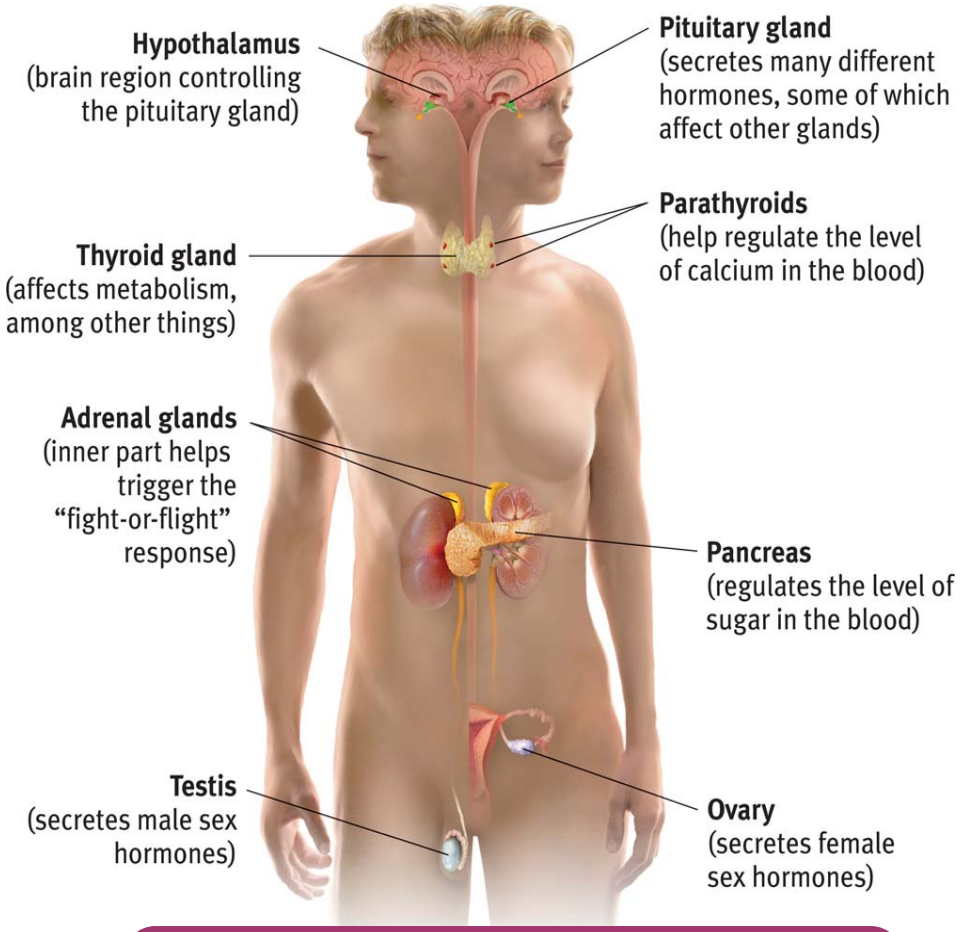
# The Body's "Slow but Sure" Endocrine Message System

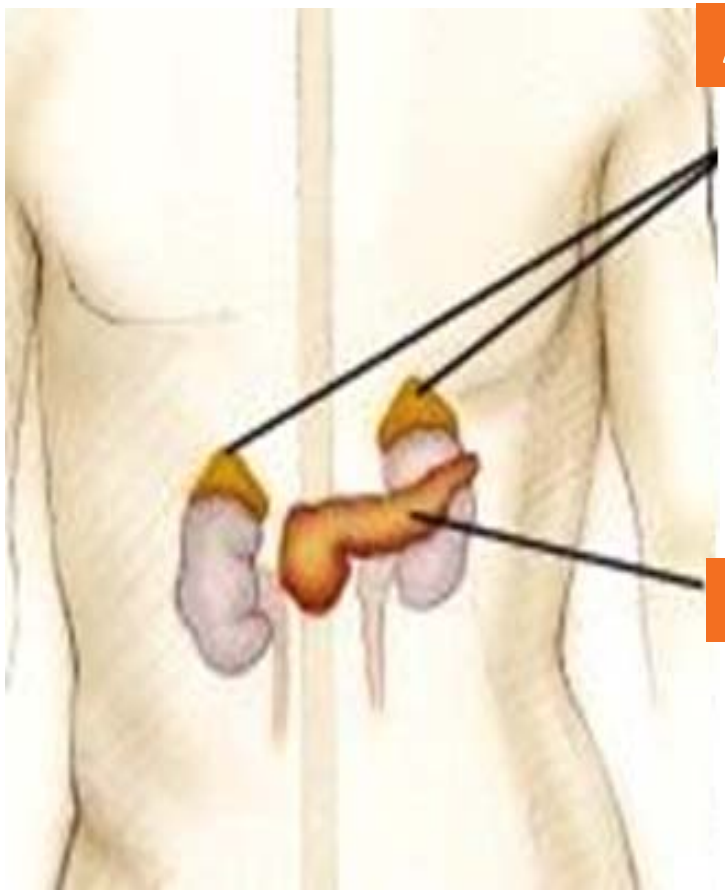
- The endocrine system sends molecules as **messages,** just like the nervous system, but it sends them **through the bloodstream** instead of across synapses.
- These molecules, called **hormones**, are produced in various glands around the body.
- The messages go to the brain and other tissues.
- Hormones hang out for a bit, so the effect of the message lasts longer.




**The endocrine system** *refers to a set of glands that produce chemical messengers called hormones.*

# Adrenal Glands

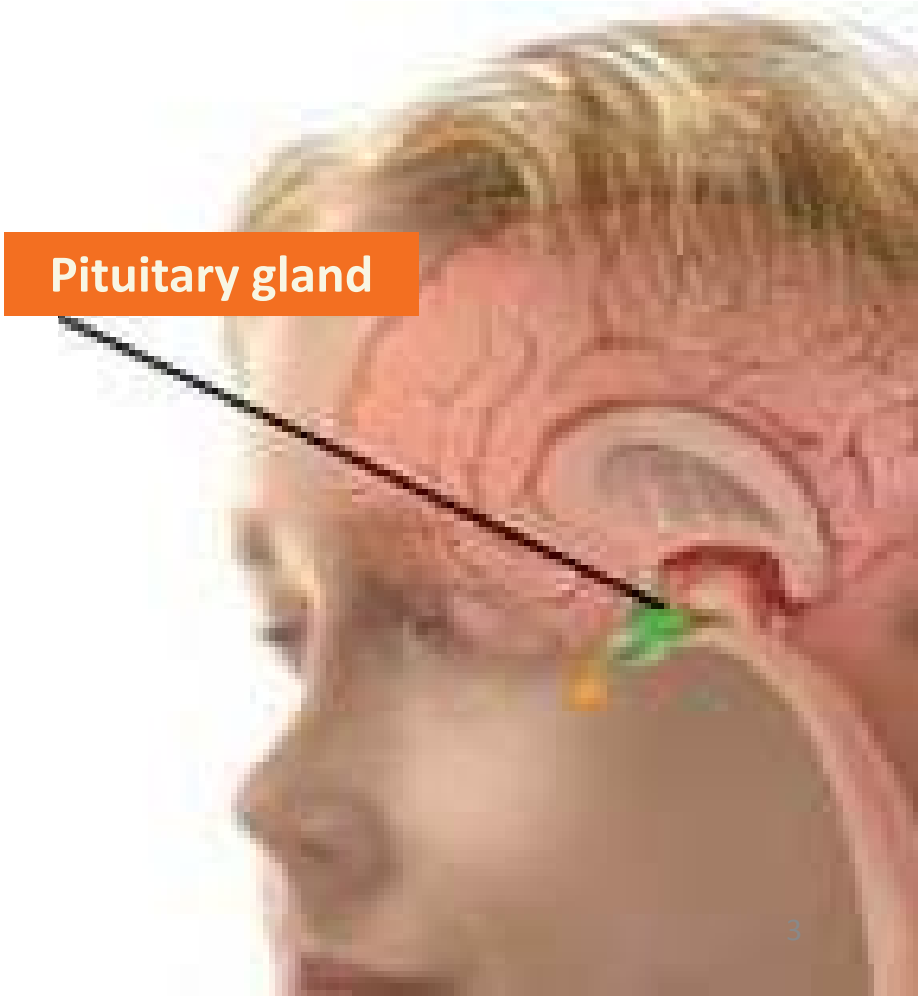
***produce hormones such as adrenaline/epinephrine, noradrenaline/norepinephrine, and cortisol.***




1. The sympathetic "fight or flight" nervous system responds to stress by sending a message to adrenal glands to release the hormones listed above.
2. Effect: increased heart rate, blood pressure, and blood sugar. These provide ENERGY for the fight or flight!

# The Pituitary Gland

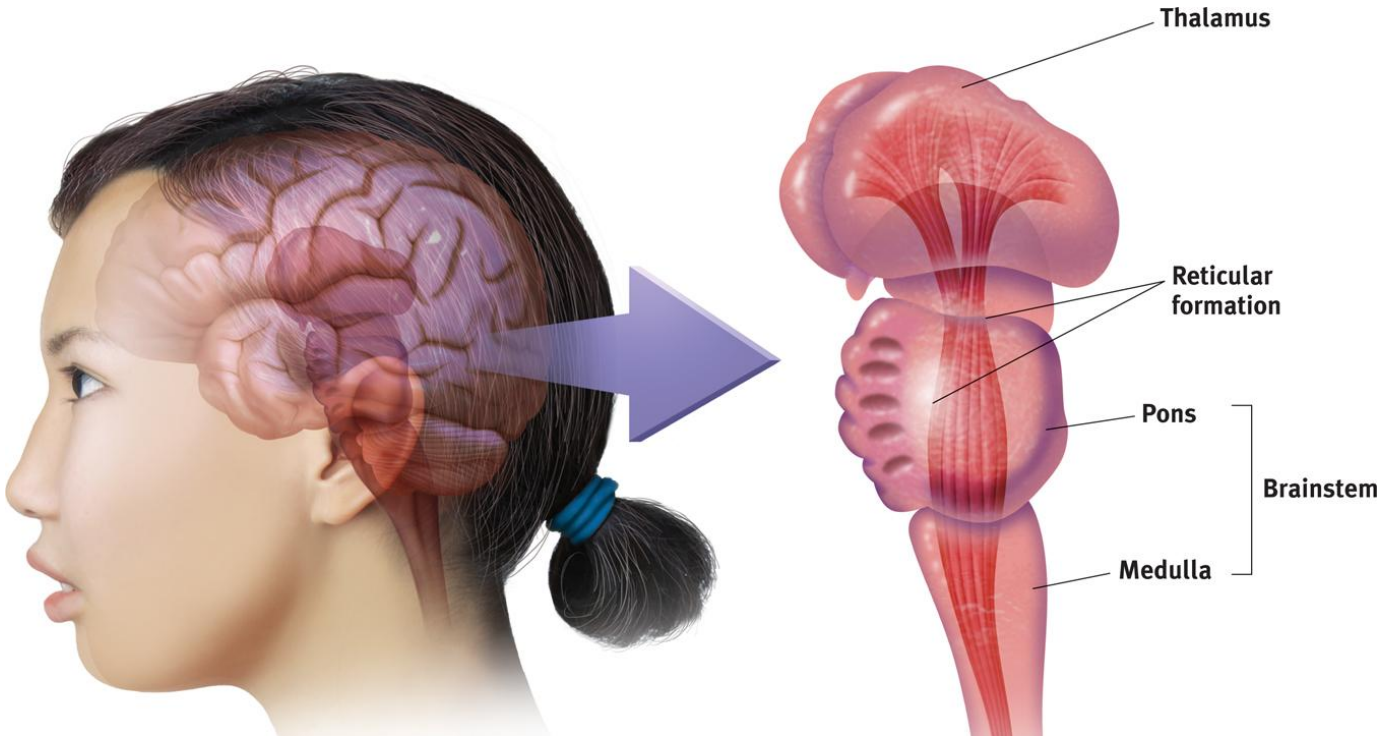
- The pituitary gland is the “master gland” of the endocrine system.
- It is controlled through the nervous system by the nearby brain area--the hypothalamus.
- The pituitary gland produces hormones that regulate other glands such as the thyroid.
- It also produces growth hormone (especially during sleep) and oxytocin, the “bonding” hormone.



# Areas of the brain and their functions

| The brainstem and cerebellum: | The limbic (border) system: | The cortex (the outer covering): |
| --- | --- | --- |
| • ensure basic survival<br>• coordinates the body | • manages emotions, and connects thought to body | • integrates information |

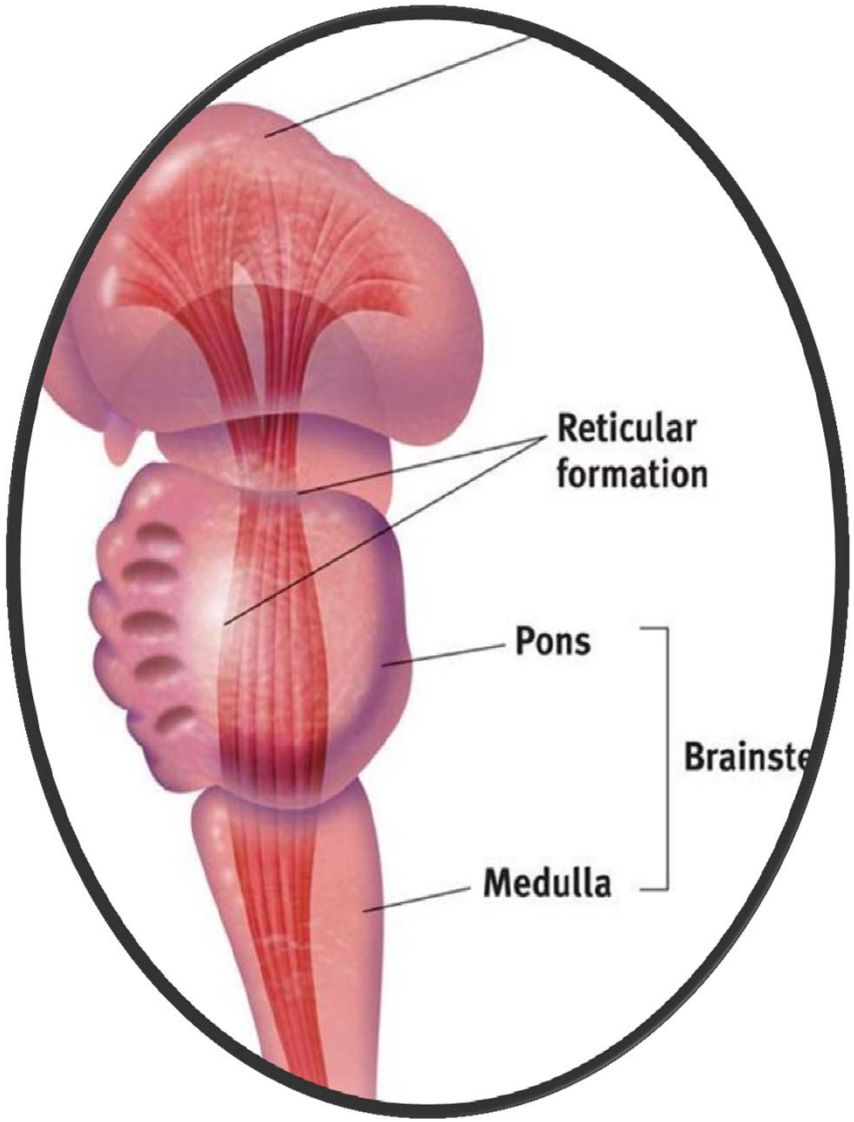
# The Brainstem: Pons and Medulla



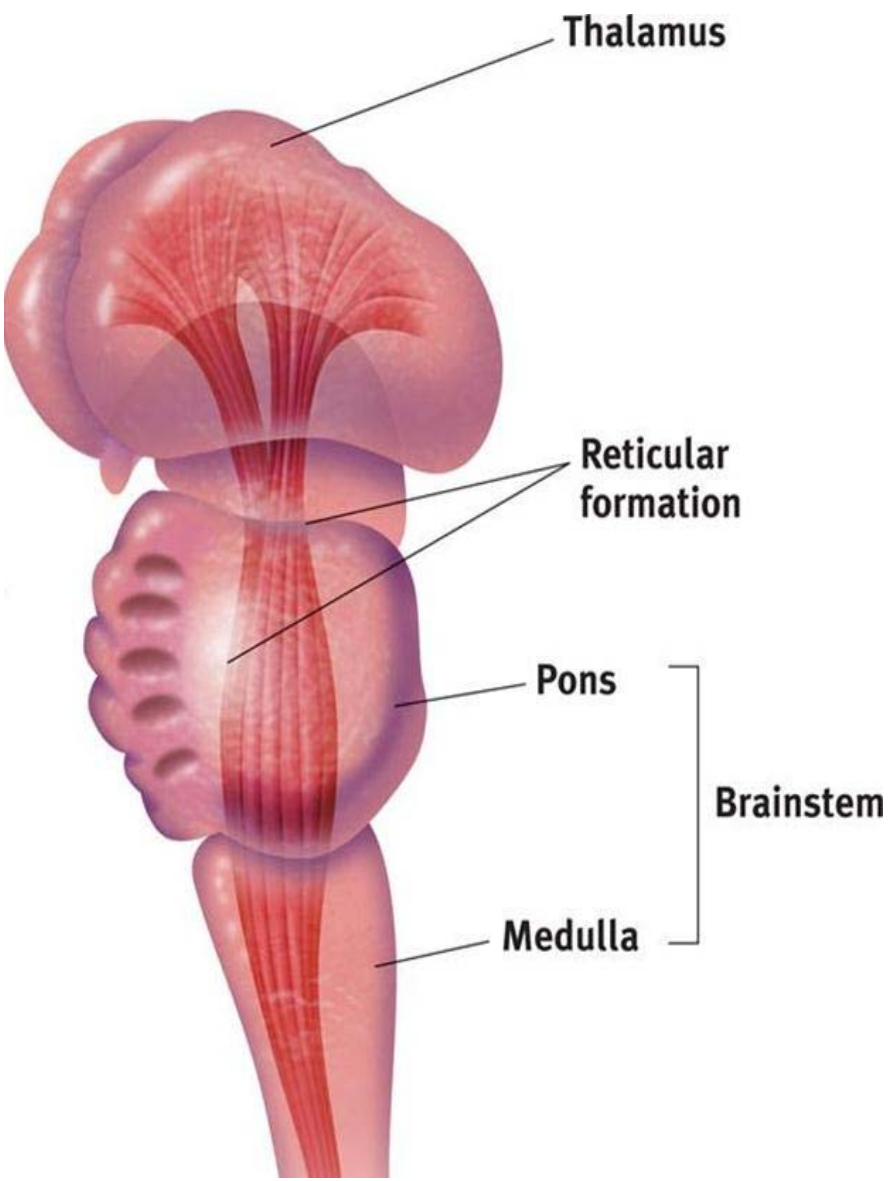

- **The medulla** controls the most basic functions such as heartbeat and respiration.
- **The pons** ("bridge") helps coordinate automatic and unconscious movements. It relays signals from the forebrain to the cerebellum, along with nuclei that deal primarily with sleep, respiration, swallowing, bladder control, hearing, equilibrium, taste, eye movement, facial expressions, facial sensation, and posture. The pons is implicated in sleep paralysis, and also plays a role in generating dreams

# Reticular ("Netlike") Formation

- The reticular formation is a nerve network in the brainstem.
- It enables alertness, (arousal) from deep sleep to wide awake when stimulated and produces permanent coma when lesioned (as demonstrated in the cat experiments).
- It also filters incoming sensory information and controls selective awareness.

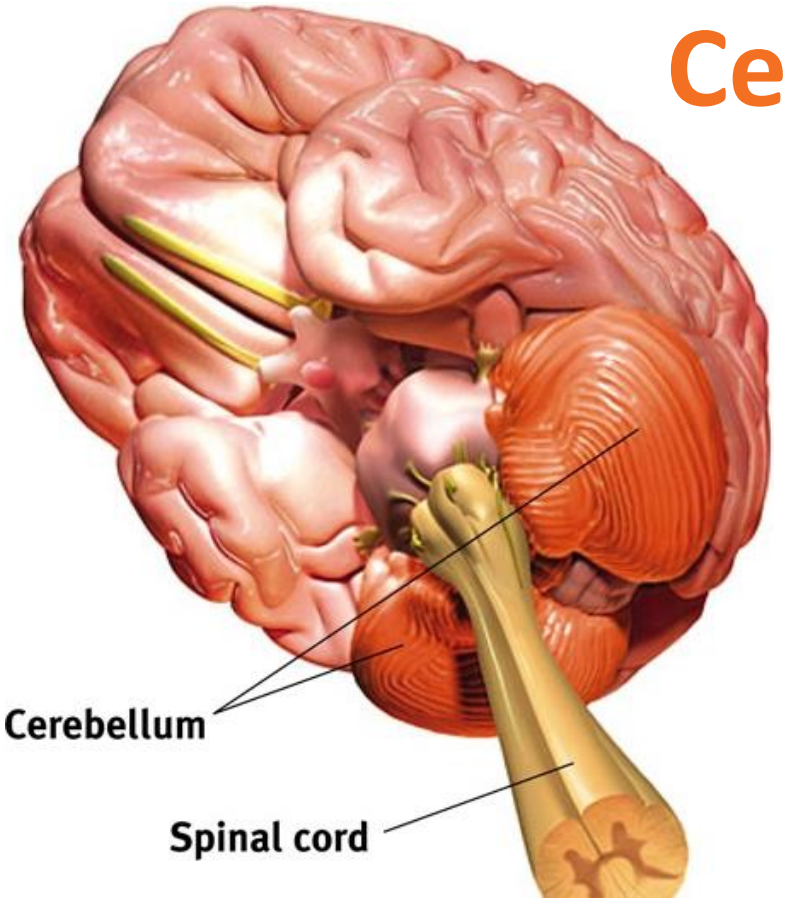


# The Thalamus ("Inner Chamber")




- The thalamus is the "sensory switchboard" or "router."
- All sensory messages, except smell, are routed through the thalamus on the way to the cortex (higher, outer brain).
- The thalamus also sends messages from the cortex to the medulla and cerebellum.
- Damage to the thalamus can cause blindness and other loss of the senses, even if the sensory organ is fine.

# Cerebellum ("little brain")




The cerebellum helps coordinate voluntary movement and balance, such as playing a sport.


The cerebellum also is the area where implicit memories and conditioning are stored. It also helps us judge time, modulate emotions, and integrate multiple sources of sensory input.

# The Limbic ("Border") System

## The limbic system coordinates:

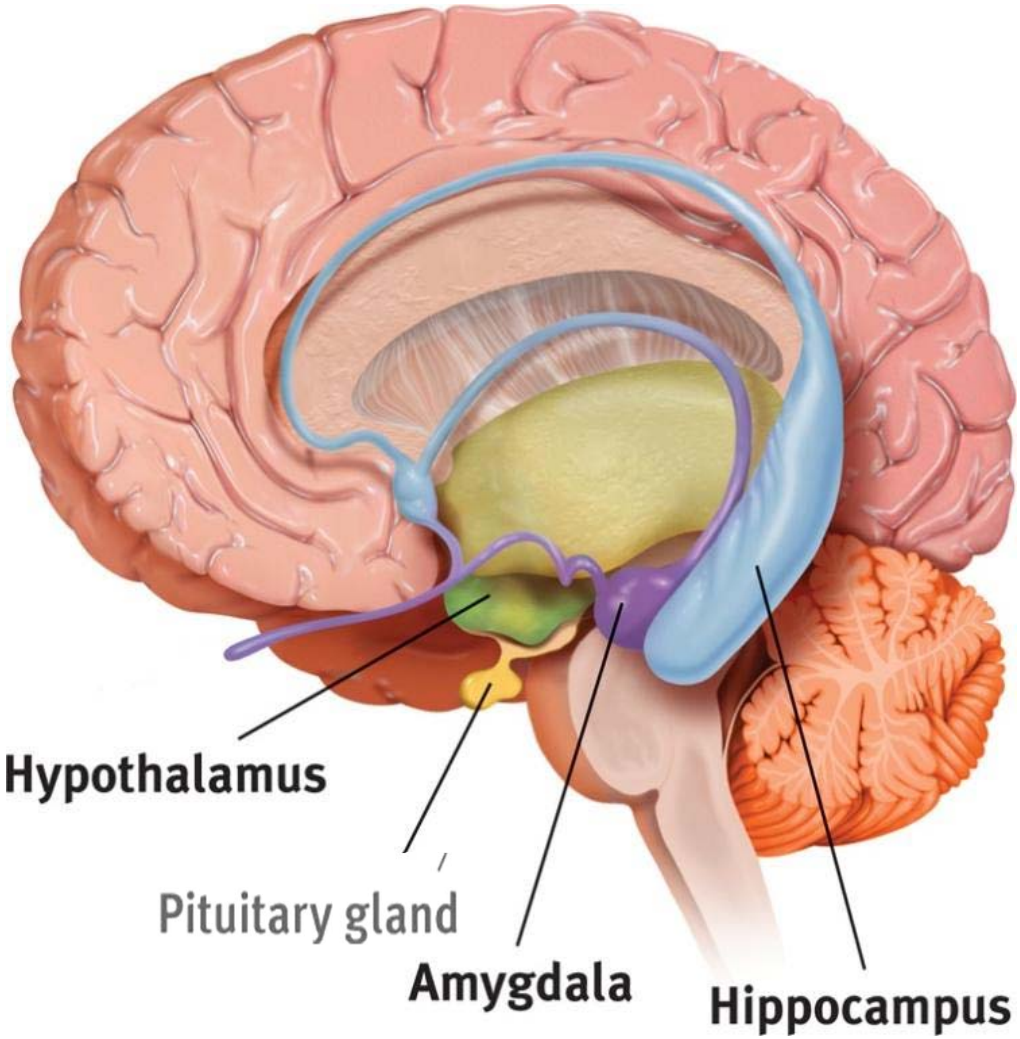
- emotions such as fear and aggression.
- basic drives such as hunger and sex.
- the formation of episodic memories.

### The hippocampus ("seahorse")

- processes conscious, episodic memories.
- works with the amygdala to form emotionally charged memories.
- one of the few places in the brain in which neurogenesis is known to take place.

### The Amygdala ("almond")

- consists of two lima bean-sized neural clusters.
- helps process emotions, especially fear and aggression.

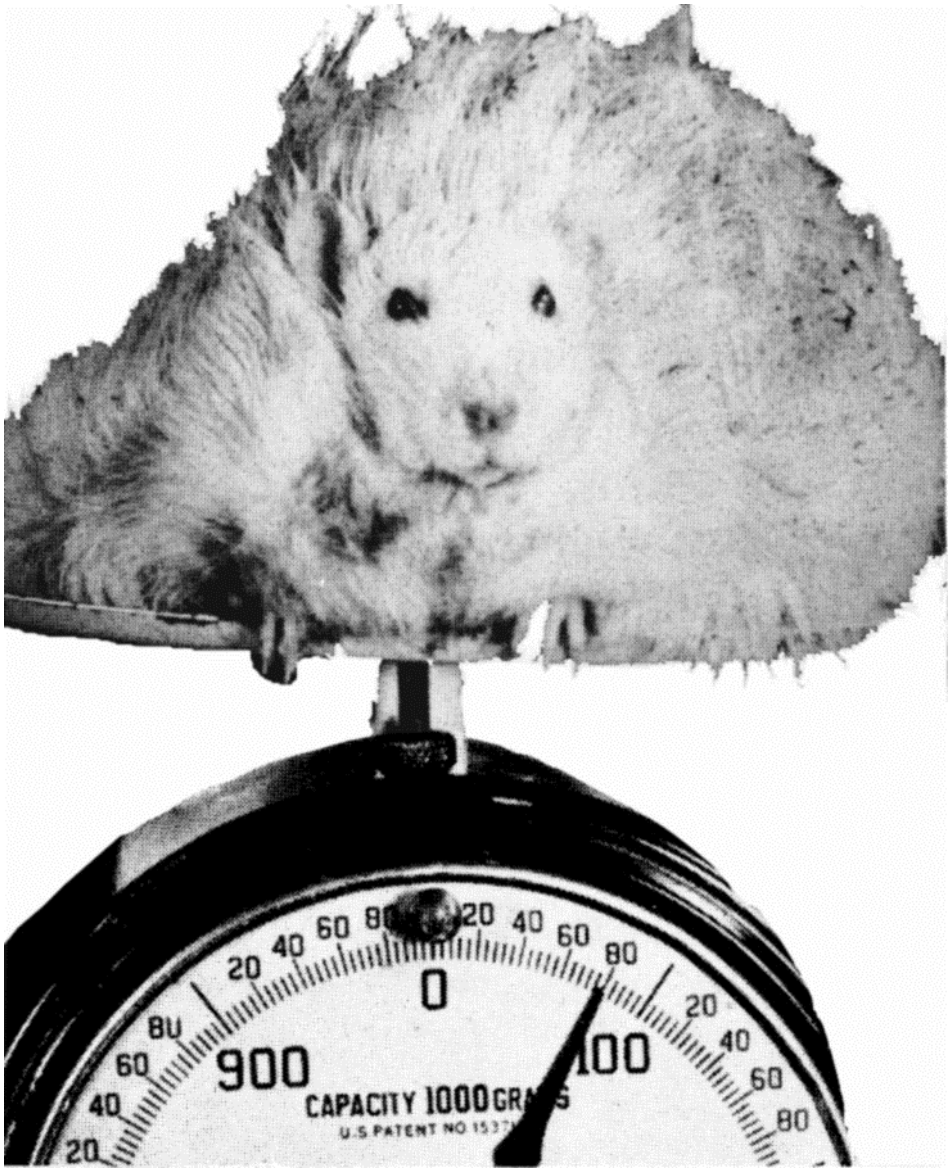


# The Amygdala

- Electrical stimulation of a cat's amygdala provokes aggressive reactions.
- If you move the electrode very slightly and cage the cat with a mouse, the cat will cower in terror.
- Destruction of part of the amygdala can apparently eliminate both emotions.

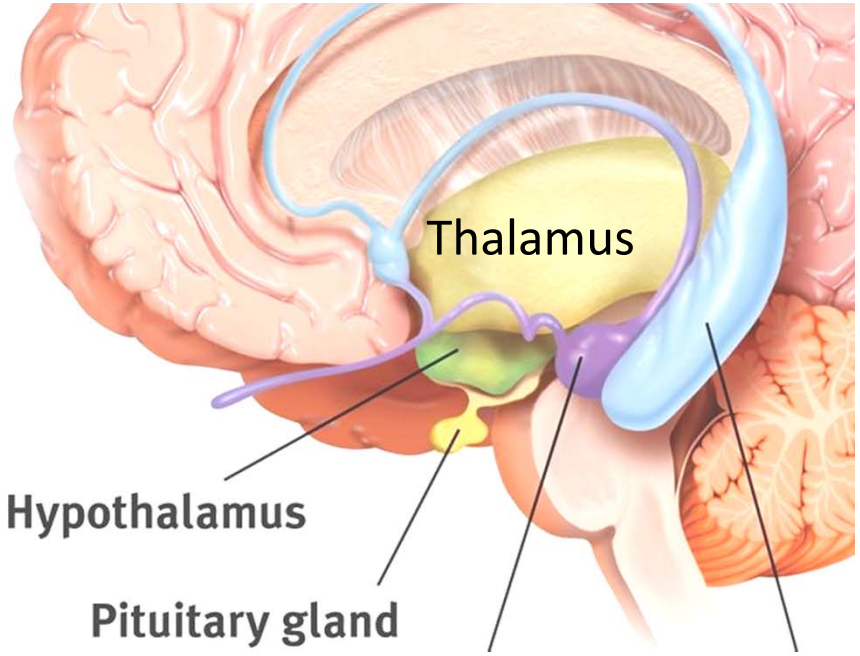
# Hypothalamus


DUDE!!! WHAT HAPPENED???

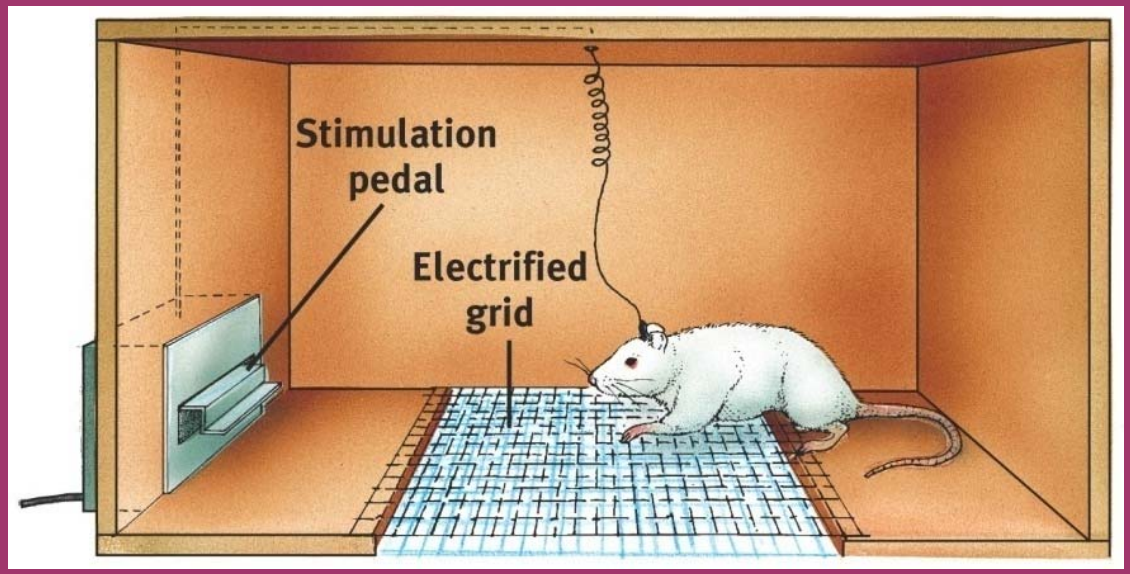


# The Hypothalamus:

- lies below ("hypo") the thalamus.
- regulates body temperature and ensures adequate food and water intake (homeostasis), and is involved in sex drive.
- directs the endocrine system via messages to the pituitary gland.




## The Hypothalamus as a Reward Center

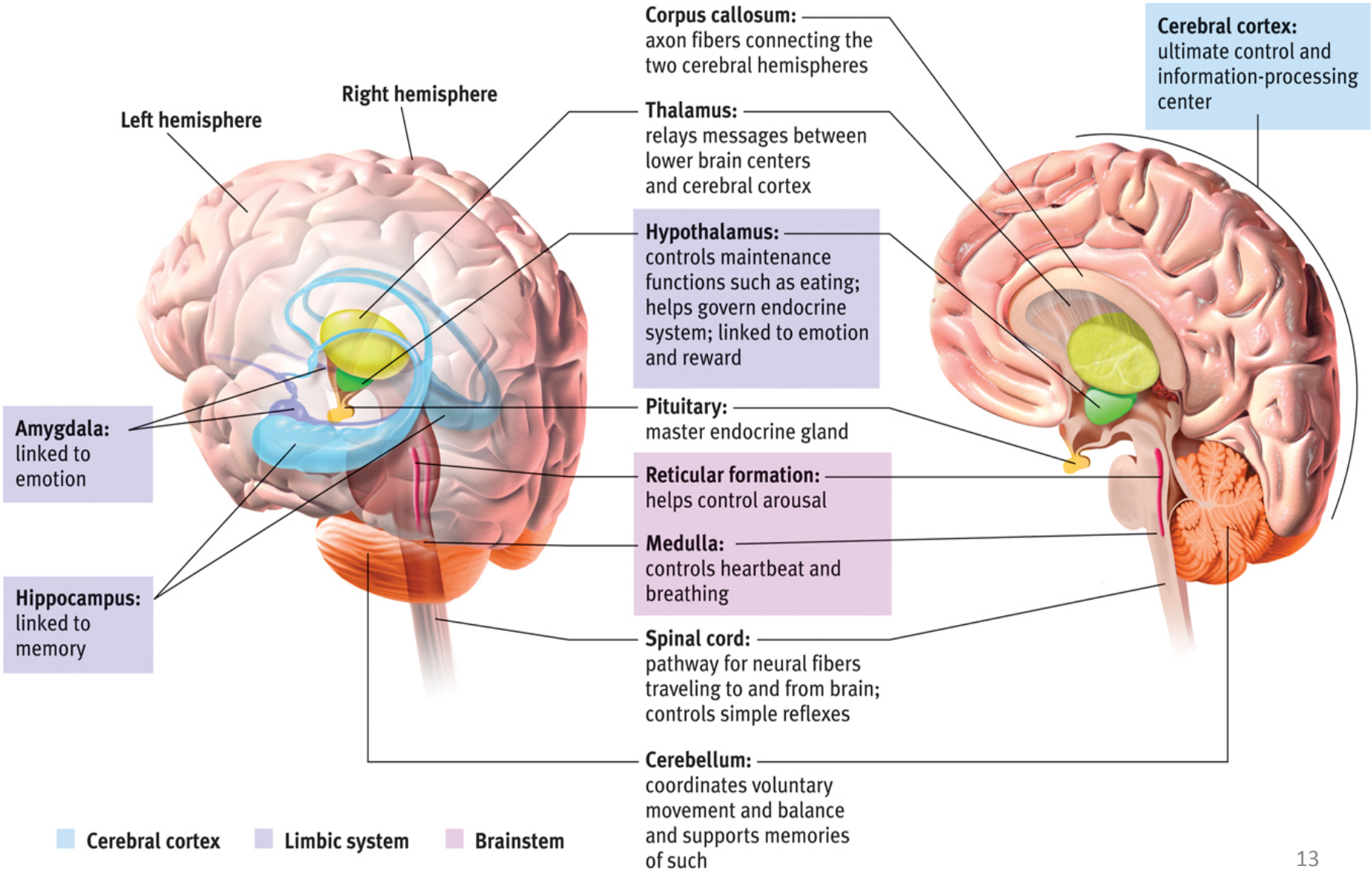



**Riddle:** Why did the rat cross the grid?

Why did the rat want to get to the other side?

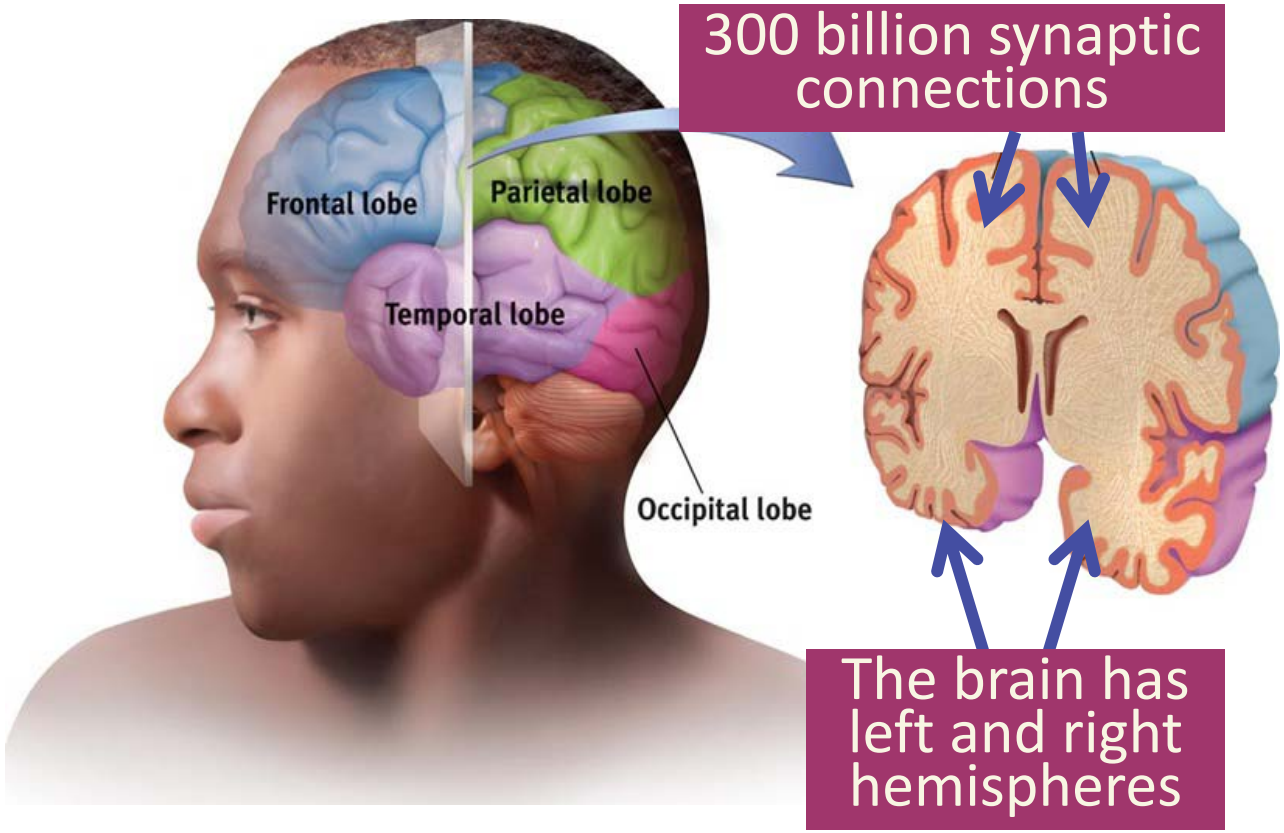
Pushing the pedal that stimulated the electrode placed in the hypothalamus was much more rewarding than food pellets.

# Review of Brain Structures



# The Cerebral Cortex
# The lobes consist of:

- outer grey "bark" structure that is wrinkled in order to create more surface area for 20+ billion neurons.
- inner white stuff—**axons** linking parts of the brain.
- 180+ billion **glial cells**, which feed and protect neurons and assist neural transmission.



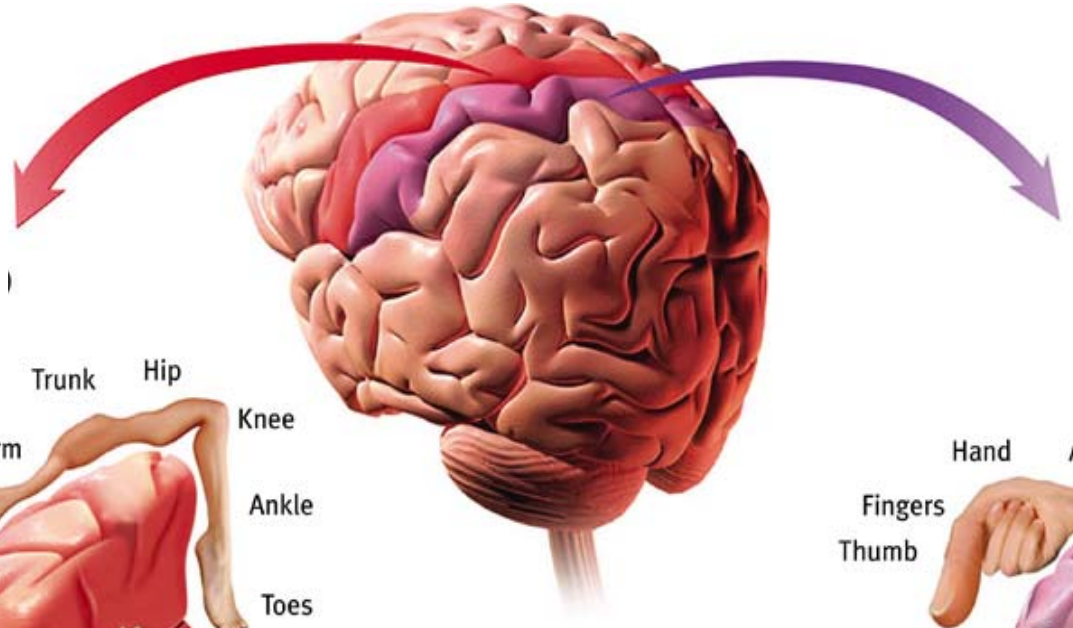
# The Lobes of the Cerebral Cortex:

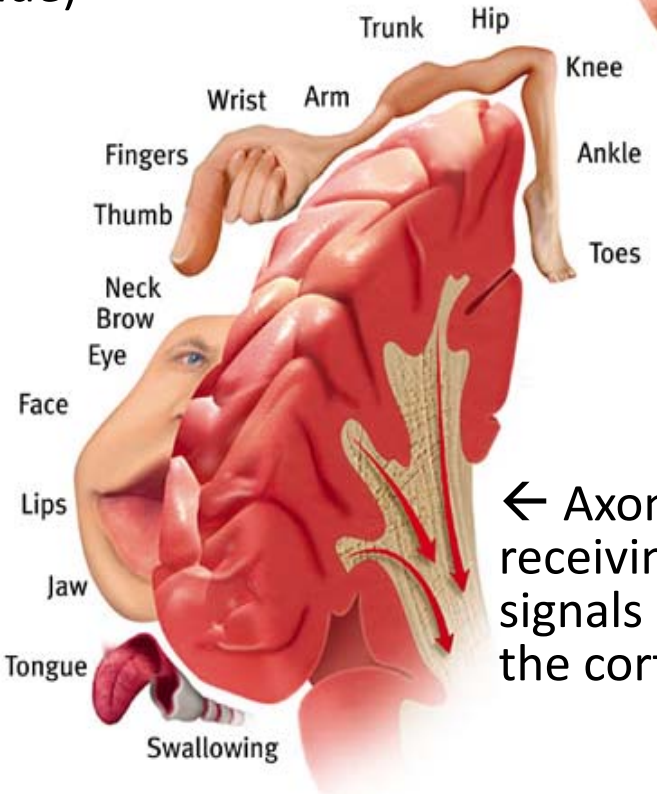
## *Preview*

- Frontal Lobes — involved in speaking and muscle movements and in making plans and judgments
- Parietal Lobes — include the sensory cortex
- Occipital Lobes — include the visual areas; they receive visual information from the opposite visual field
- Temporal Lobes — include the auditory processing areas

# *Functions of the Brain:*
# The Motor and Sensory Strips

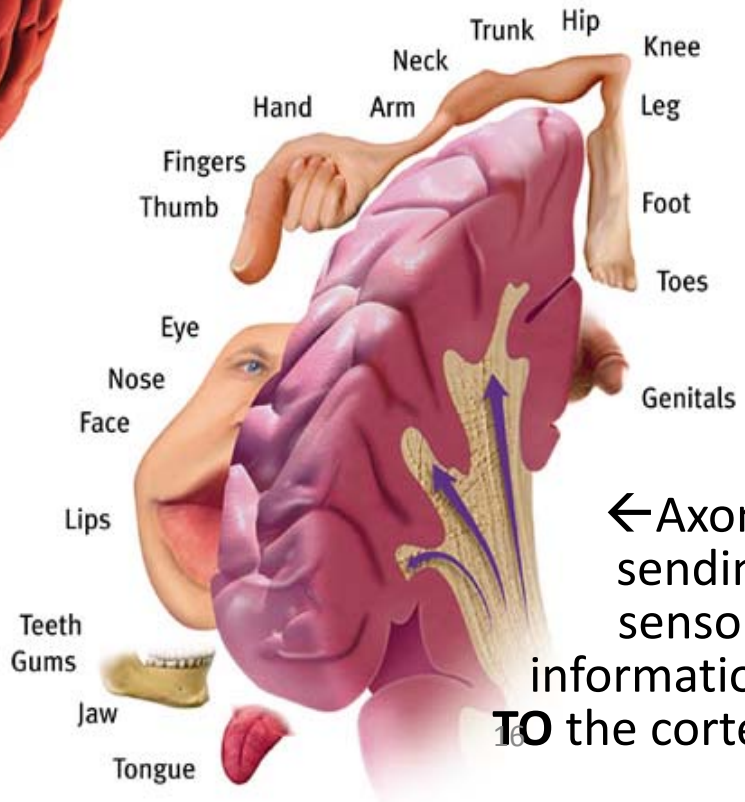
**Output: Motor cortex** (Left hemisphere section controls the body's right side)






← Axons receiving motor signals **FROM** the cortex

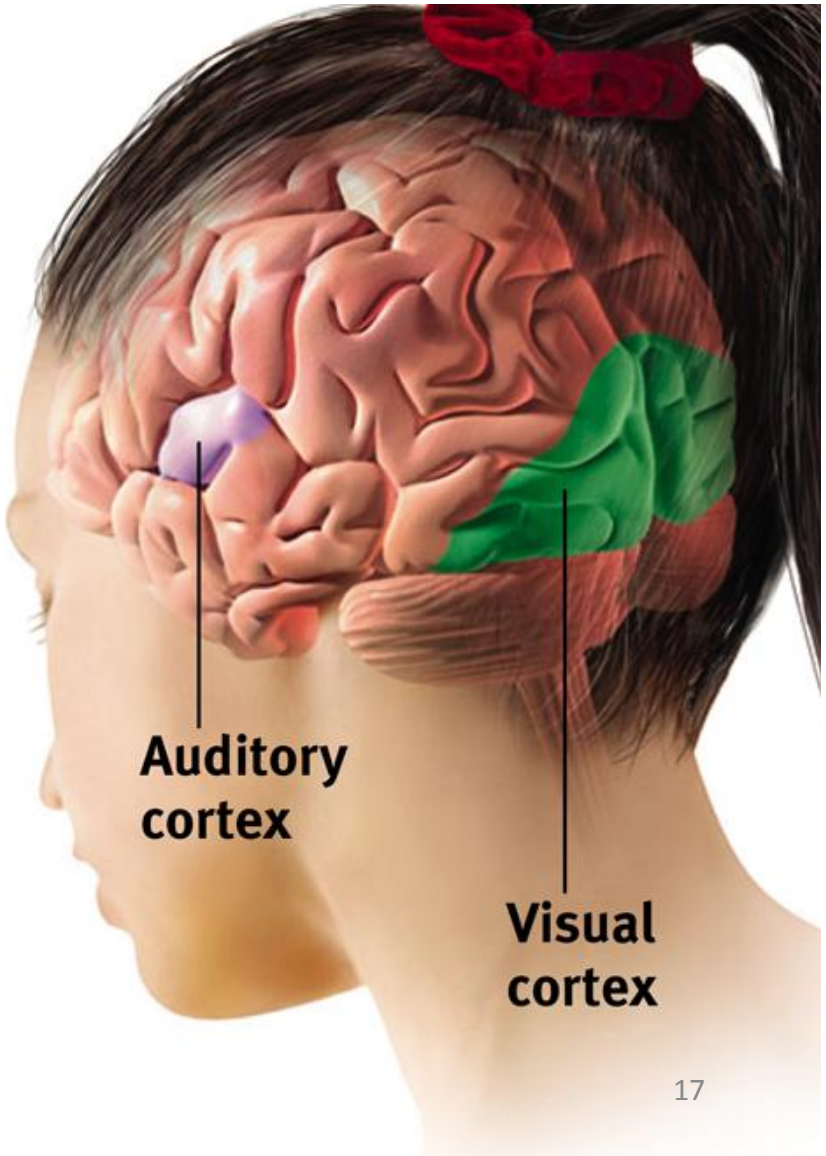
**Input: Sensory cortex** (Left hemisphere section receives input from the body's right side)




←Axons sending sensory information **TO** the cortex

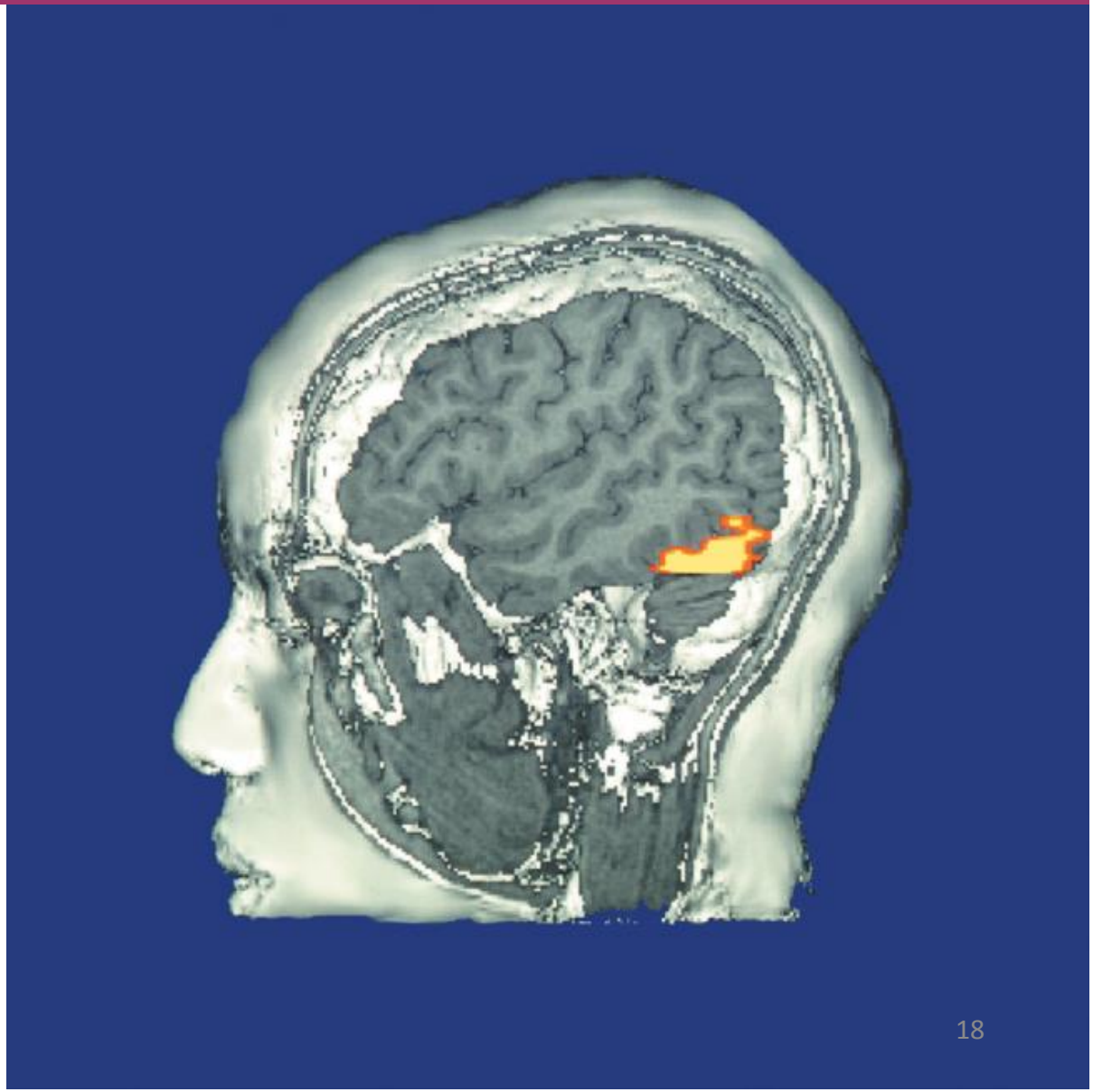
# Sensory Functions of the Cortex

- The **sensory strip** deals with information from **touch** stimuli.
- The **occipital lobe** deals with **visual** information.
- **Auditory** information is sent to the **temporal lobe**.
- Auditory areas are also active when someone in a psychotic state is experiencing “voices” or auditory hallucinations



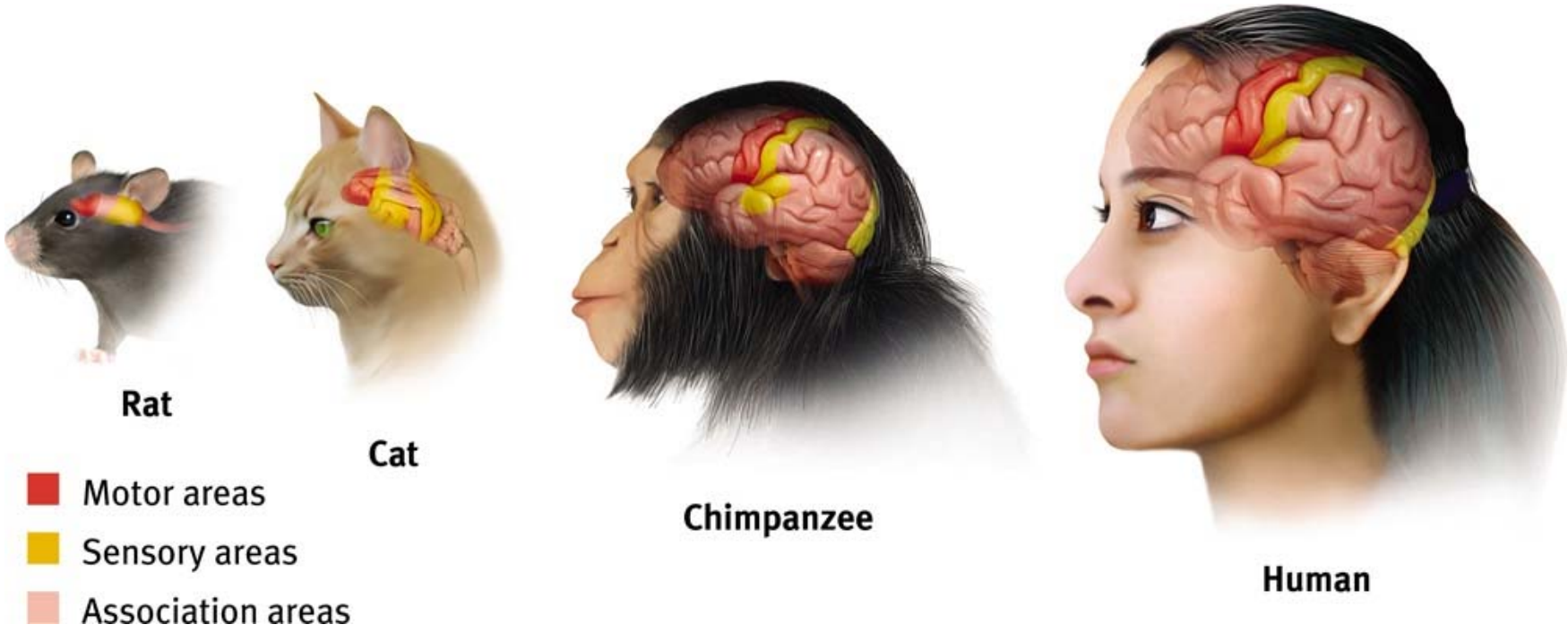
# The Visual Cortex

This fMRI scan shows increased activity in the visual cortex when a person looks at a photograph.



# Association function of the cortex

More intelligent/complex animals have more cortical space devoted to integrating and associating information, hence: **association areas**



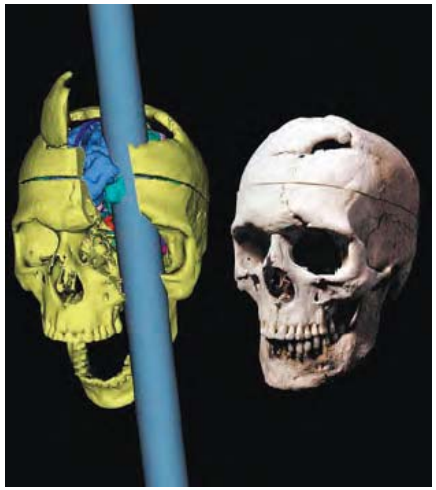
# Association Areas: Frontal Lobes

- The frontal lobes are active in “executive functions” such as judgment, planning, and inhibition of impulses.
- The frontal lobes are also active in the use of working memory and the processing of new memories.
- They contribute largely to making us uniquely “human.”

# Phineas Gage (1823-1860)

Case study: In a work accident, a metal rod shot up through Phineas Gage's skull, destroying his eye and part of his frontal lobes.

After healing, he was able to function in many ways, but his personality changed; he was rude, odd, irritable, and unpredictable.



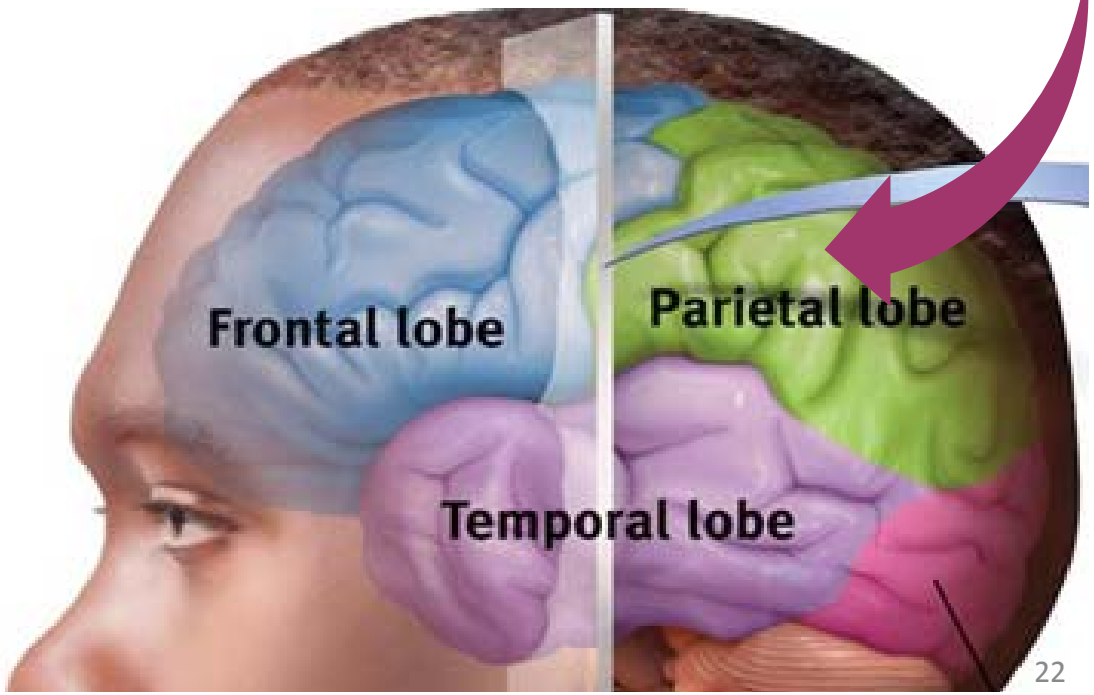
**Possible explanation:**

Damage to the frontal lobes could result in loss of the ability to suppress impulses and to modulate emotions.

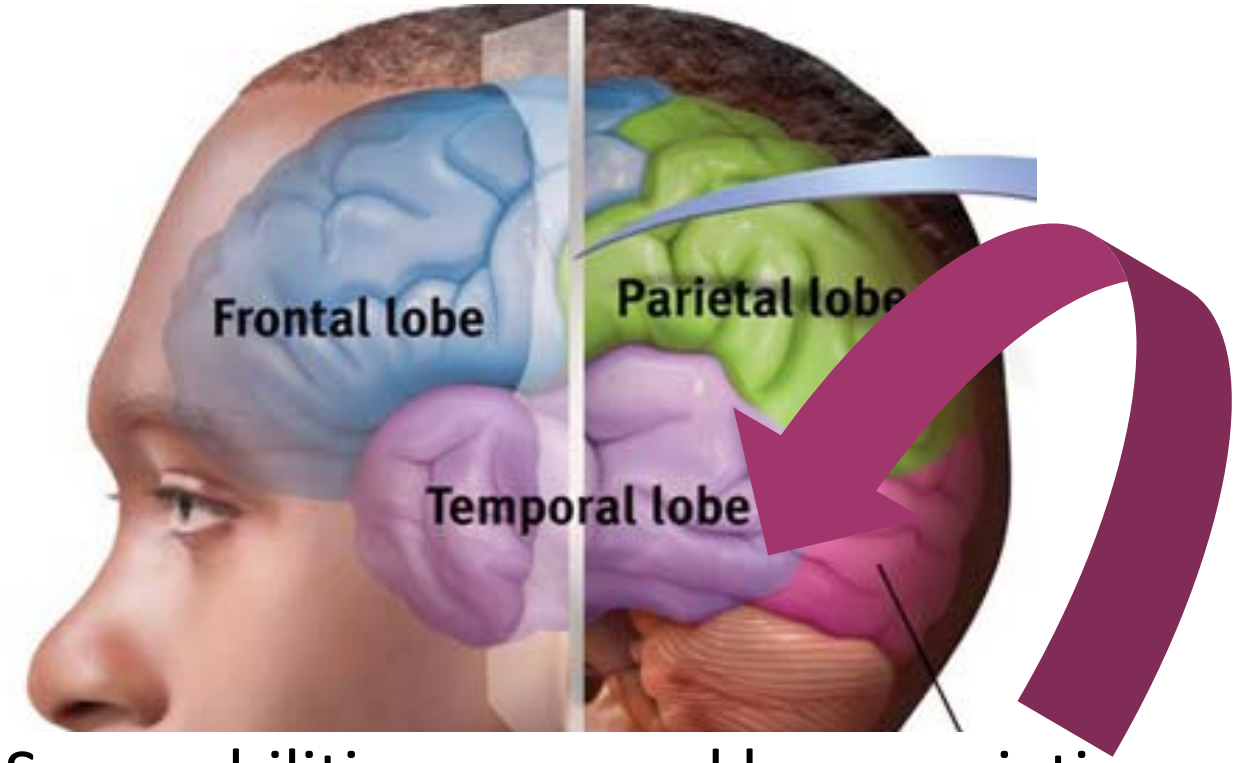
# Parietal Lobe Association Areas

This part of the brain has many functions in the association areas behind the sensory strip:

- managing input from multiple senses
- performing spatial and mathematical reasoning
- monitoring the sensation of movement



# Temporal Lobe Association Areas



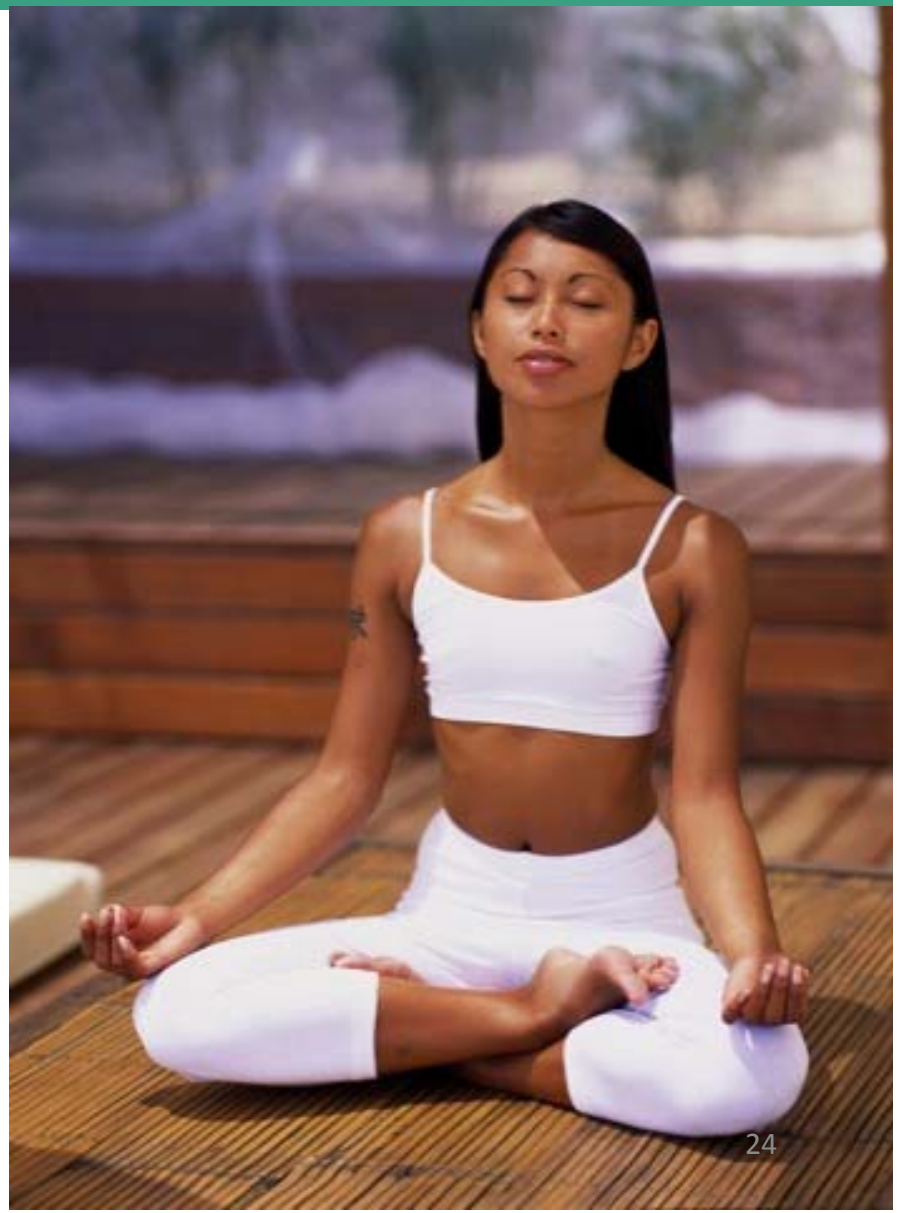

Some abilities managed by association areas in this “by the temples” lobe:

- recognizing specific faces
- managing sensory input related to sound, which helps the understanding of spoken words

# Whole-brain Association Activity

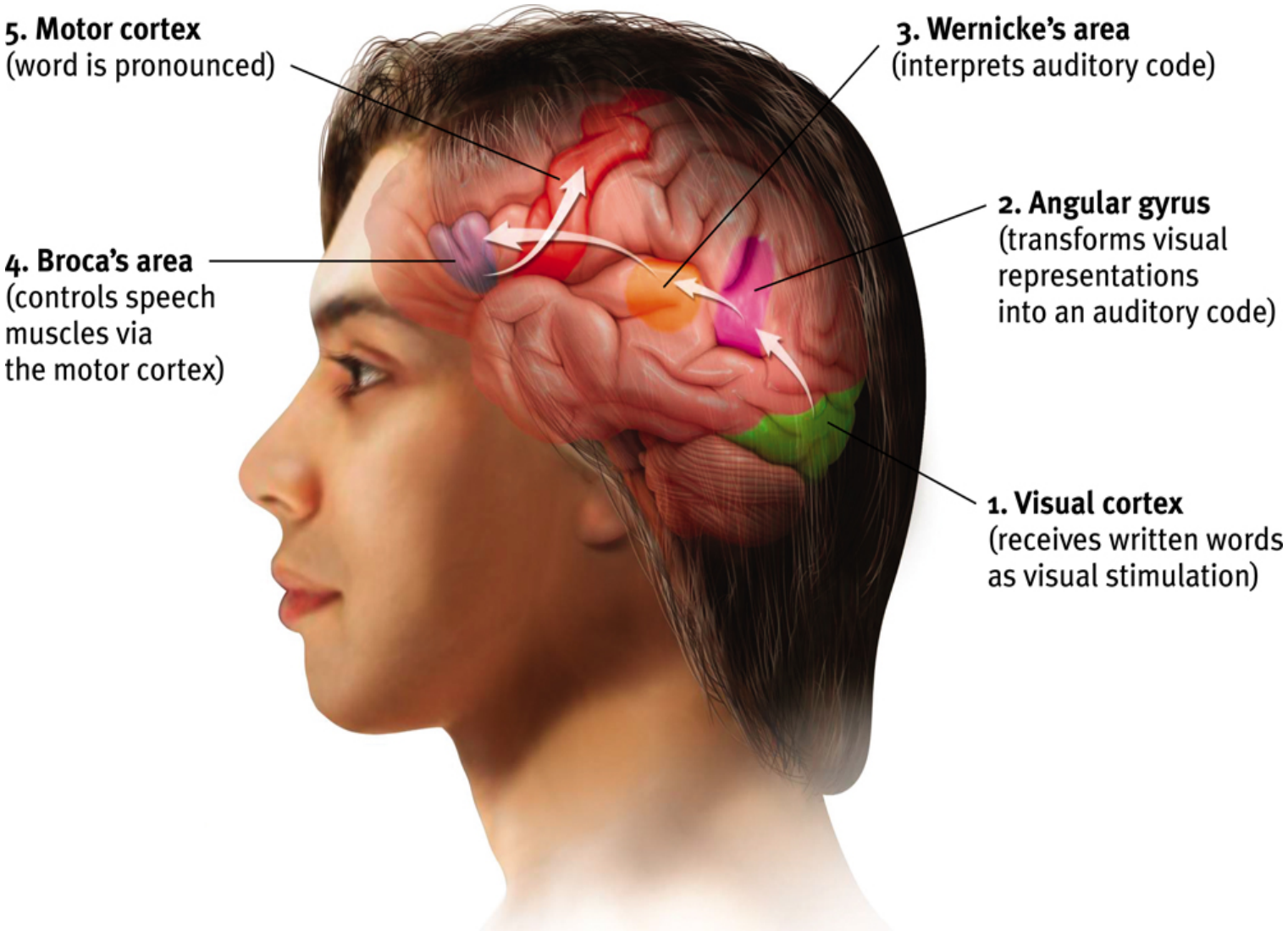
Whole-brain association activity involves complex activities which require communication among association areas across the brain such as:

- memory
- language
- attention
- meditation and spirituality
- consciousness



# Specialization and Integration

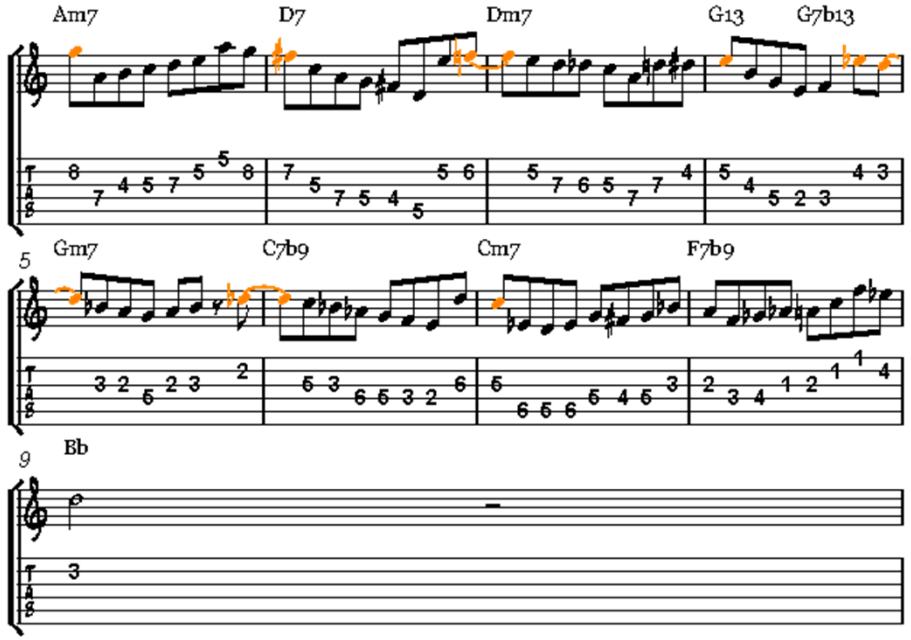
## *Five steps in reading a word aloud:*



# Language – A Lateralized Function

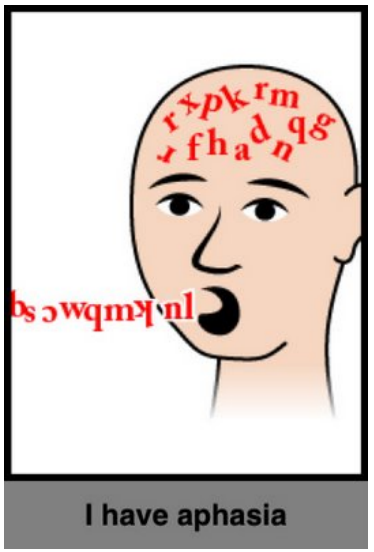
- Broca's Area
  - an area of the left frontal lobe that **directs the muscle movements involved in speech**

- Expressive Aphasia
  - difficulty initiating and executing voluntary movement patterns necessary to produce speech when there is no paralysis or weakness of speech muscles.
  - Signs:
    - Producing the desired speech sound.
    - Using the correct rhythm and rate of speaking.

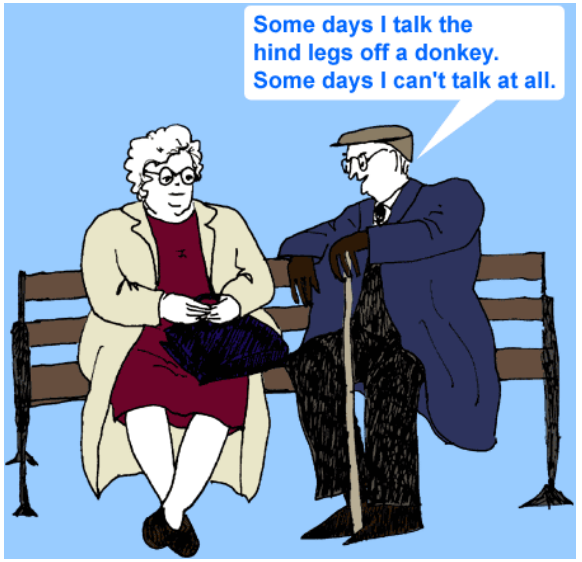



# Language – A Lateralized Function

- Wernicke's Area
  - an area of the left temporal lobe involved in **language comprehension and expression**




- Receptive Aphasia
  - impairment in the ability to use or comprehend words
  - Signs:
    - Understanding words.
    - Finding the word to express a thought
    - Understanding grammatical sentences.
    - Reading or writing words or sentences.



# Plasticity: The Brain is Flexible

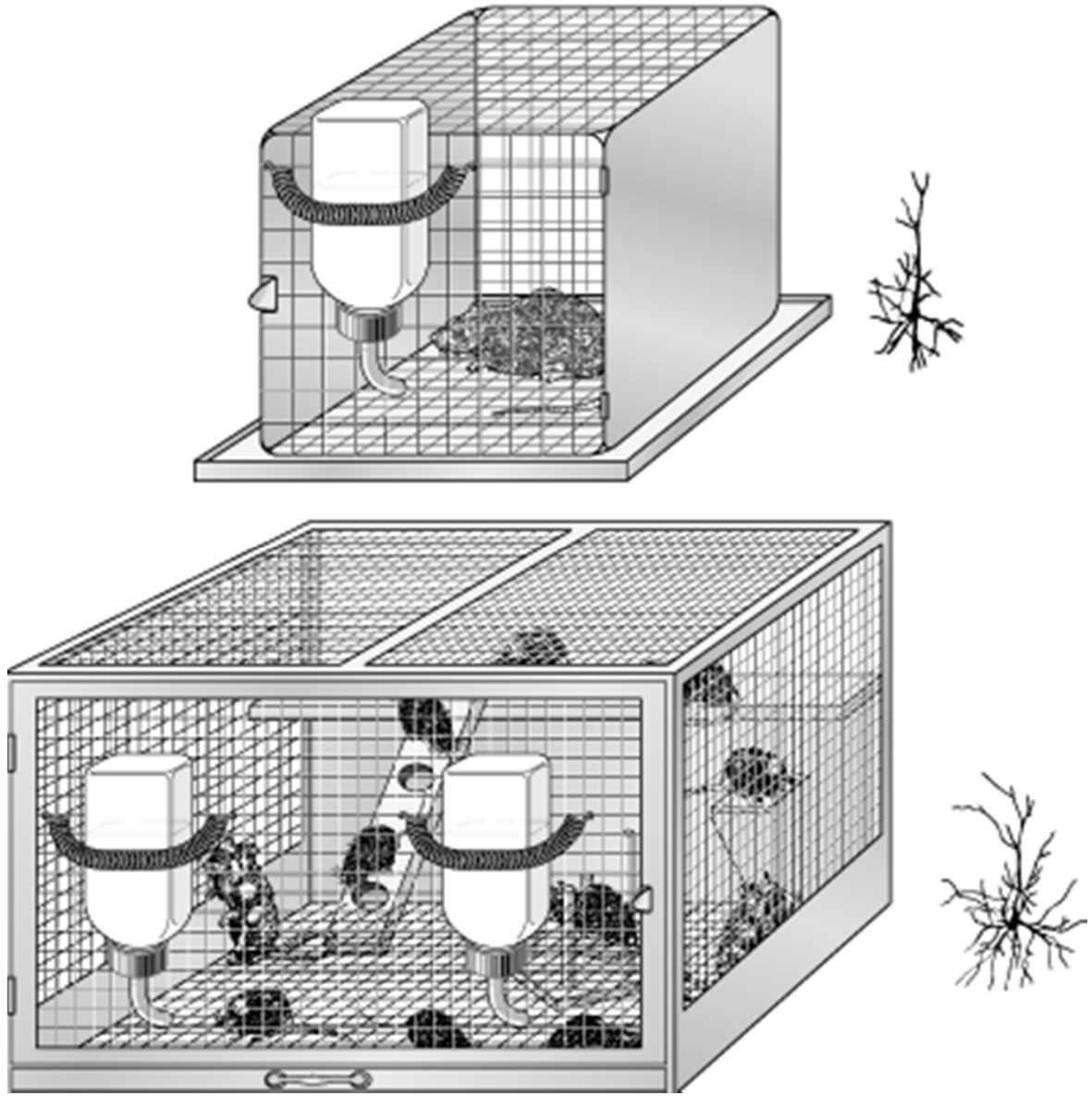
If the brain is damaged, especially in the general association areas of the cortex:

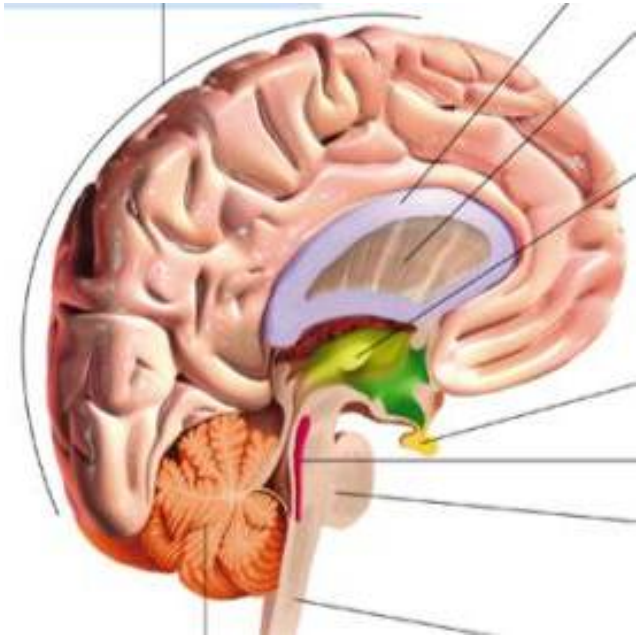
- the brain does not repair damaged neurons, BUT it can restore some functions
- it can form new connections, reassign existing networks, and insert new neurons, some grown from stem cells

This 6-year-old had a hemispherectomy to end life-threatening seizures; her remaining hemisphere compensated for the damage.

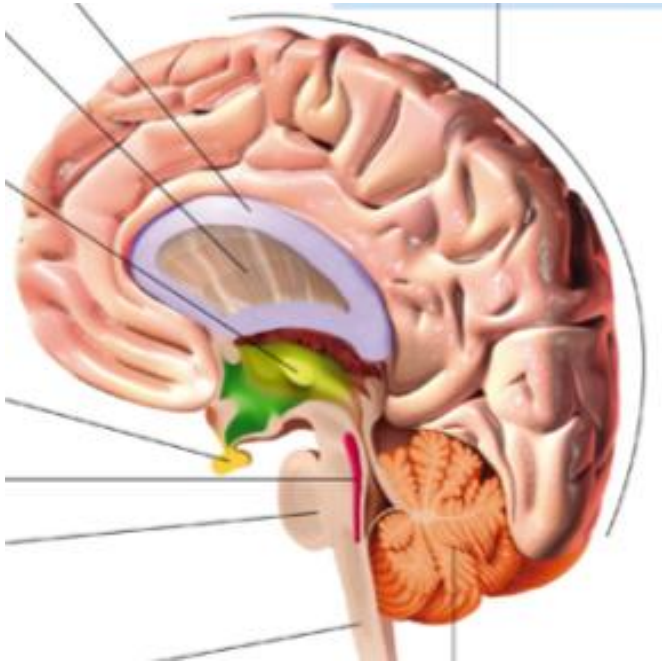
# Cerebral Cortex – Neural Organization Experiment

- Some rats are housed alone in empty cages
- Their littermate twins are group-housed in cages with toys, which are changed frequently
- Richer environments led to heavier, thicker brains, more synapses, and better learning





# Our Two Hemispheres



**Lateralization** ("going to one side")

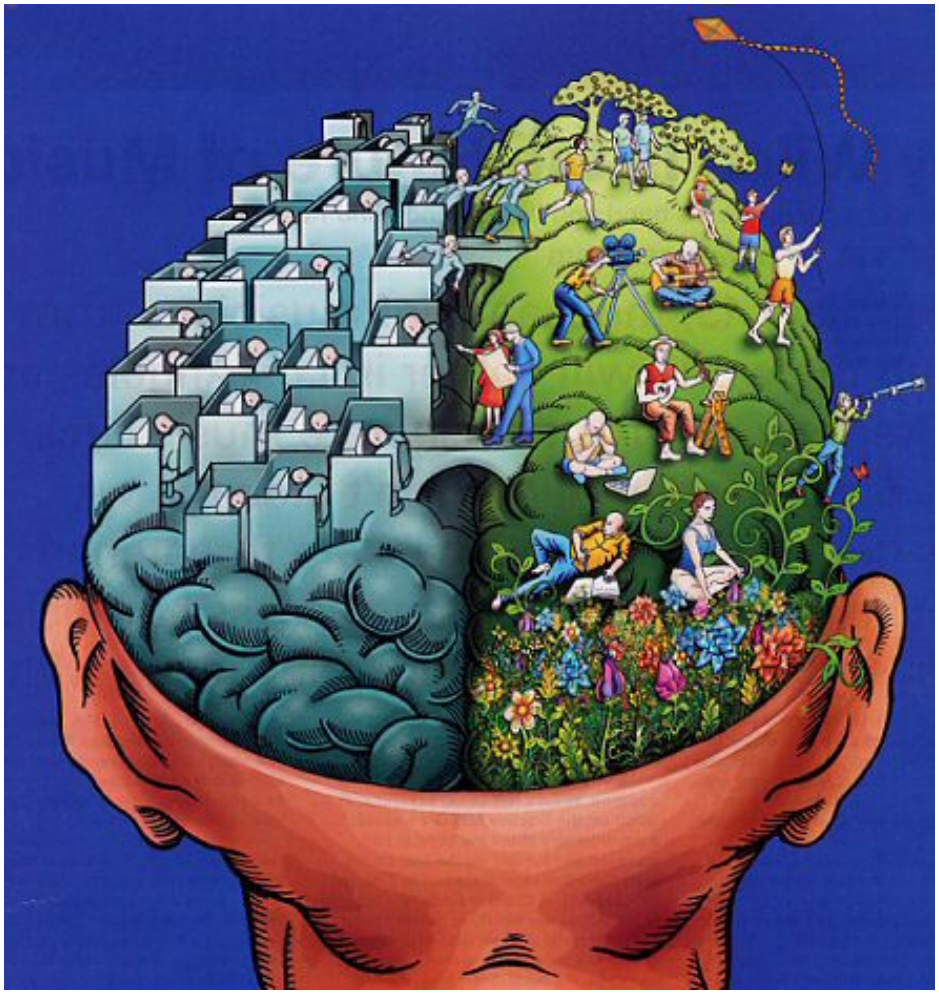
The two hemispheres serve some different functions.

How do we know about these differences?

- Brain damage studies revealed many functions of the left hemisphere.
- Brain scans and split brain studies show more about the functions of the two hemispheres, and how they coordinate with each other.

# Our Divided Brain – The Two Hemispheres

- Left Hemisphere
  - Verbal
  - Math
  - Analytic
  - Boring



- Right Hemisphere
  - Spatial
  - Holistic
  - Nonverbal
  - Fun Party

*The intact but lateralized brain*

# Right-Left Hemisphere Differences

## Left Hemisphere

Thoughts and logic

Details such as “trees”

Language: words and definitions

Linear and literal

Calculation

Pieces and details

## Right Hemisphere

Feelings and intuition

Big picture such as “forest”

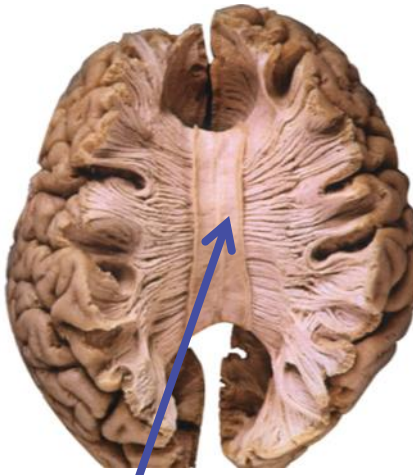
Language: tone, inflection, context

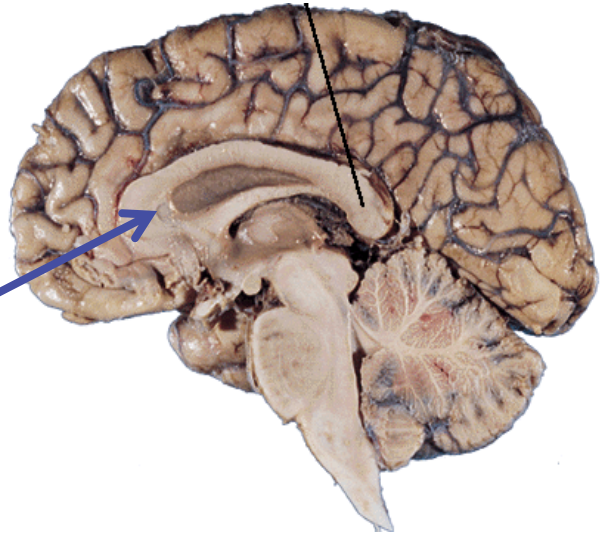
Inferences and associations

Perception

Wholes, including the self

# Split-Brain Studies



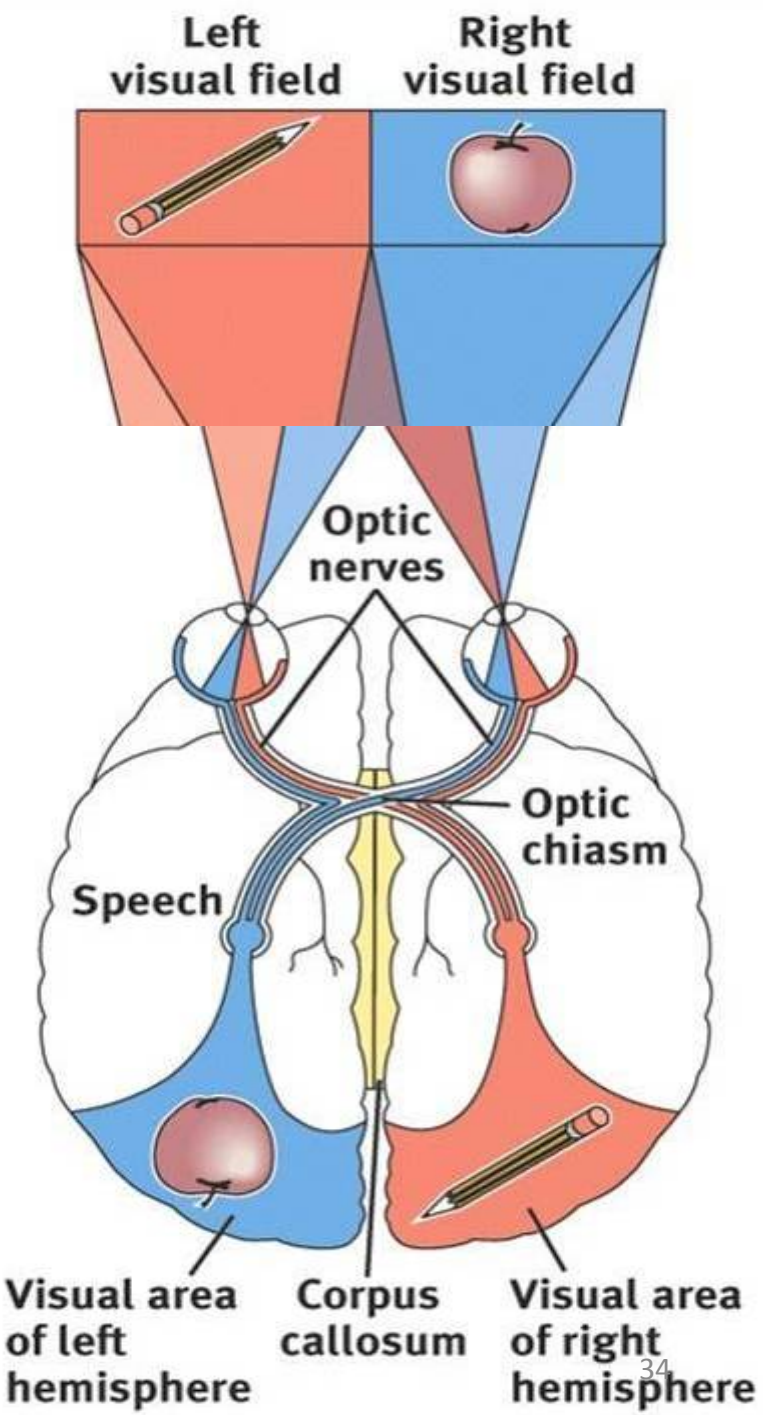


To end severe whole-brain seizures, some people have had surgery to cut the **corpus callosum**, a band of axons connecting the hemispheres.

Researchers have studied the impact of this surgery on patients' functioning.

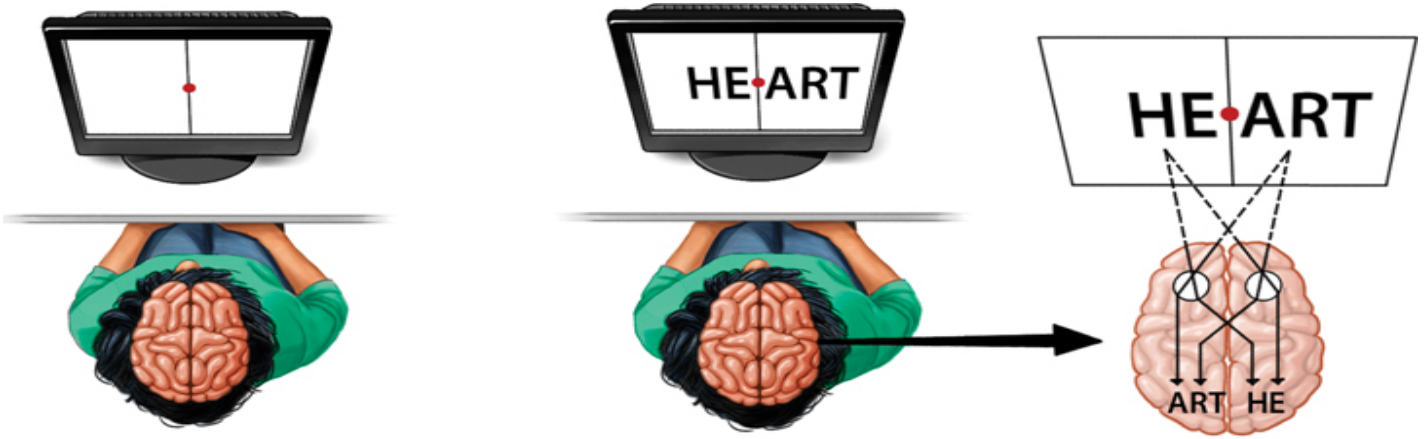
# Split visual field

Each hemisphere does **not** perceive what each EYE sees. Instead, it perceives the half of the view in front of you that goes with the half of the body that is controlled by that hemisphere.



# Divided Awareness in the Split Brain

## Try to explain the following result:

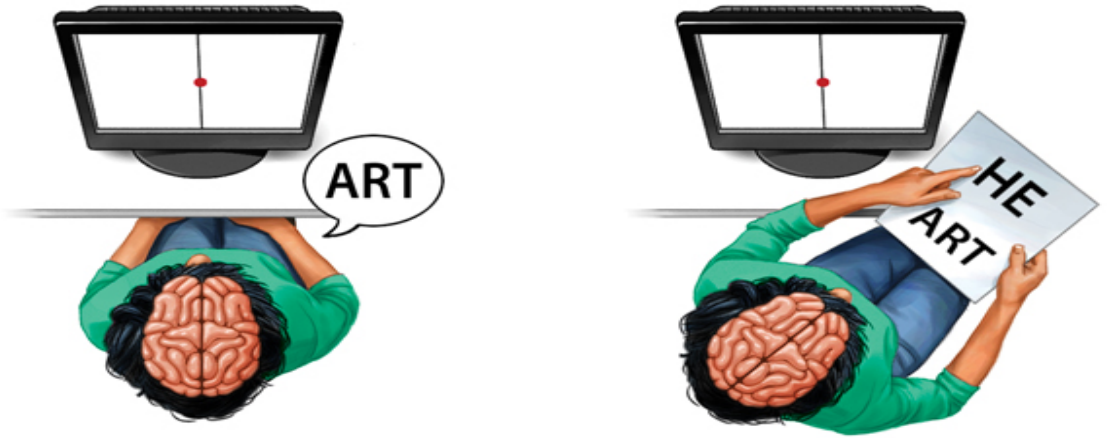



"Look at the dot."

(a)

Two words separated by a dot are momentarily projected.

(b)




"What word did you see?"

or

"Point with your left hand to the word you saw."

(c)

# The divided brain in action

- Talent: people are able to follow two instructions and draw two different shapes simultaneously
- Drawback: people can be frustrated that the right and left sides do different things