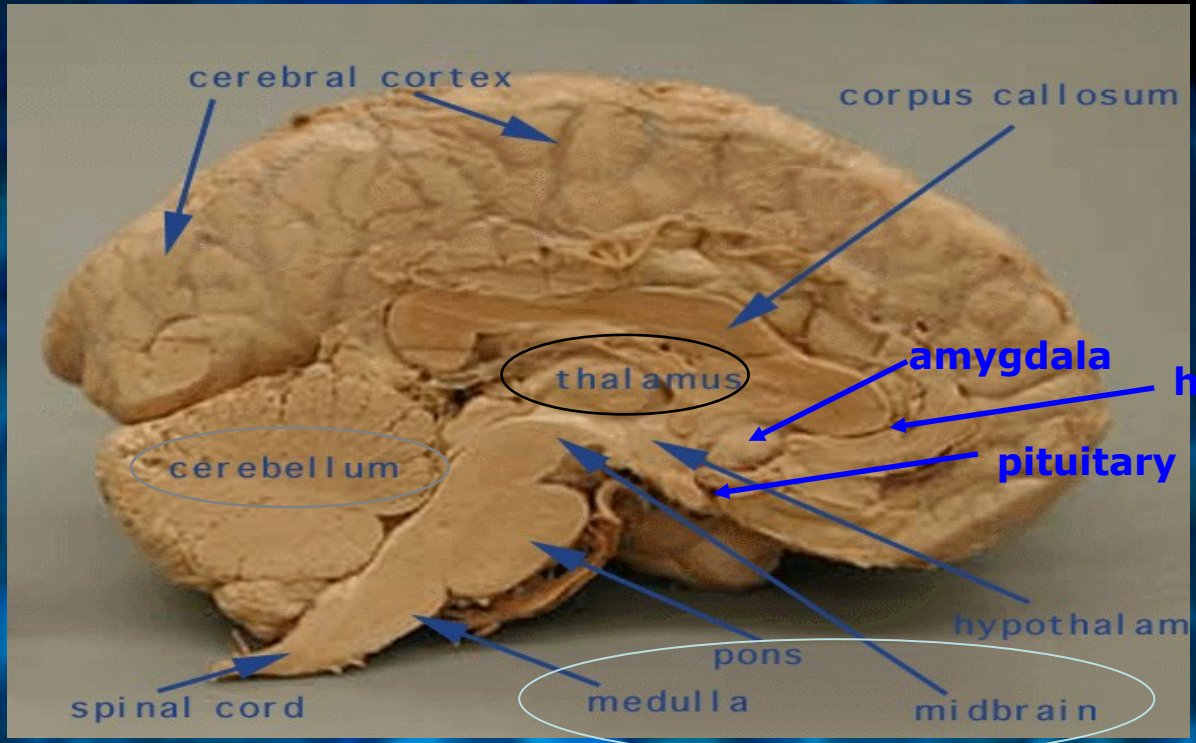
Areas and Parts of the Brain



Parts of the Brain

THALAMUS
→ Relays messages

CEREBELLUM
→ Coordination and balance



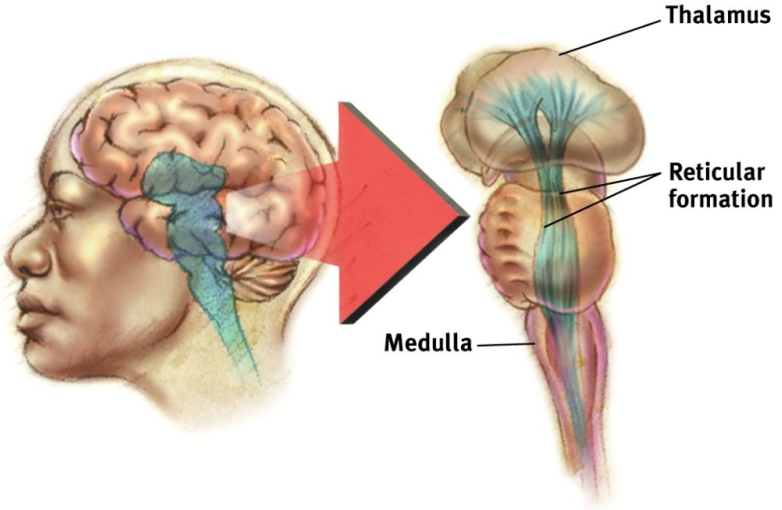
BRAINSTEM → Heart rate and breathing

I. Older Brain Structures

A. The Brainstem
    1. Medulla
    2. Pons
    3. Reticular Formation
B. Thalamus
C. Cerebellum
D. The Limbic System
    1. Amygdala
    2. Hypothalamus
    3. Hippocampus

The Brainstem

The Brainstem is the oldest part of the brain, beginning where the spinal cord swells and enters the skull. It is responsible for automatic survival functions.

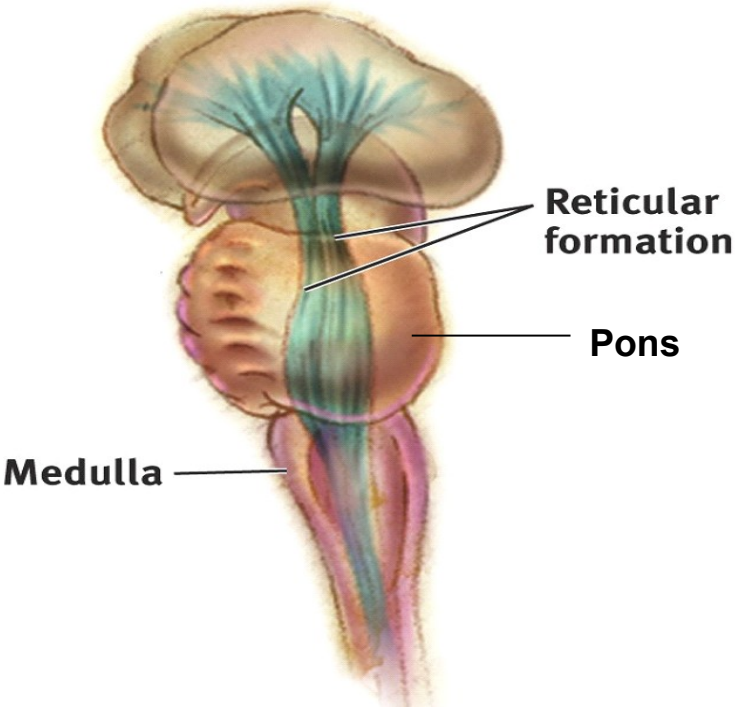


Parts of the Brain Stem:

The Medulla is the base of the brainstem that controls heartbeat and breathing.

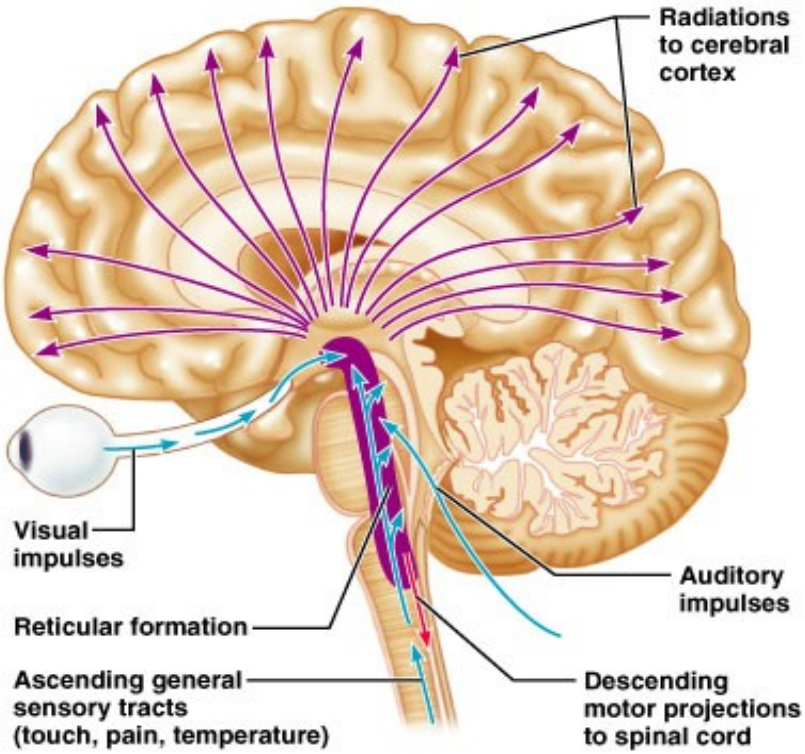
Pons helps with movement and facial expression.

Reticular Formation is a nerve network in the brainstem that plays an important role in controlling arousal.



Reticular Formation

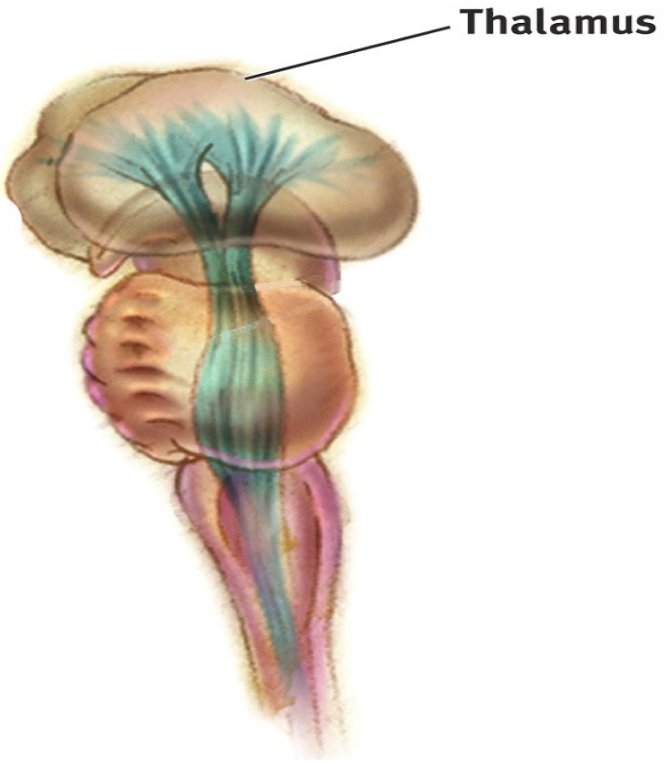
- Widespread connections
  - Arousal of the brain as a whole
- Reticular activating system (RAS)
  - Maintains consciousness and alertness
  - Functions in sleep and arousal from sleep



Parts of the Brain Stem

The Thalamus is the brain's sensory switchboard, located on top of the brainstem. It *directs messages to the sensory areas in the cortex and transmits replies to the cerebellum and medulla.*

It receives information for all of the senses EXCEPT for smell.

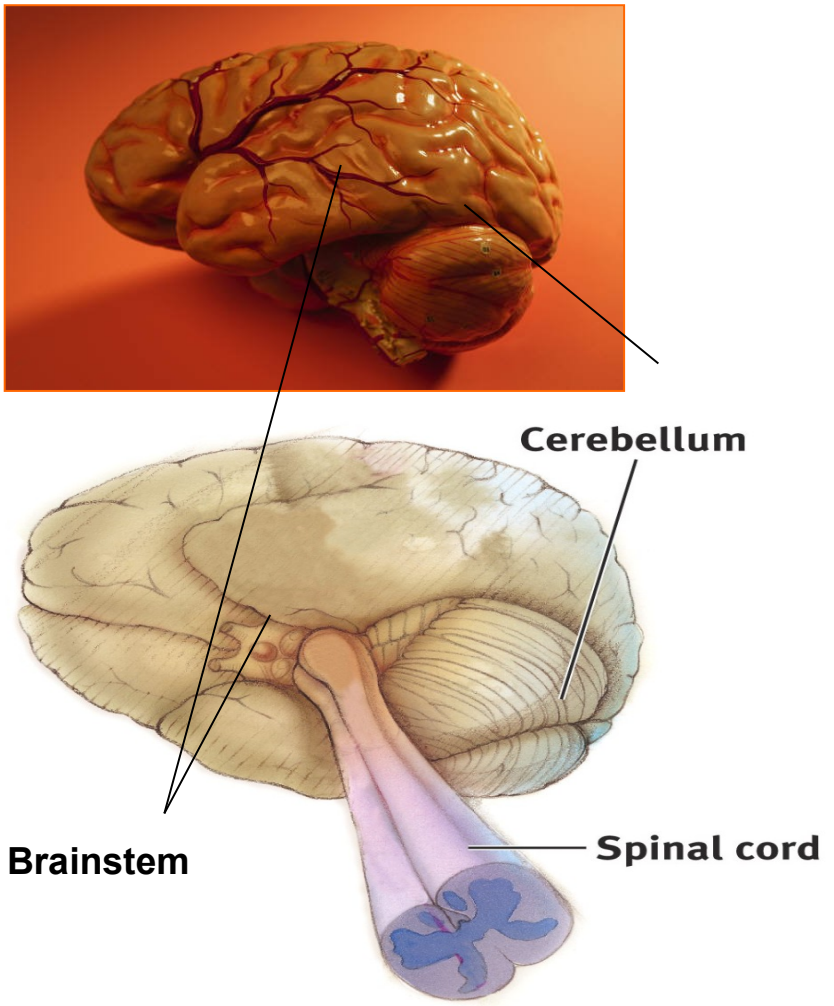


Cerebellum

The Cerebellum is called the "little brain" and is attached to the rear of the brainstem.

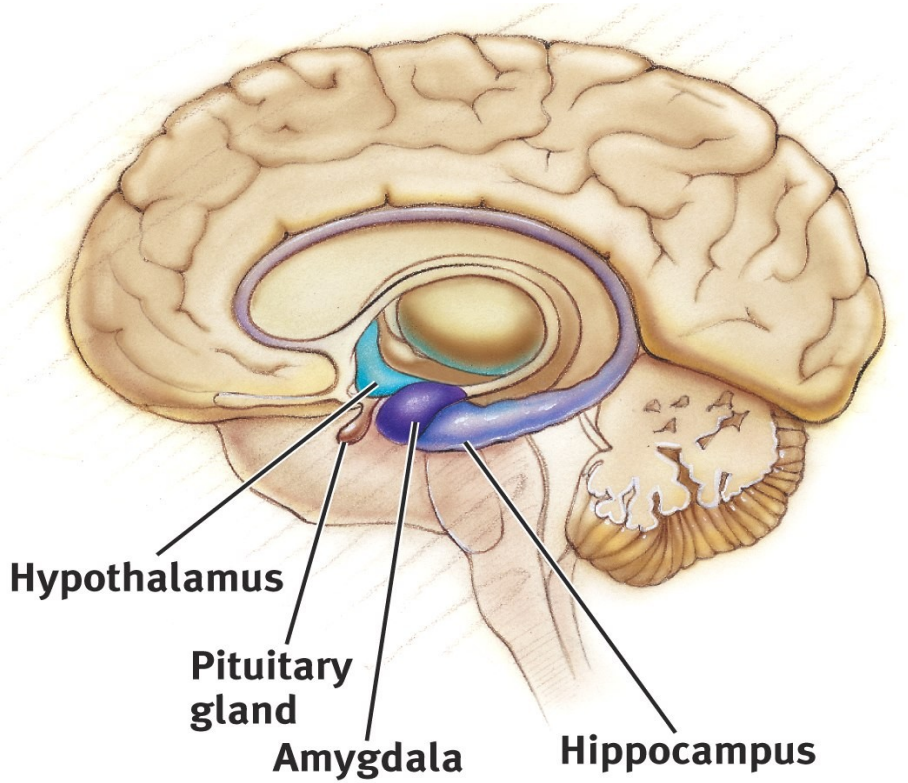
It helps coordinate voluntary movements and balance.

It *also plays a part in memory, emotion regulation, timing, emotional modulation and sensory discrimination*.



The Limbic System

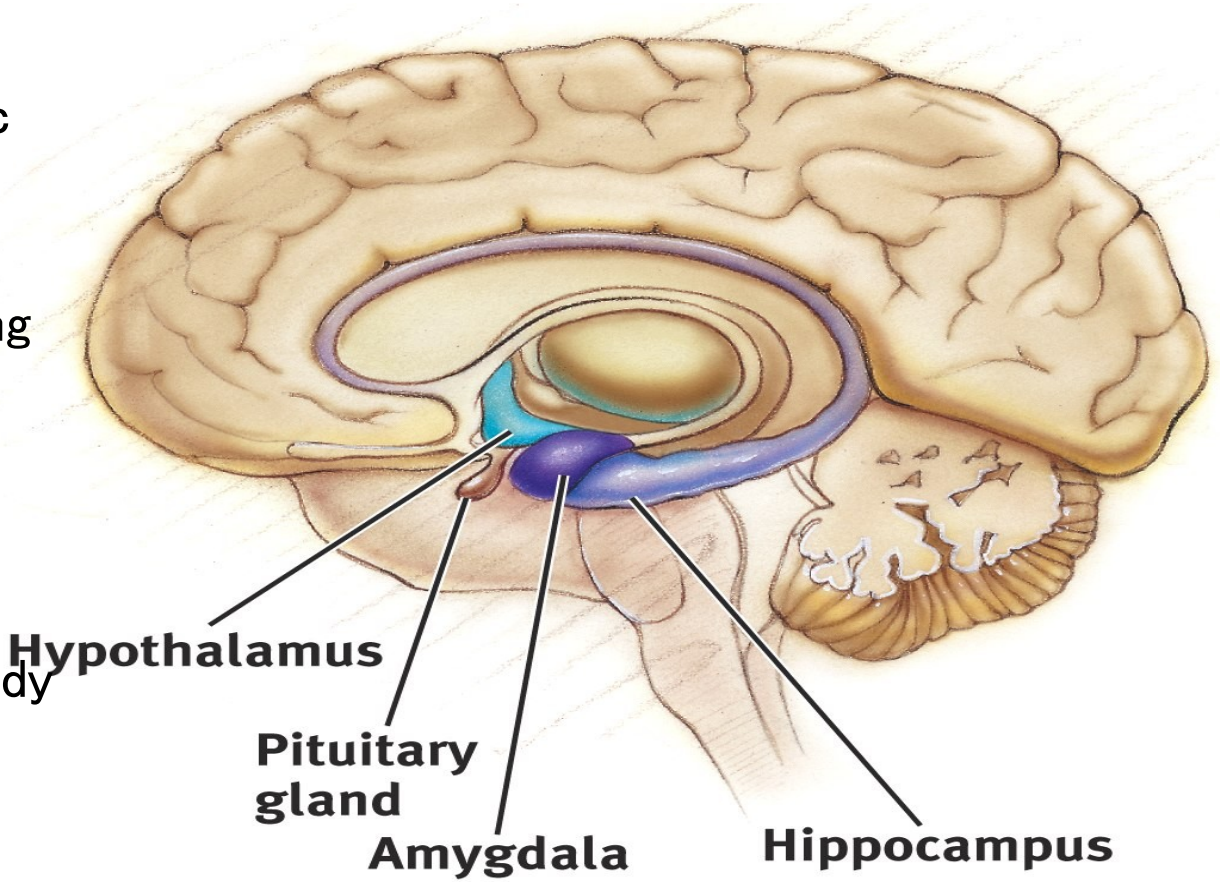
The Limbic System is a doughnut-shaped system of neural structures at the border of the brainstem and cerebrum, associated with emotions such as fear, aggression and drives for food and sex.



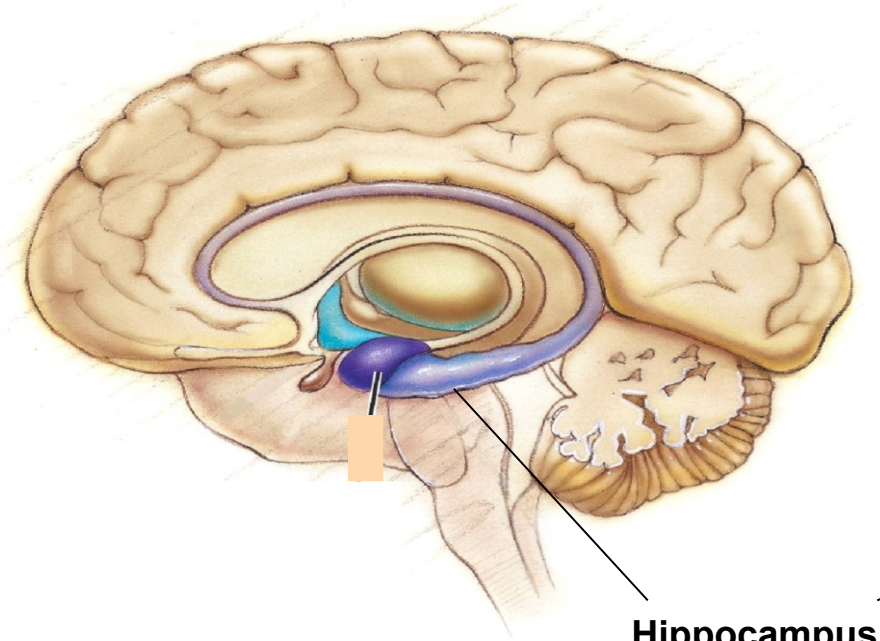
It includes the hippocampus, amygdala, and hypothalamus.

The Limbic System

- Hypothalamus, pituitary, amygdala, and hippocampus all deal with basic drives, emotions, and memory
- Hippocampus → Memory processing
- Amygdala → Aggression (fight) and fear (flight)
- Hypothalamus → Hunger, thirst, body temperature, pleasure; regulates pituitary gland (hormones)



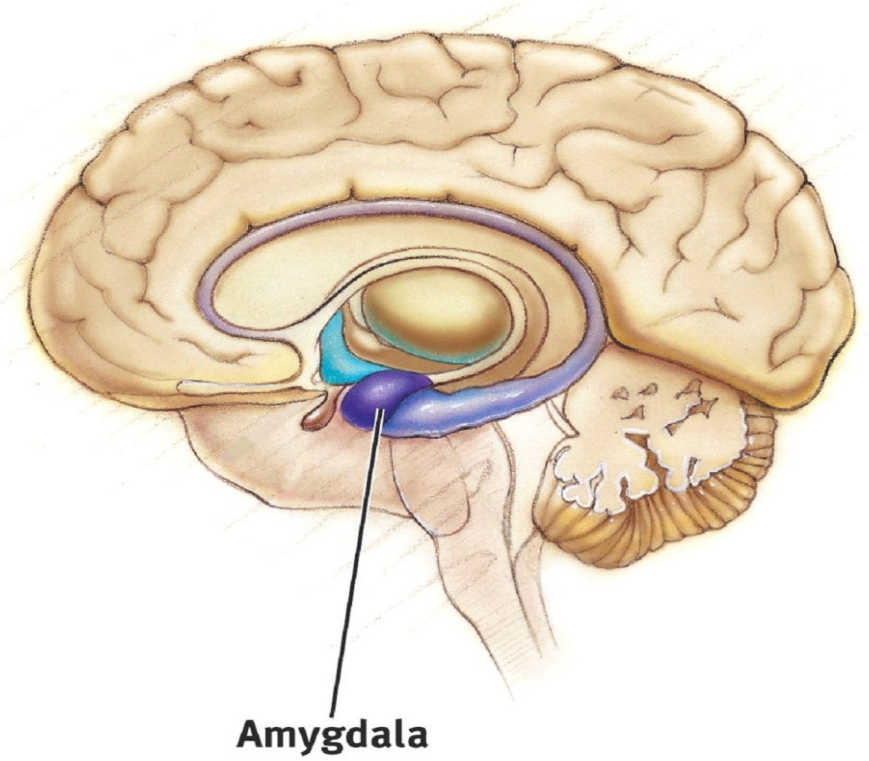
Hippocampus



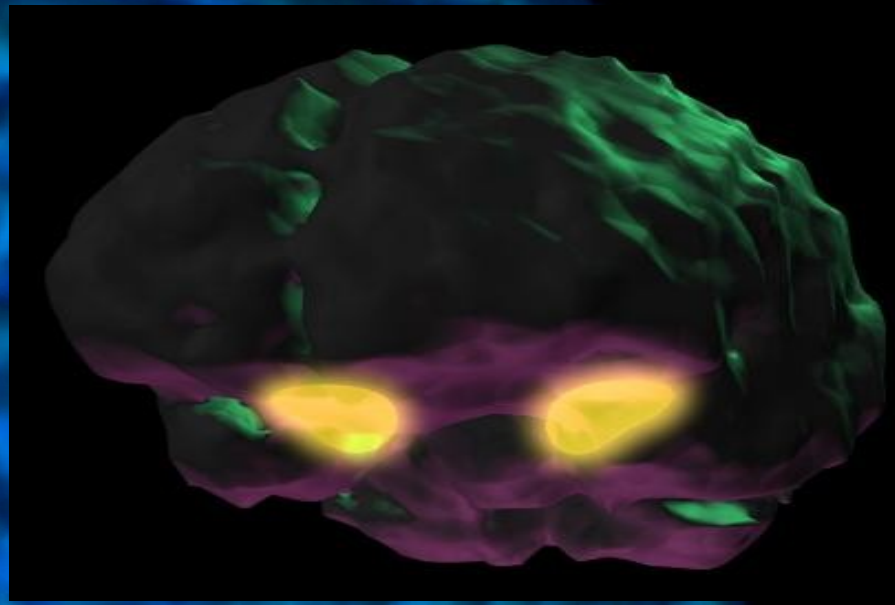
The Hippocampus processes memories.

Amygdala

The Amygdala consists of two almond-shaped neural clusters linked to the emotions of fear and anger.



- Amygdala
  - –two almond-shaped neural clusters that are components of the limbic system and are linked to emotion and fear

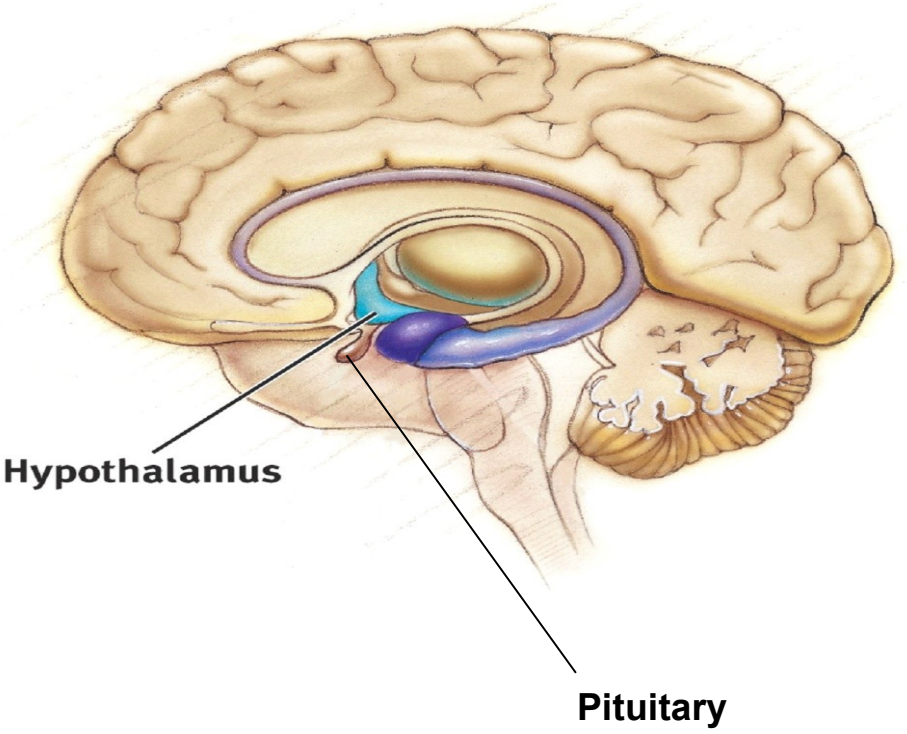


Hypothalamus

The Hypothalamus lies below (*hypo*) the thalamus.

It directs several maintenance activities like eating, drinking, body temperature, and control of emotions.

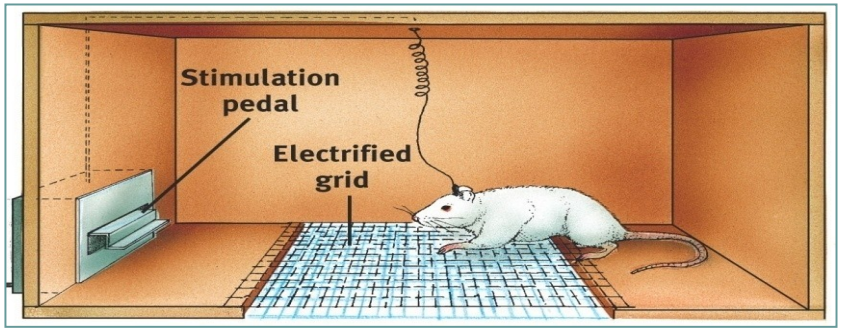
It helps control the endocrine system by giving directions to the pituitary gland.



- Hypothalamus
  - neural structure lying below (*hypo*) the thalamus; directs several maintenance activities
    - eating
    - drinking
    - body temperature
  - helps govern the endocrine system via the pituitary gland
  - linked to emotion
  - (show video)

The Limbic System contains many Reward/Pleasure Centers

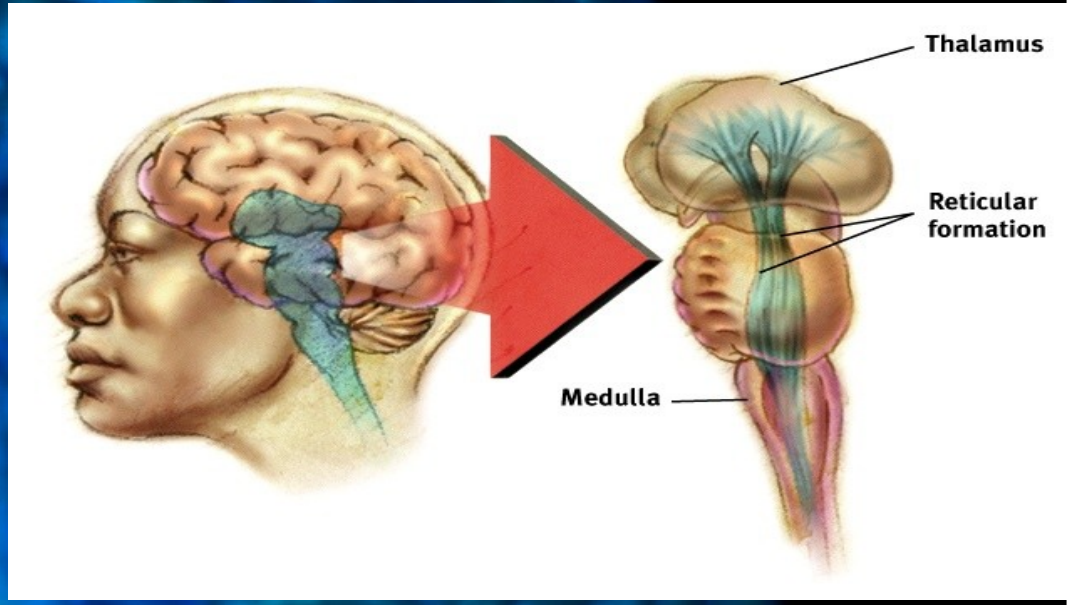
Olds and Milner (1954) discovered that Rats cross an electrified grid for self-stimulation when electrodes are placed in the reward (hypothalamus) center. When the limbic system is manipulated, a rat will navigate fields or climb up a tree (bottom picture).



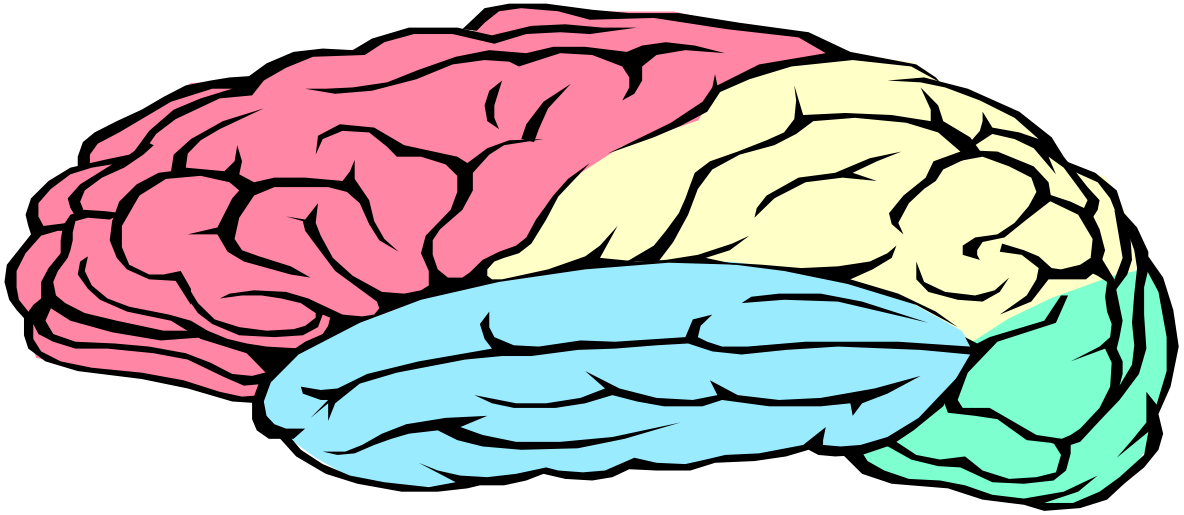
It is possible that some addictive behavior may be related to a genetic disorder (reward deficiency syndrome).

Thalamus

- Thalamus
  - the brain's sensory switchboard, located on top of the brainstem
  - it directs messages to the sensory receiving areas in the cortex and transmits replies to the cerebellum and medulla

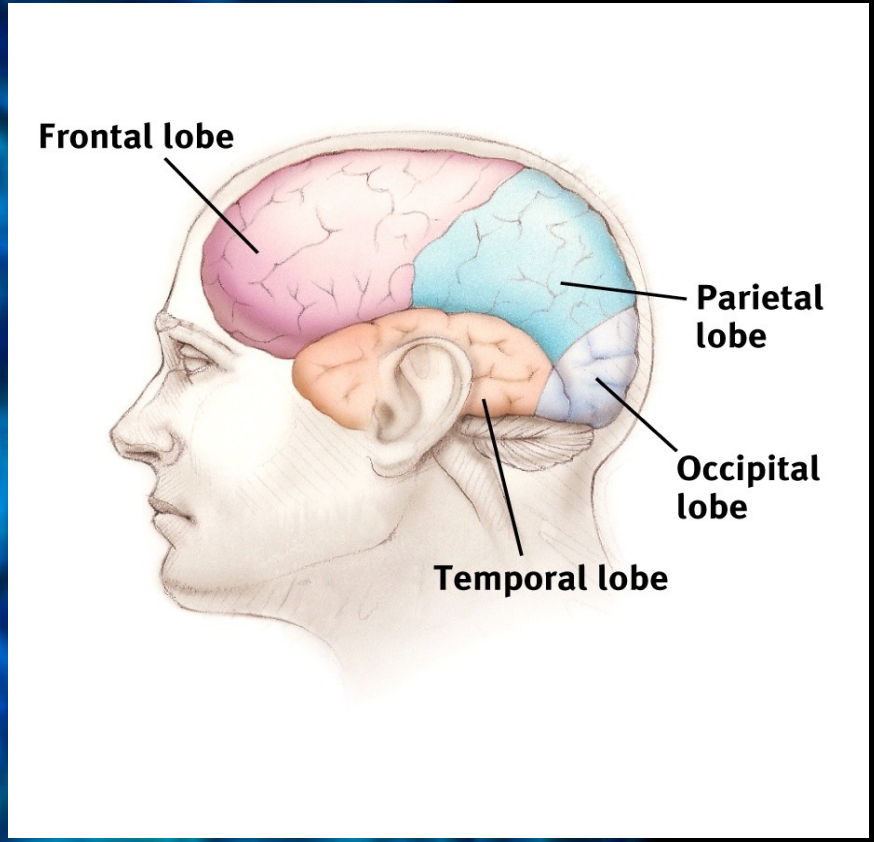


II. The Cerebral Cortex

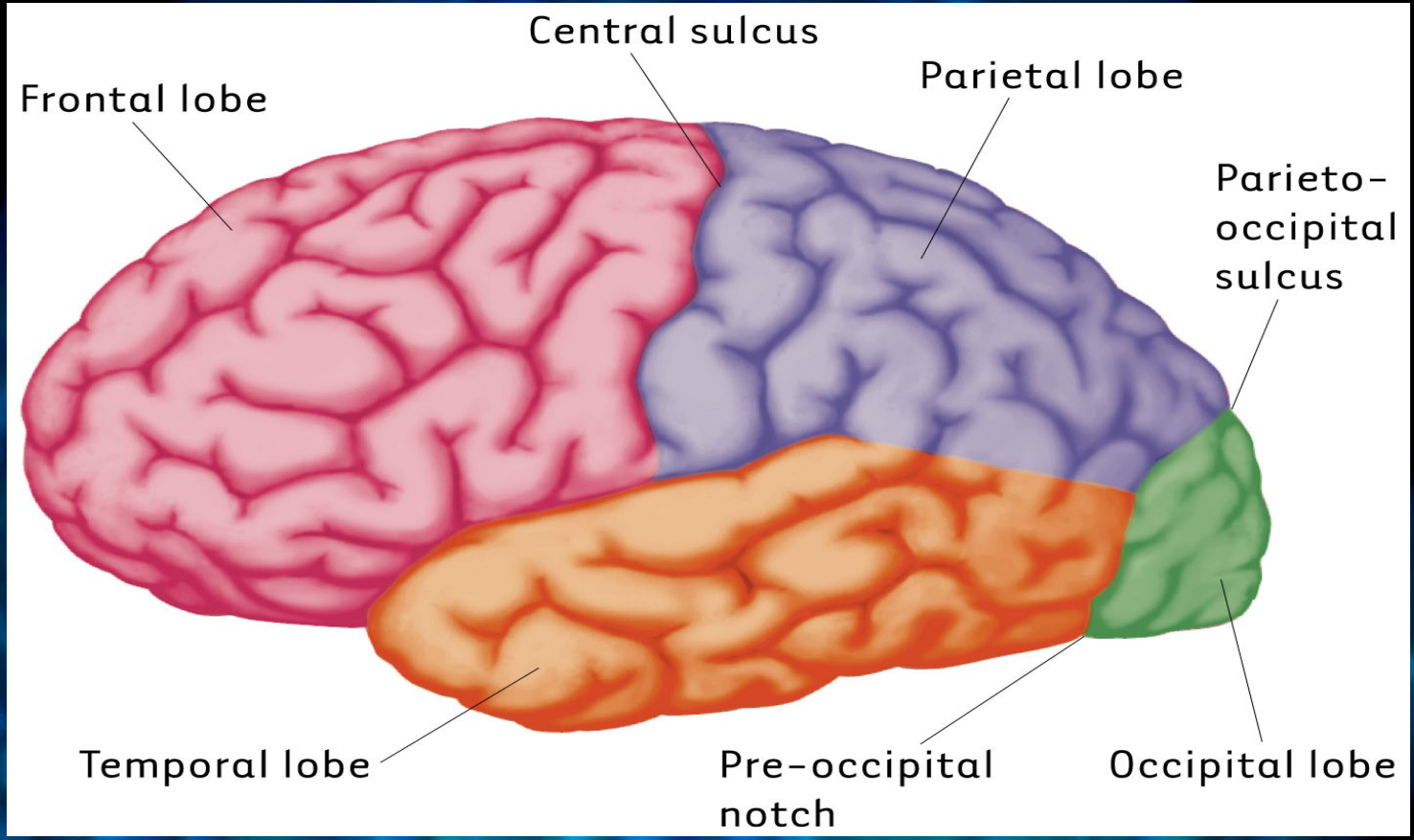


The Cerebral Cortex

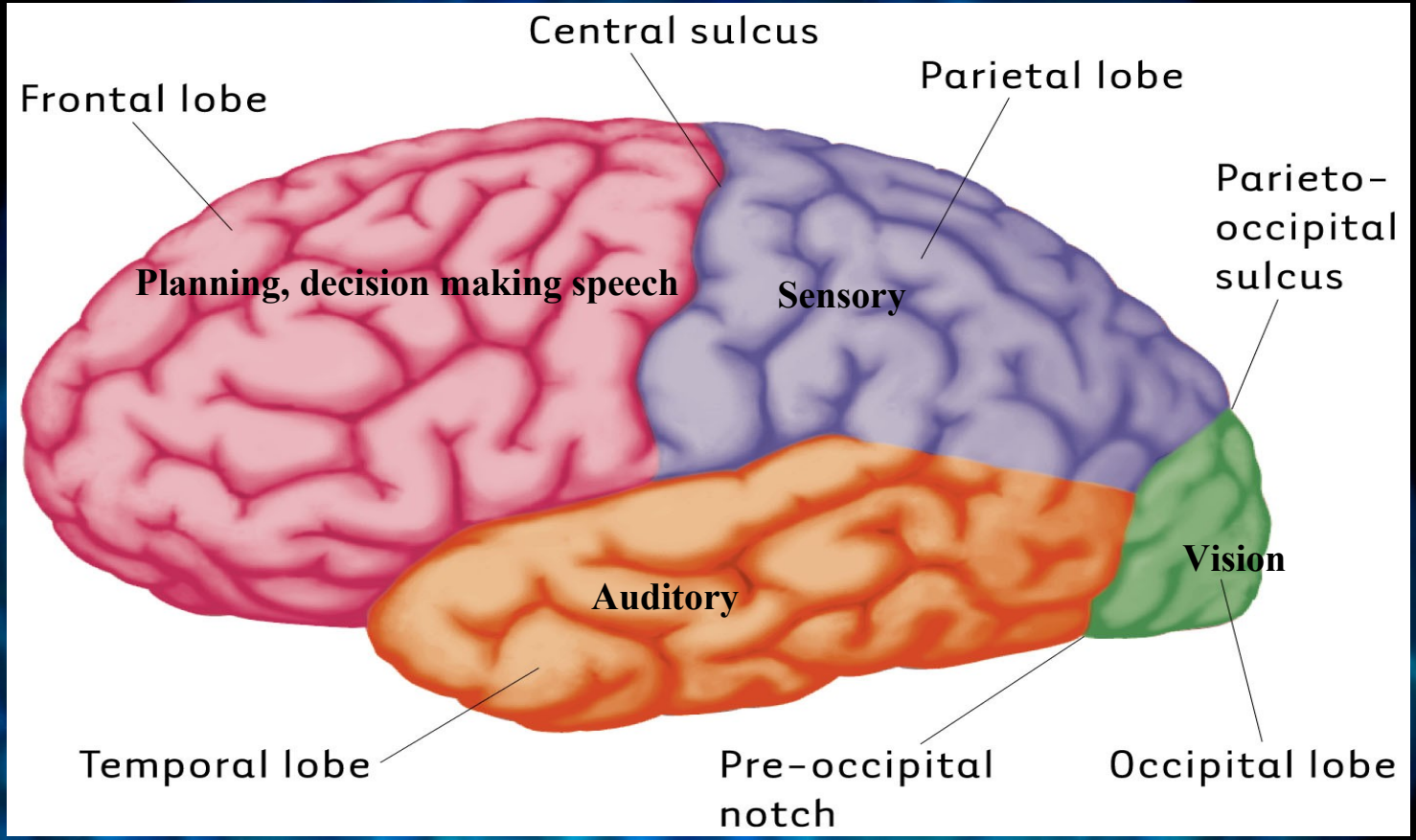
- Cerebral Cortex
  - –the body's ultimate control and information processing center



The lobes of the cerebral hemispheres

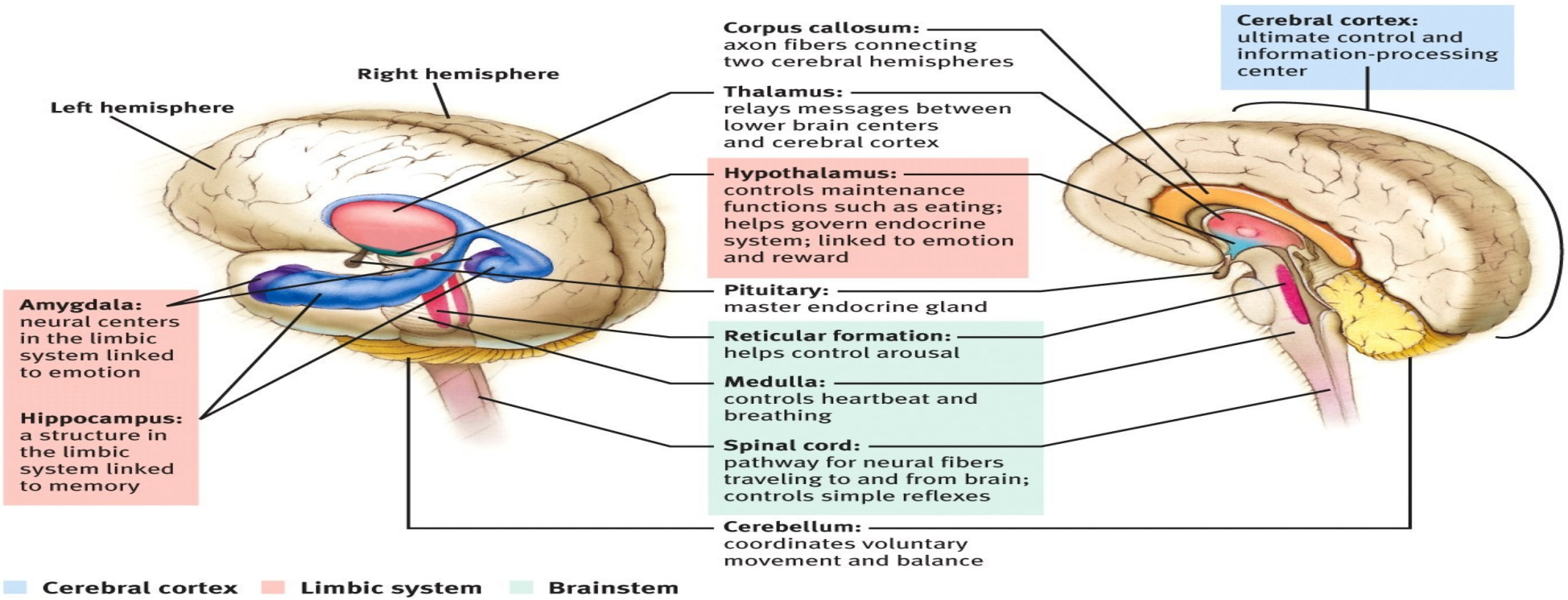


The lobes of the cerebral hemispheres



Cerebral Cortex

The intricate fabric of interconnected neural cells that covers the cerebral hemispheres. It is the body's ultimate control and information processing center.



Structure of the Cerebral Cortex

Each brain hemisphere is divided into four lobes that are separated by prominent fissures.

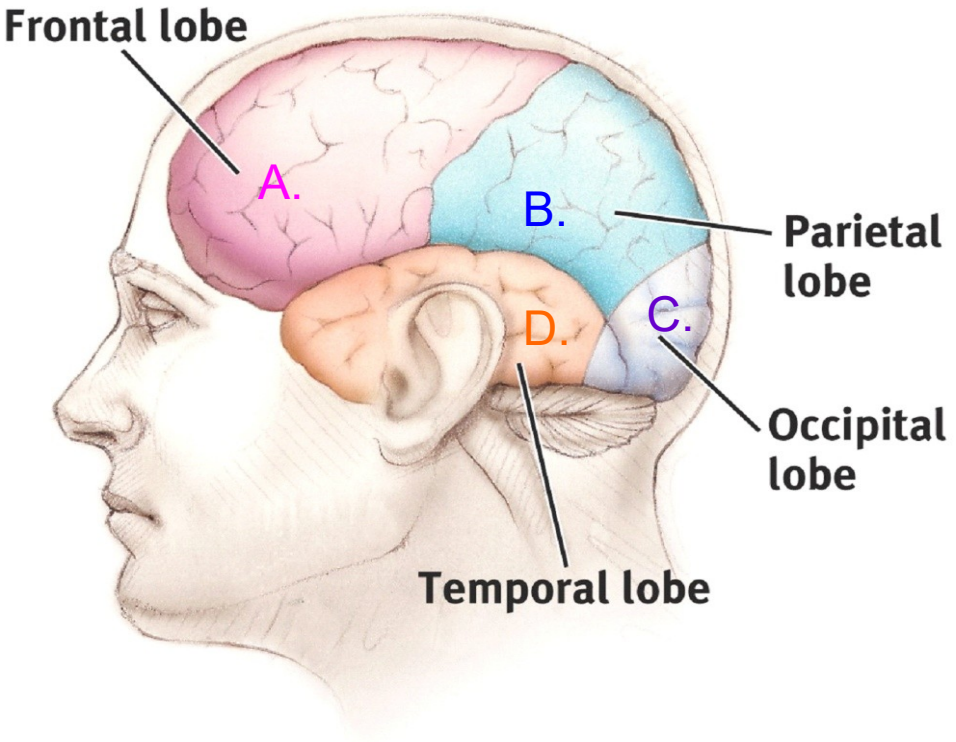
These lobes are the:

a. frontal lobe – judgement/reasoning

b. parietal lobe – senses

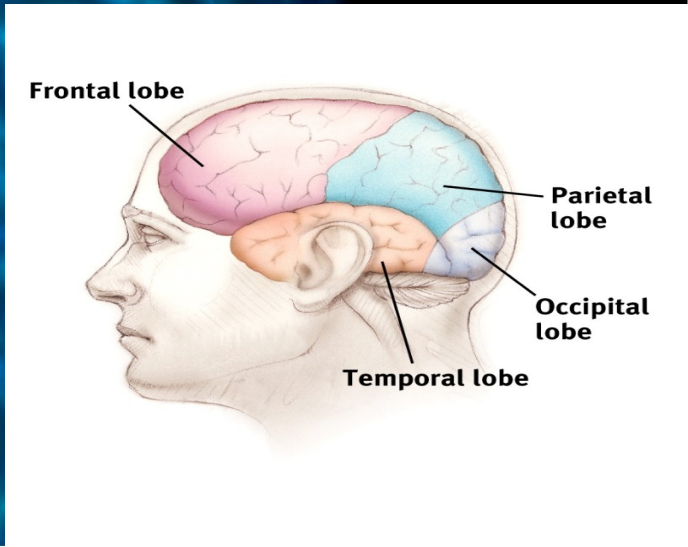
c. occipital lobe – vision

d. temporal lobe – hearing



The Cerebral Cortex

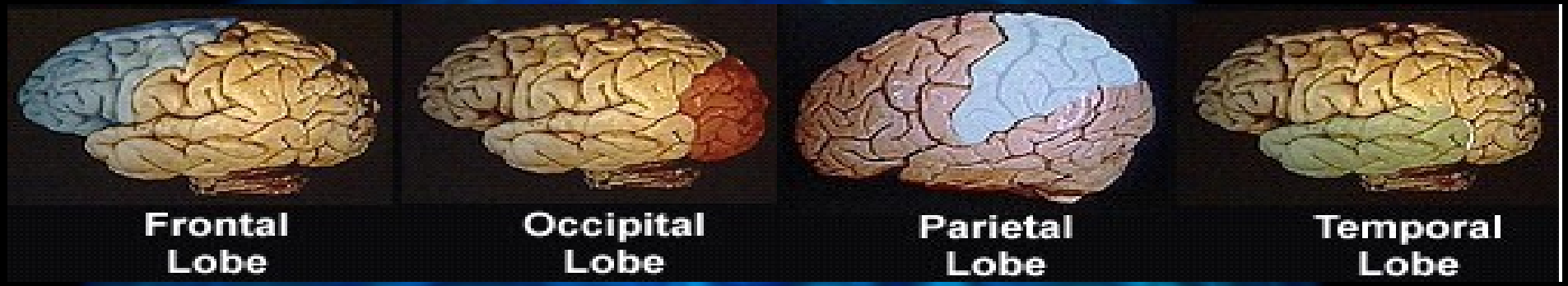
- Frontal Lobes
  - involved in speaking and muscle movements and in making plans and judgments
  - the "executive"
- Parietal Lobes
  - include the sensory cortex



The Cerebral Cortex

- Occipital Lobes
  - include the visual areas, which receive visual information from the opposite visual field
- Temporal Lobes
  - include the auditory areas, each of which receives auditory information primarily from the opposite ear

The Cerebral Cortex

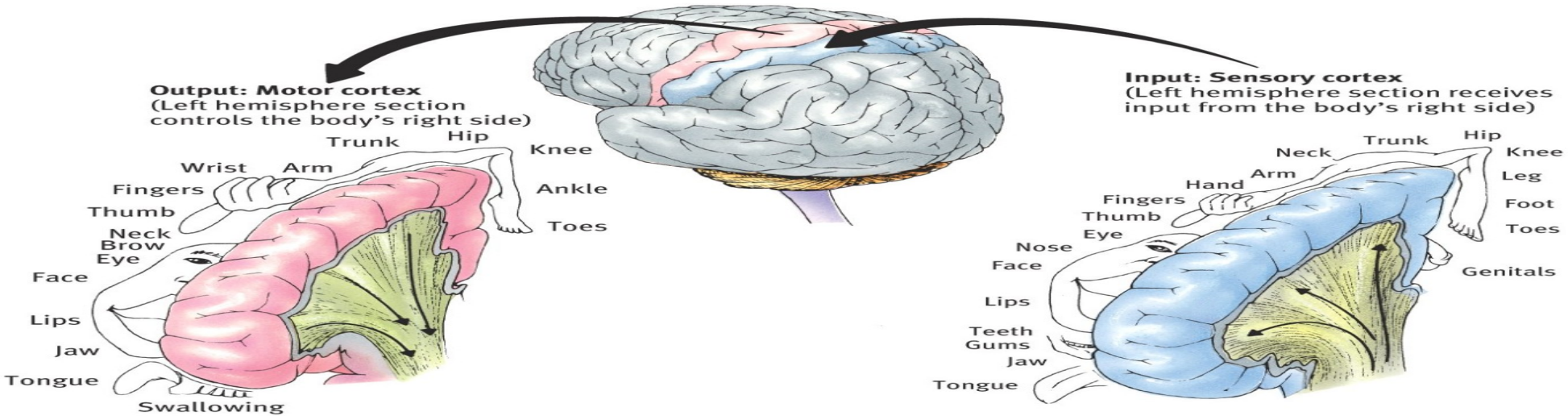


- Frontal (Forehead to top) → Motor Cortex
- Parietal (Top to rear) → Sensory Cortex
- Occipital (Back) → Visual Cortex
- Temporal (Above ears) → Auditory Cortex

Functions of the Cerebral Cortex

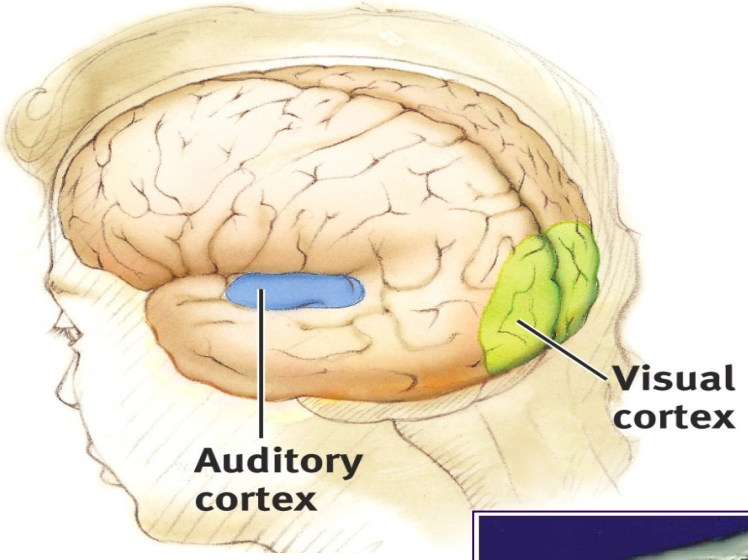
The Motor Cortex is the area at the rear of the *frontal lobes* that control voluntary movements.

The Sensory Cortex is the area at the front of the *parietal lobes* that receives information from skin surface and sense organs.

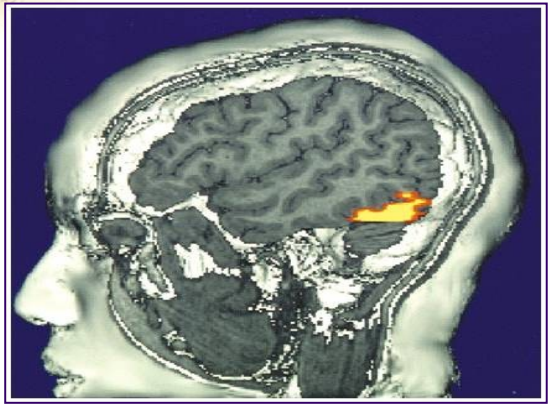


Functions of the Cerebral Cortex

The visual cortex is located in the occipital lobe of the brain.

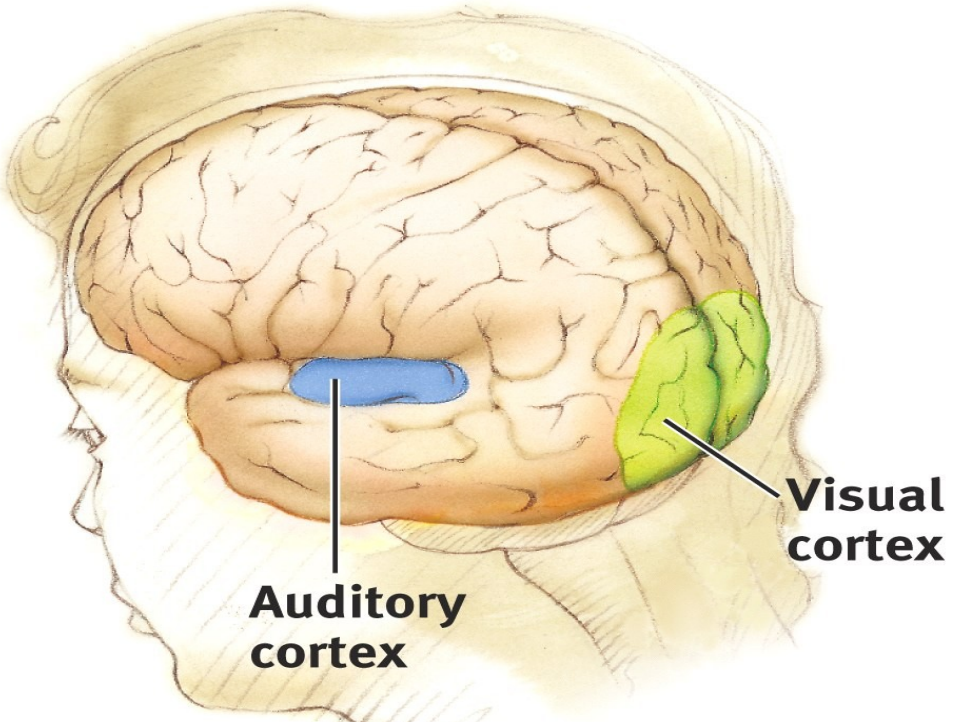


The functional MRI scan shows the visual cortex is active as the subject looks at faces.



Functions of the Cerebral Cortex

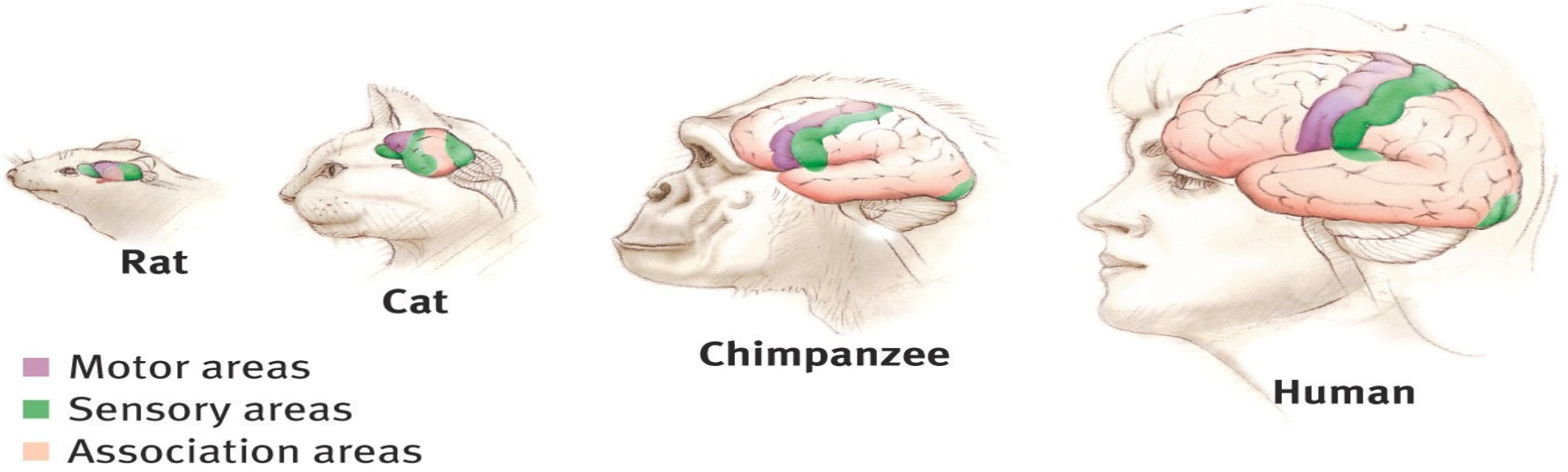
The auditory cortex is located in the temporal lobe of the brain.



http://www.ted.com/talks/lang/eng/oliver_sacks_what_hallucination_reveals_about_our_minds.html

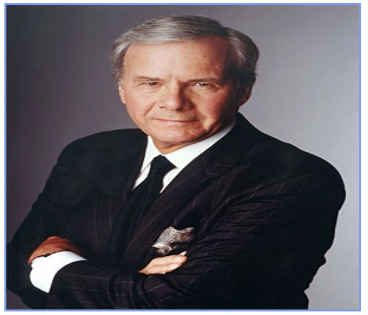
Association Areas

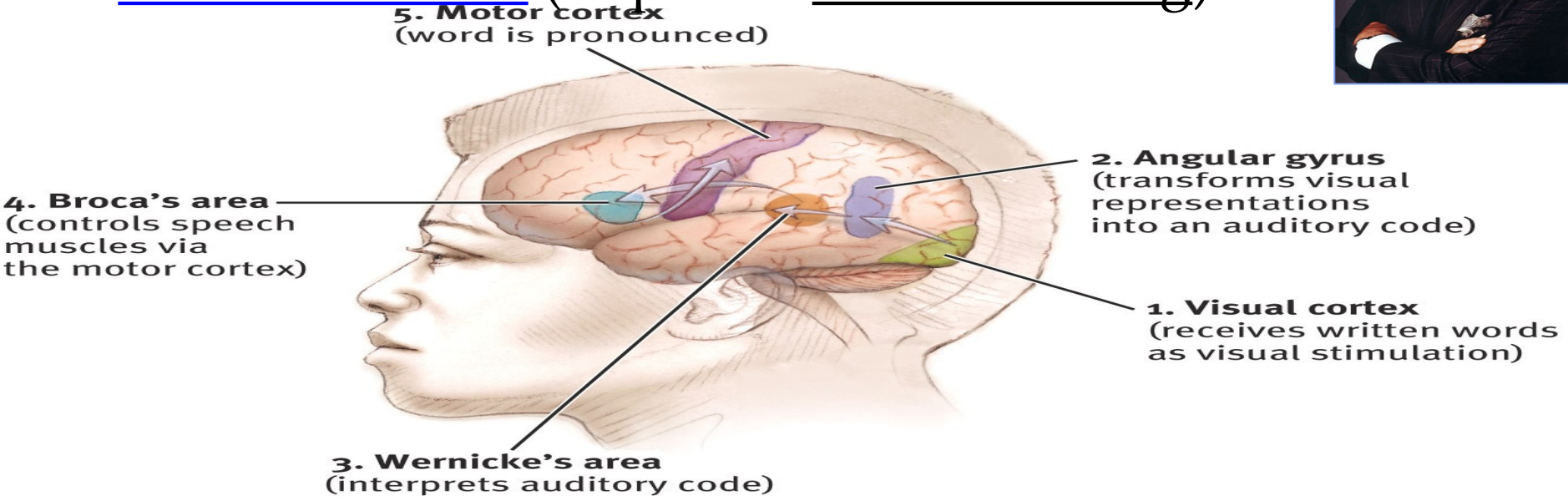
The association areas integrate sensory information and stored memories. More intelligent animals have increased "uncommitted" or association areas of the cortex.



Language

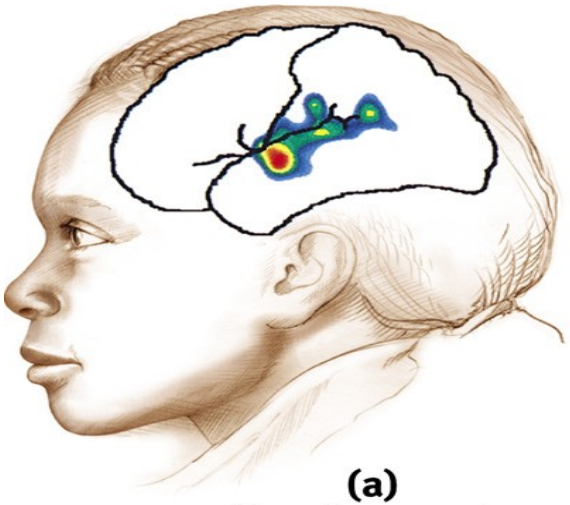
Aphasia is an impairment of language, usually caused by left hemisphere damage either to Broca's area (impaired speaking) or to Wernicke's area (impaired understanding).



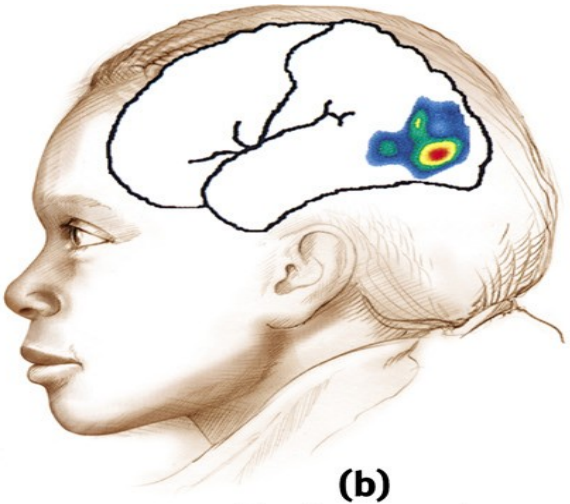


Specialization & Integration

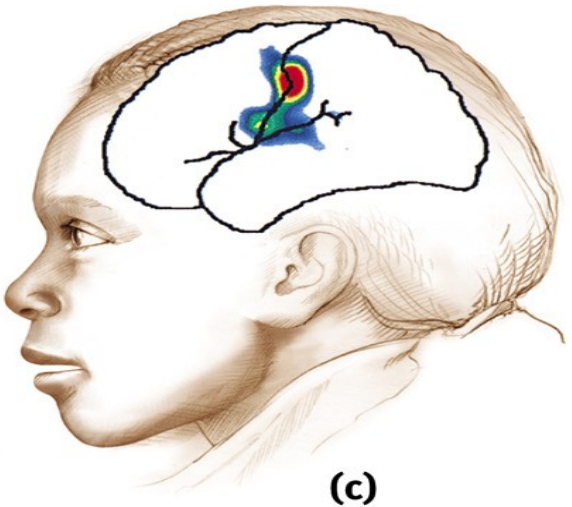
Brain activity when hearing,
seeing, and speaking words.



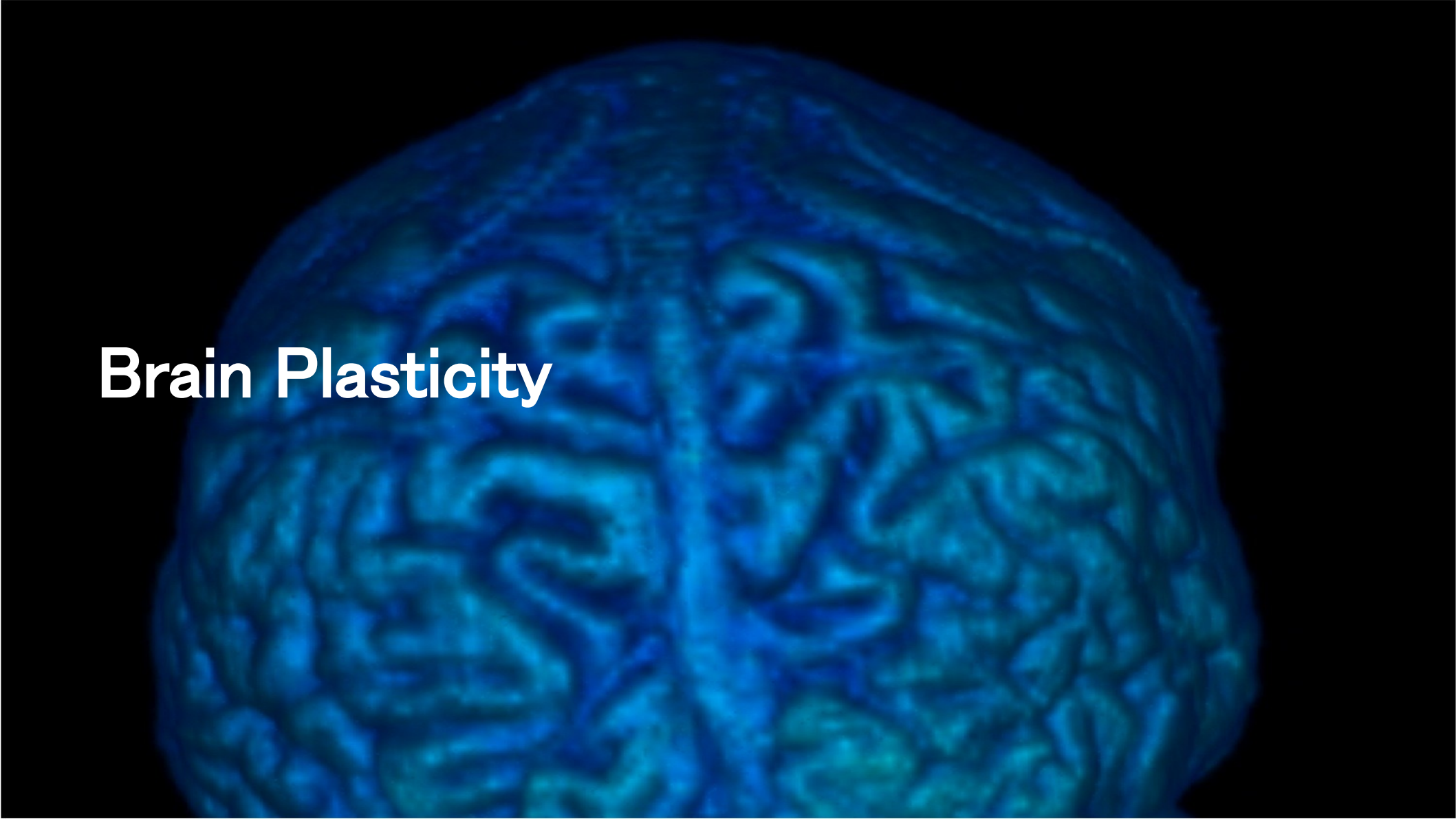
(a)
Hearing words
(auditory cortex and
Wernicke's area)



(b)
Seeing words
(visual cortex and
angular gyrus)



(c)
Speaking words
(Broca's, area and
the motor cortex)


Brain Plasticity

Brain Plasticity

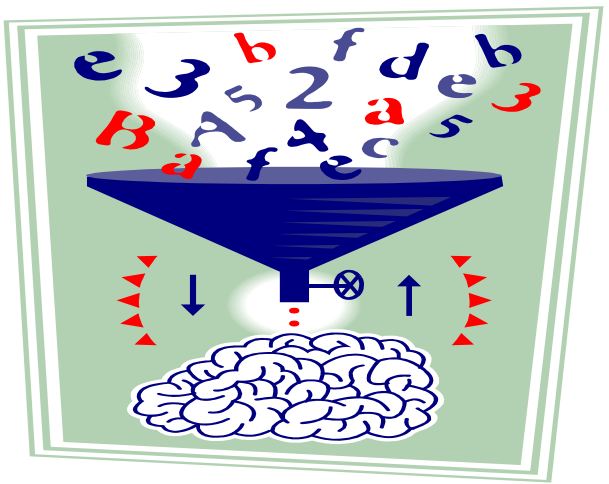
- The ability of the brain to reorganize neural pathways based on new experiences
- Persistent functional changes in the brain represent new knowledge
- Age dependent component
- Brain injuries

The Brain's Plasticity

- The brain is sculpted by our genes but also by our experiences.
- Plasticity refers to the brain's ability to modify itself after some type of injury or illness.
  - Usually the brain areas that are related to the damaged/missing part develop the ability to function as a part of the new system. For example, in blind people the visual cortex may register and process touch and/or hearing also (heightening those senses)
- Our brains demonstrate more plasticity when we are children.

Brain Lateralization

The Divided Brain

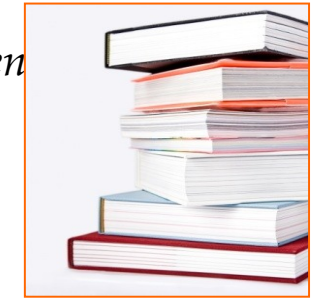


Our Divided Brains

- Corpus collosum – large bundle of neural fibers (myelinated axons, or white matter) connecting the two hemispheres

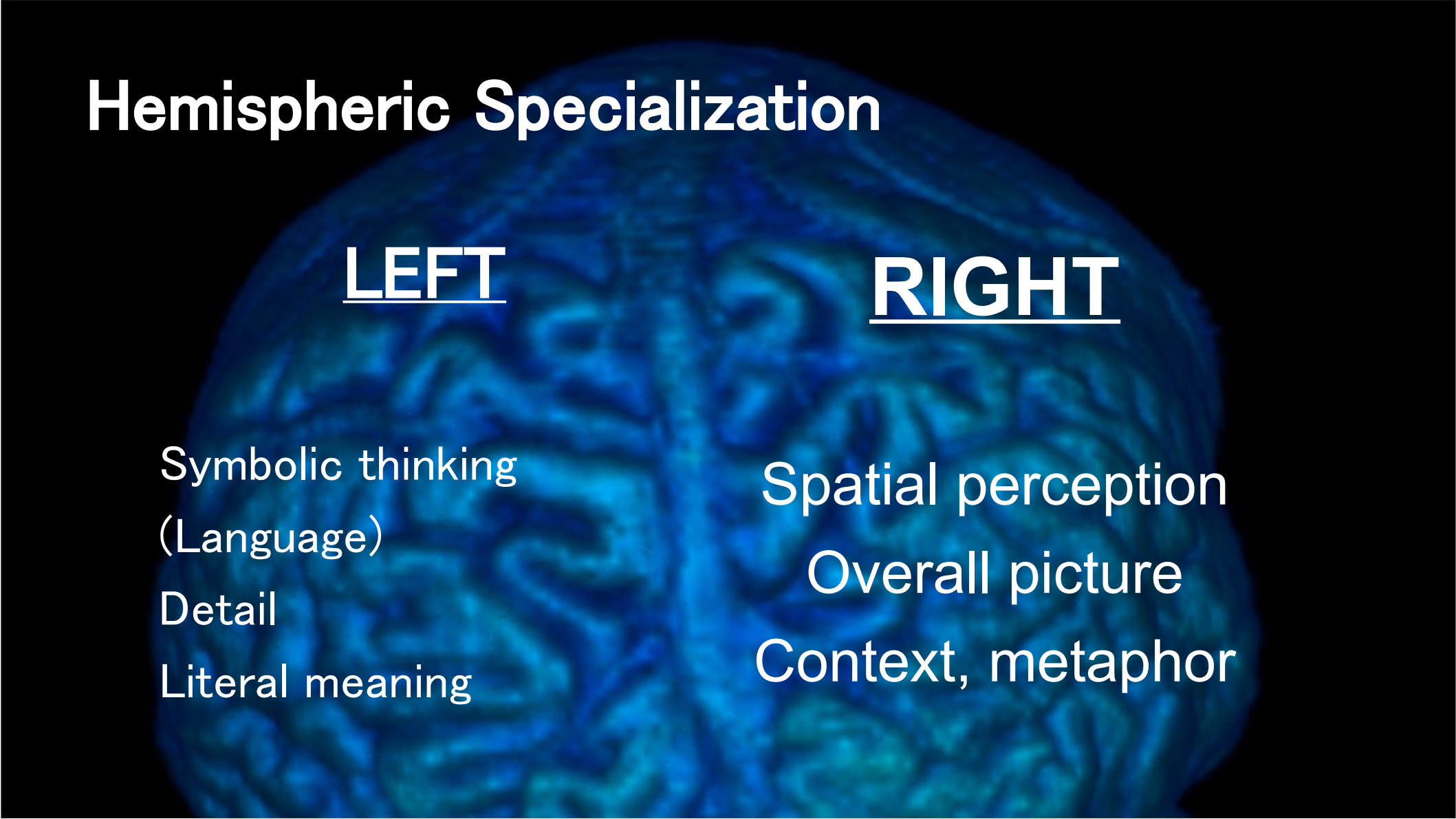
Our Divided Brain

- Our brain is divided into two hemispheres.
  - The Left Hemisphere
    - Processes logical tasks (*reading, writing, speaking, mathematics, and comprehen skills*)
    - Controls the right side of our body
    - In the 1960s, it was termed as the dominant brain.
  - The Right Hemisphere
    - Processes non-verbal tasks/perceptual (*spatial relationships, musical/artistic ability and mental imagery*)
    - Controls the left side of our body
    - May also be related to some negative emotions



- The Corpus Callosum is a wide band of axon fibers that connect the two hemispheres and allow them to communicate.

Hemispheric Specialization



LEFT

Symbolic thinking

(Language)

Detail

Literal meaning

RIGHT

Spatial perception

Overall picture

Context, metaphor

The Nervous System| In the next tutorial..

- The nervous system is made up of **neurons**, nerve cells that transmit signals or “messages” throughout the body.

- **Dendrites** – The rootlike structures at the ends of neurons that receive messages from other neurons.

- **Axon** – The long, thin part of a neuron along which nerve impulses travel.

The Brain| in the next tutorial

Techniques for Studying the Brain

Need More Mnemonics?

- **Cerebral Cortex**: imagine a Texas cowboy hat on top of a brain. The cortex is the outer layer of the brain just under the hat where complex thinking occurs.
- **Corpus Callosum**: The corpus callosum is the fibers that connect the two halves of the brain. Thus, it *adds* the two parts together. Think of the corPLUS CalloSUM. Since the corpus callosum coordinates communication between the two hemispheres, think of corpus Call Someone.
- **Thalamus**: the thalamus takes sensations that come from the body and directs them to the appropriate part of the brain for processing. Thus, think of Hal and Amos – two traffic cops in the brain who direct these sensations to the right route.
- **Hypothalamus**: the hypothalamus regulates a number of things in the body such as body temperature, thirst, hunger, and sex drive. Think of “hypo the llamas”. Your llamas are hot, sweaty and thirsty and you use a hypo to spray water on them to cool them down and give them some water.
- **Hippocampus**: the hippocampus is the seat of memory. Think of a hippo with a compass. The hippo uses the compass to find his way back to the swamp because he can’t remember where it is.
- **Amygdala**: the amygdala controls your sense of fear. Think of either a MIG coming right at you and, of course, making you afraid, or picture a scary wig with dollars in it
- **Pons**: the pons helps you relax and sleep. Think of a relaxing pond.
- **Cerebellum**: the cerebellum helps in coordination and balance. Picture your favorite athlete with bells all over his/her body (hanging from his/her clothes, hands, feet, etc.).
- **Reticular Formation**: the reticular formation helps you to become alert and aroused when you need to be. Think of what would happen if you were napping and someone *tickled* you: your reticular formation would kick into gear to wake you up.
- **Medulla**: the medulla regulates the autonomic activity of your heart and lungs. Picture medals over your heart and lungs, or stick those medals into a heart.