Lecture 2: The Brain

Lecture 2. The Human Brain

Lecture 1 (Cont'd)

- Chemical Process of message transmission
- Neurotransmitter

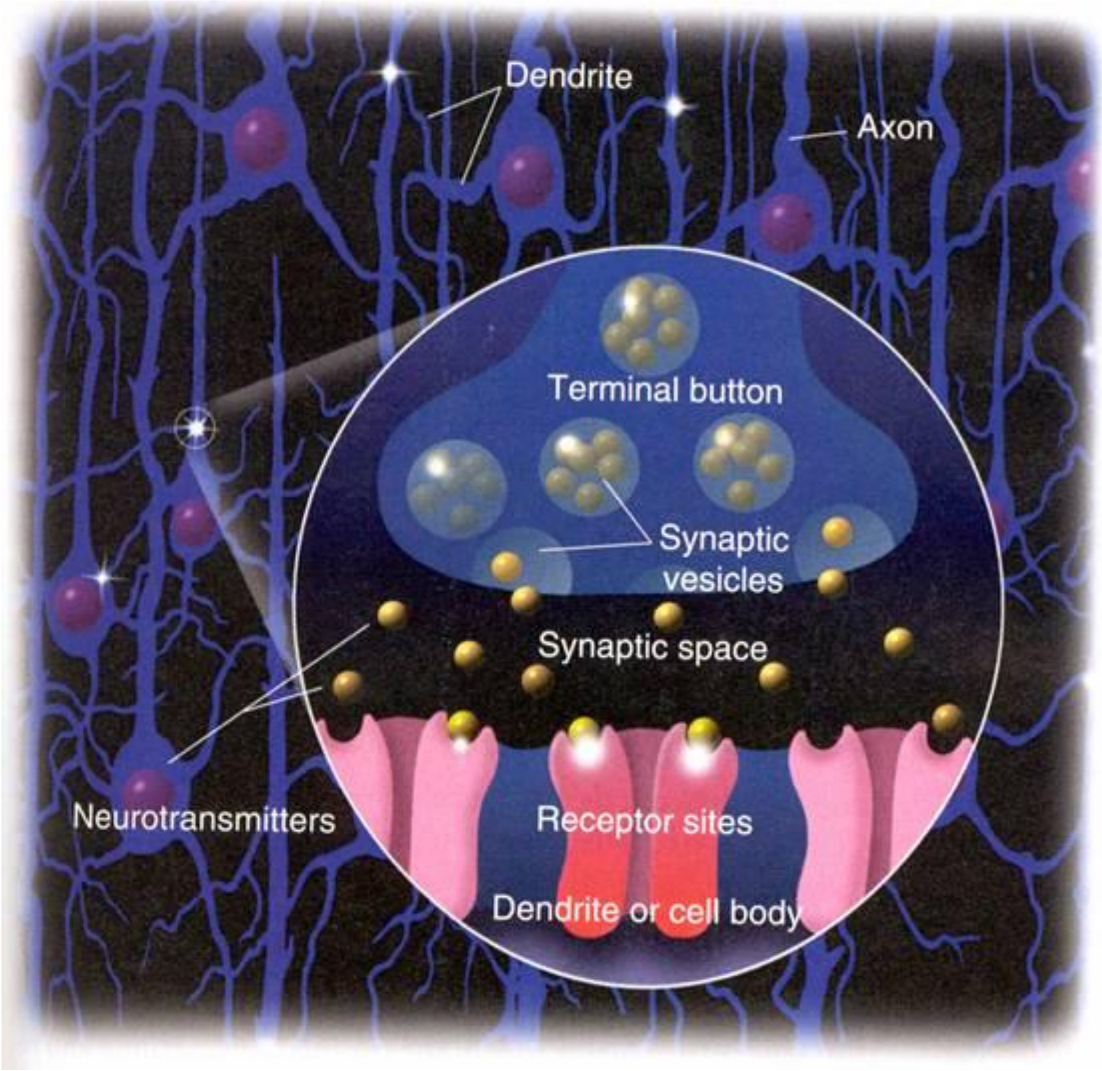
Lecture 2

- Brain: Structure and associated functions
- Hemispheric Specialization & split-brain patients
- Neuroplasticity

Points to highlight from the video: How neurons communicate

- Chemical process involving *neurotransmitters* traveling across *synaptic cleft.*
- It binds briefly on the receptor site of the receiving neuron, like a key fits into a lock.
- Neurotransmitters deliver either excitatory or inhibitory messages that determine whether the receiving neuron fires or not fires.
- Neurotransmitters fundamental to behaviors.

Synaptic transmission



Neurotransmitters (also read Chpt 16, pp.522-526)

TABLE 2.1

Neurotransmitters: An Overview

Neurons communicate with one another across the synapse through neurotransmitters. Several of these are listed and described here.

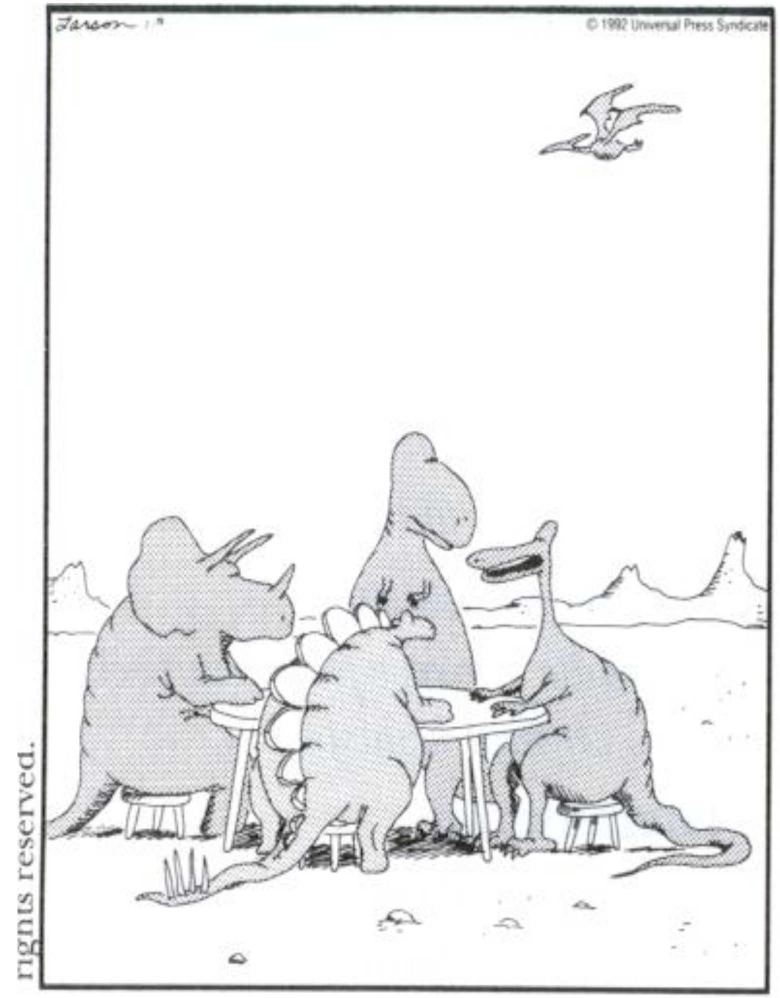
Neurotransmitter	Location	Effects
Acetylcholine	Found throughout the central nervous system, in the autonomic nervous system, and at all neuromuscular junctions.	Involved in muscle action, learning, and memory.
Norepinephrine	Found in neurons in the autonomic nervous system.	Primarily involved in control or alertness and wakefulness.
Dopamine	Produced by neurons located in a region of the brain called the substantia nigra.	Involved in movement, attention, and learning. Degeneration of dopamine-producing neurons has been linked to Parkinson's disease. Too much dopamine has been linked to schizophrenia.
Serotonin	Found in neurons in the brain and spinal cord.	Plays a role in the regulation of mood and in the control of eating, sleep, and arousal. Has also been implicated in the regulation of pain and in dreaming.
GABA (gamma-amino-butyric acid)	Found throughout the brain and spinal cord.	GABA is the major inhibitory neurotransmitter in the brain. Abnormal levels of GABA have been implicated in sleep and eating disorders.

Parkinson's disease: A deficiency in dopamine

The black cells of the substantia nigra die and thus no longer able to produce dopamine. See that the midbrain on the left does not have a visible dark band due to the death of the pigmental neurons.

The organization of the brain

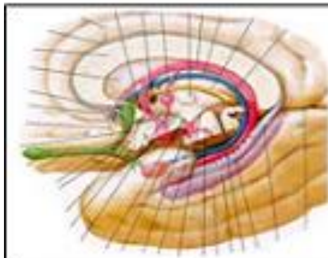
Our brain is ***hierarchically organized.*** *The more sophisticated regions of the brain that are evolutionarily newer regulate the older, more primitive parts of the nervous system. As we moved up along the spinal cord and continue upwards into the brain, the functions controlled by various regions become progressively more advanced.*



"Well, time for our weekly brain-stem storming session."

Evolution of the human Brain — Triune Model

The R-Complex (Reptile): Evolved during the Triassic Period 248-206 million years ago. Regulates: hunger, temperature control, fight-or-flight response. Shared with reptiles such as fish.



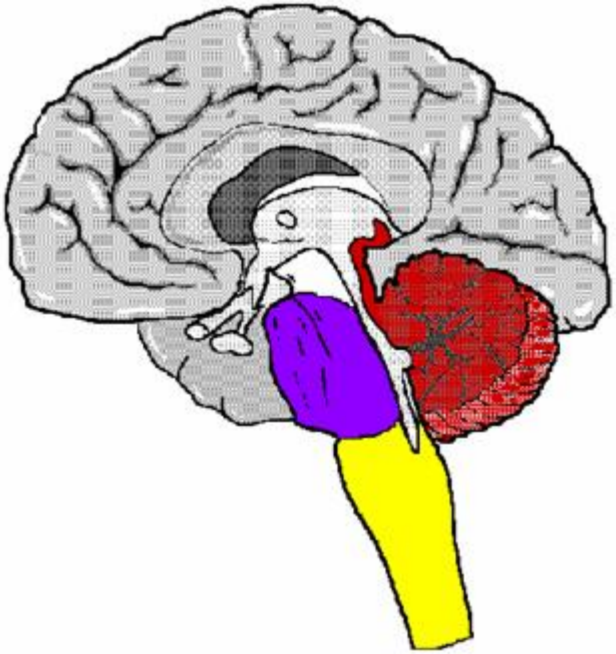
The Limbic System: Evolved during the Jurassic Period 206-144 million years ago. Regulates: mood, memory, and hormone control. Shared with the older mammals such as dogs, cats and mice.

The Neocortex: Evolved during the Eocene & Oligocene Epochs 55-24 million years ago. Regulates: logic and thought required for complex social situations etc. Shared with monkeys and chimpanzees.

The Organization of the brain

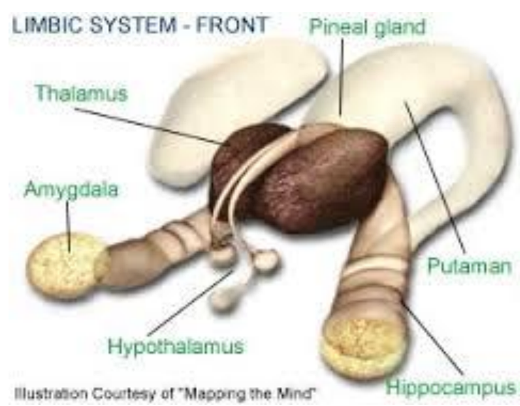
- Brainstem & subcortical structures (hindbrain)
  - Brainstem
    - the “stalk” that connects the spinal cord to the higher regions of the brain and supports basic vital life function.
    - Includes the pons and the medulla
  - Cerebellum concerns primarily with muscular movement coordination,
    - **Medulla**
    - **Pons**
    - **Cerebellum**

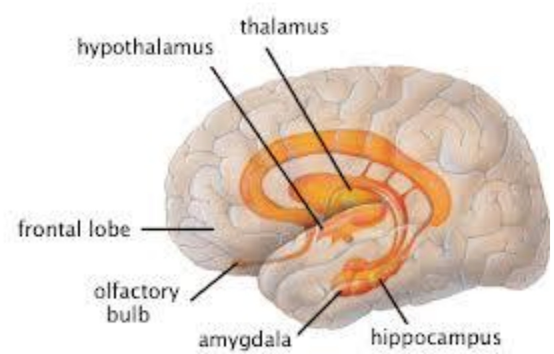
hindbrain



The Organization of the brain (forebrain)

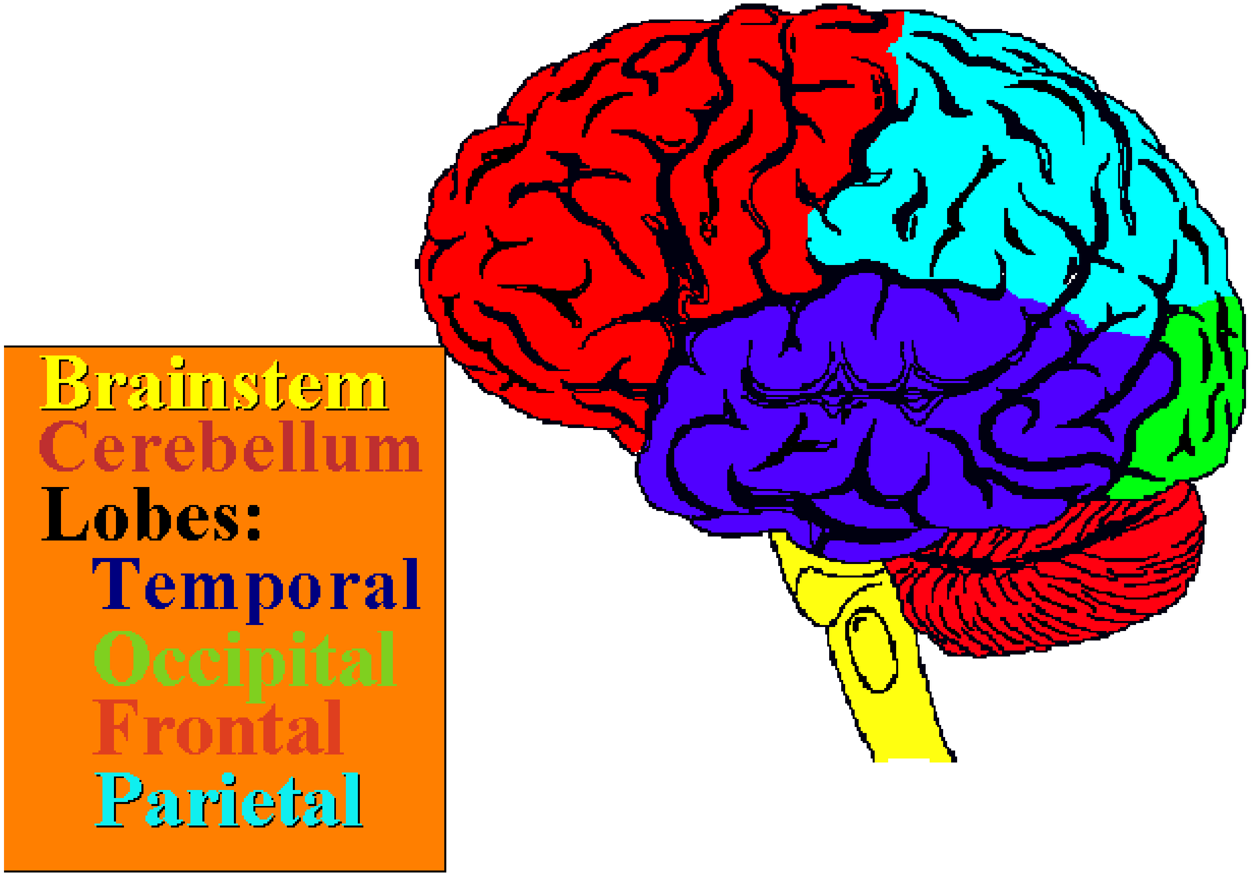
- Limbic System: a core part of the forebrain that regulates <u>motivational</u> behaviors such as eating, drinking and sex; also responsible for <u>emotional</u> behaviors such as fear, anger and aggression.
  - Amygdala: evaluate other's and controls one's own emotional display
  - Hippocampus: memory formation
  - Thalamus: Relay station for sensory info
  - Hypothalamus: maintains homeostasis and regulates autonomic system



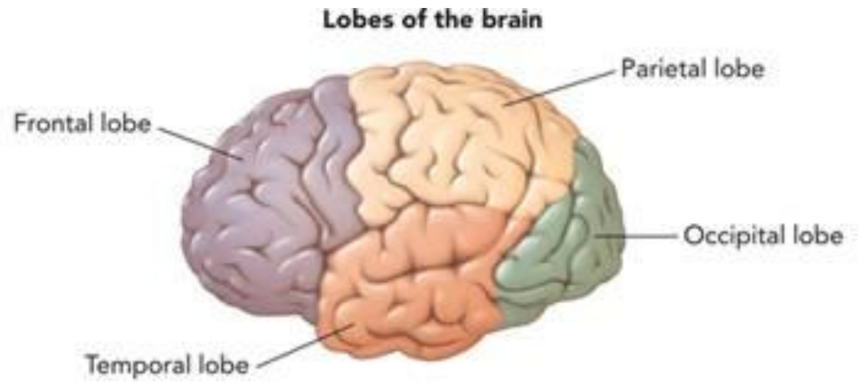


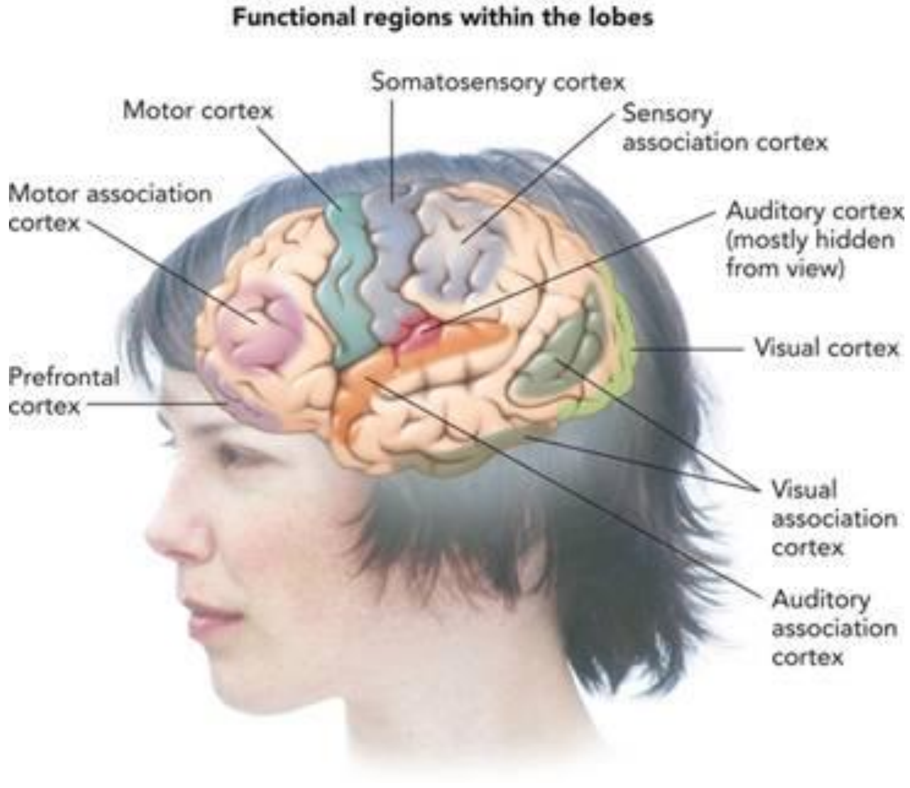
Cerebral cortex: responsible for the most sophisticated information processing in the brain

Lobes: frontal, temporal, parietal and occipital



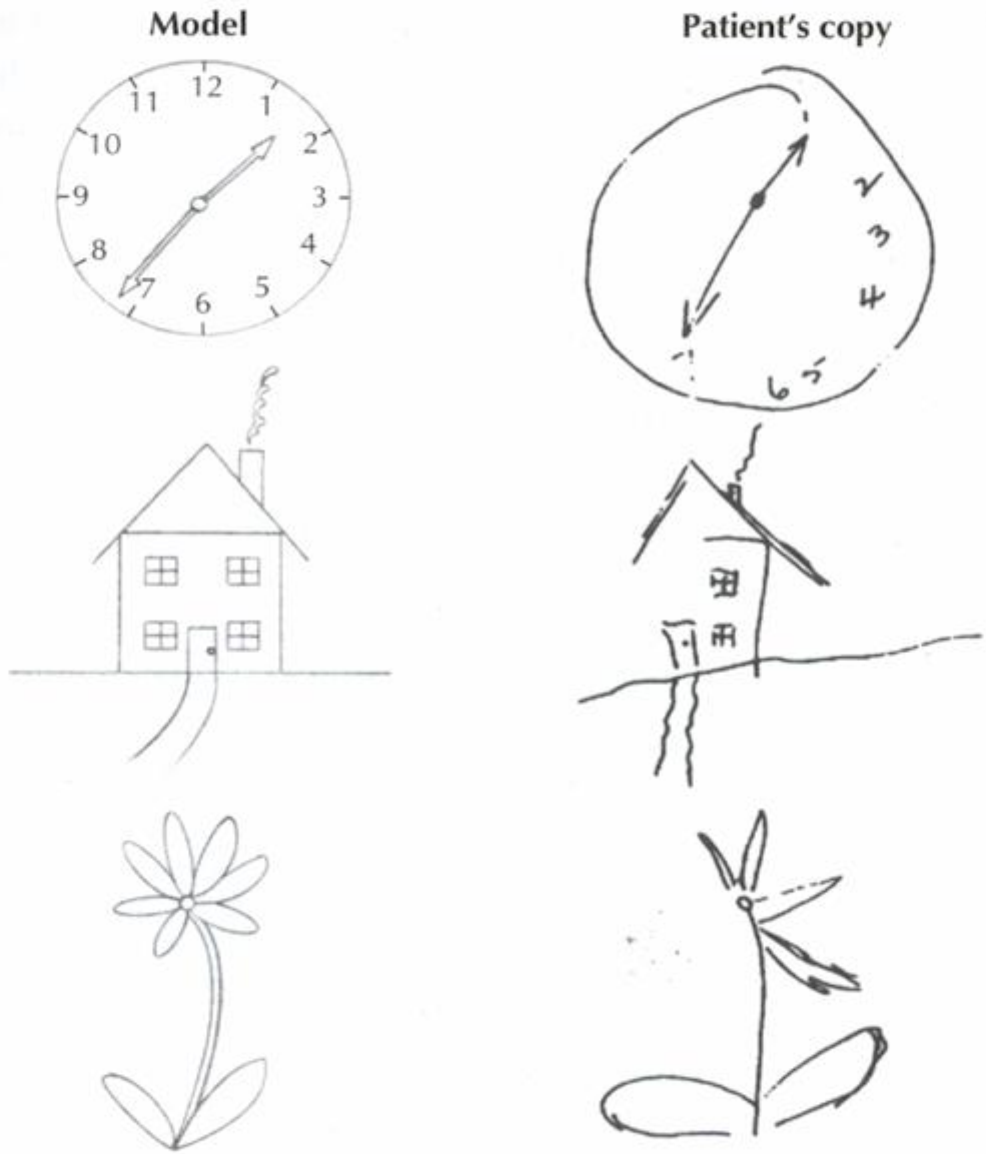
Cerebral Cortex





The Specialization of the Hemispheres

- Hemispheres
  – two symmetrical left and right halves of the brain that control the side of the body opposite to their location (contralateral control).
  – Two halves of the brain connected by corpus callosum.
  – Spatial neglect in patients who suffered damage in right hemisphere.



(From Left Brain, Right Brain by Springer and Deutsch © 1998, 1993, 1989, 1985, 1981 by Sally P. Springer and Georg Deutsch. Used with permission by W.H. Freeman and Company.)

Lateralization of functions

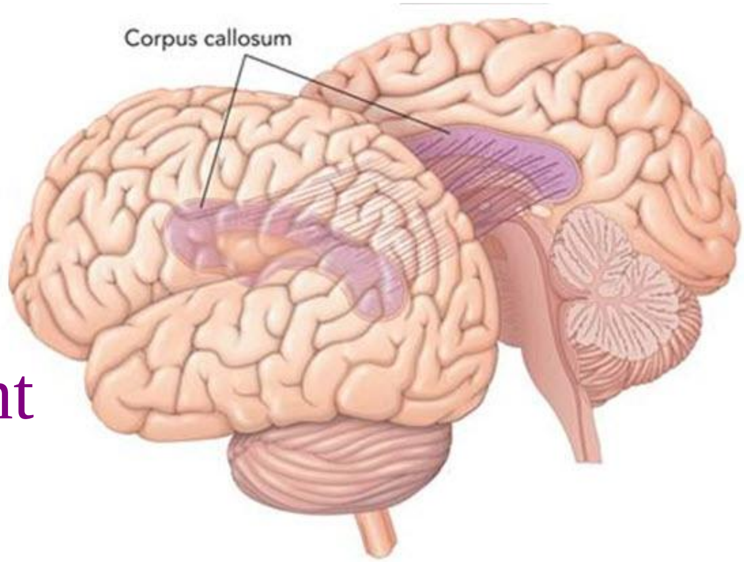
- Lateralized: functions are primarily handled by one hemisphere.
- Functions lateralized to the left hemisphere:
  – Speaking, reading, thinking, reasoning.
  – More analytical and process information sequentially
- Functions lateralized to the right hemisphere:
  – Spatial skills, pattern recognition, music, emotional expression (mainly non-verbal)
  – Process info simultaneously and holistically

Language lateralization in left hemisphere:

- LeBon and Broca's area
- Behavior when left and then right brain is anesthetized.

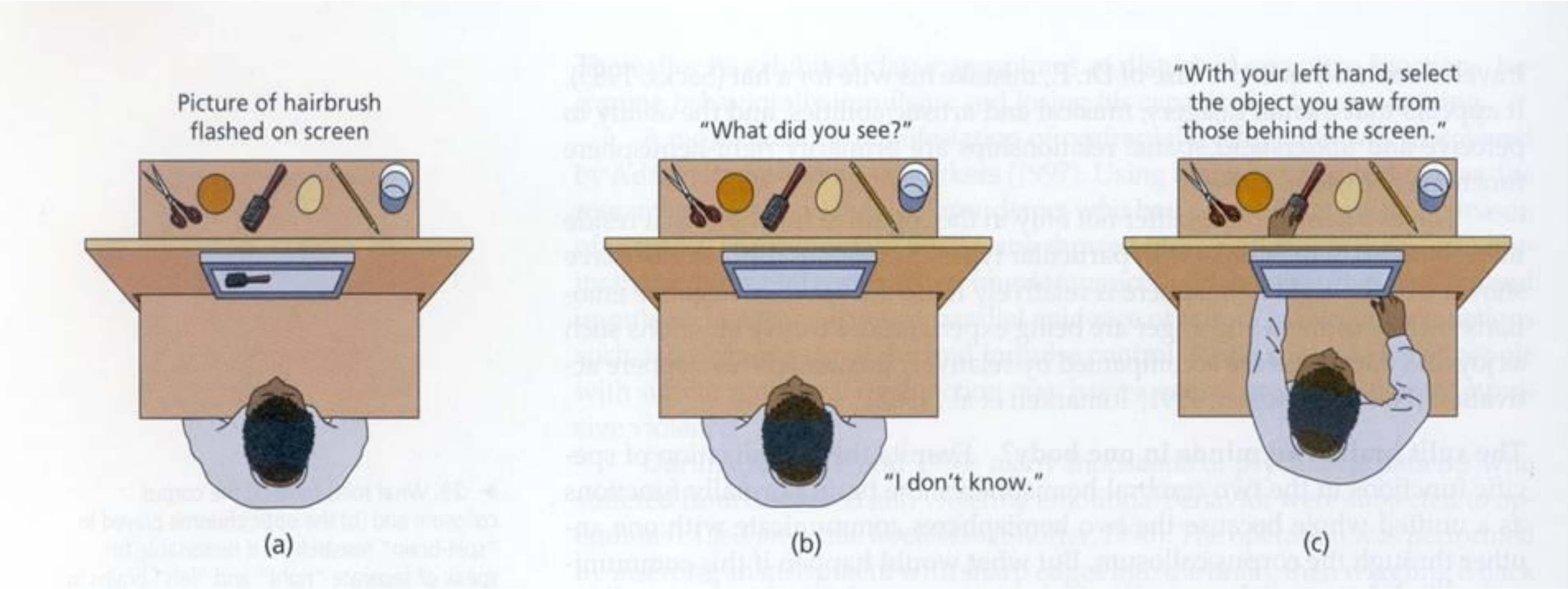
Split Brain Study (Roger Sperry)

- Split-brain patients
  - surgically cutting the corpus callosum
  - suffers from independent functioning of the two halves of the brain



- Functional specialization of the brain becomes apparent.

An experiment of Split-brain research



Neuroplasticity

- Refers to the brain's ability to adopt new functions, reorganizes itself, or make new neural connections throughout life, in response to experience or even trauma.
- Neuroplasticity occurs in several main ways:
  - Formation of new neurons (neurogenesis)
  - Growth of dendrites in existing neurons
  - Formation of new synapses.

Principles of brain plasticity

1. Almost every major structure of the neuron is capable of experience-based change.
2. Not all regions of the brain are equally plastic.
   – The hippocampus is more plastic than any other part of the brain.
3. Brain plasticity varies with age.
   – Brain plasticity at its strongest during infancy and childhood, and gradually decrease with age.

Neuroplasticity – what have we learned

- Researchers at Salk Institute found that simply giving animals an opportunity to exercise increases the number of newly born hippocampal neurons.
  - Implications...
- With determination and perseverance, it is possible to recover from stroke…
- Explains why blind people seem to have better hearing…
  - It is only their peripheral hearing that is better than that of the sighted people…
  - Because these peripheral sounds are processed by the visual cortex that is not used.