
Topic 2

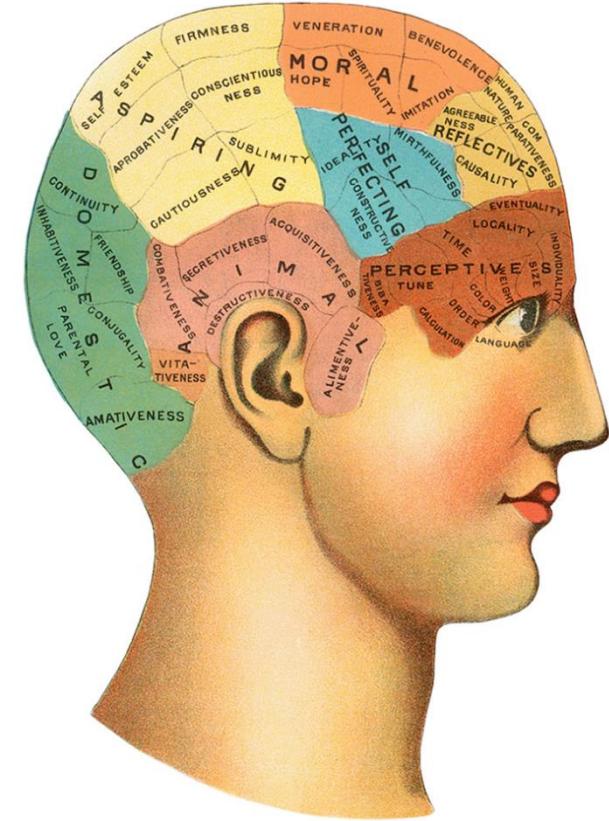
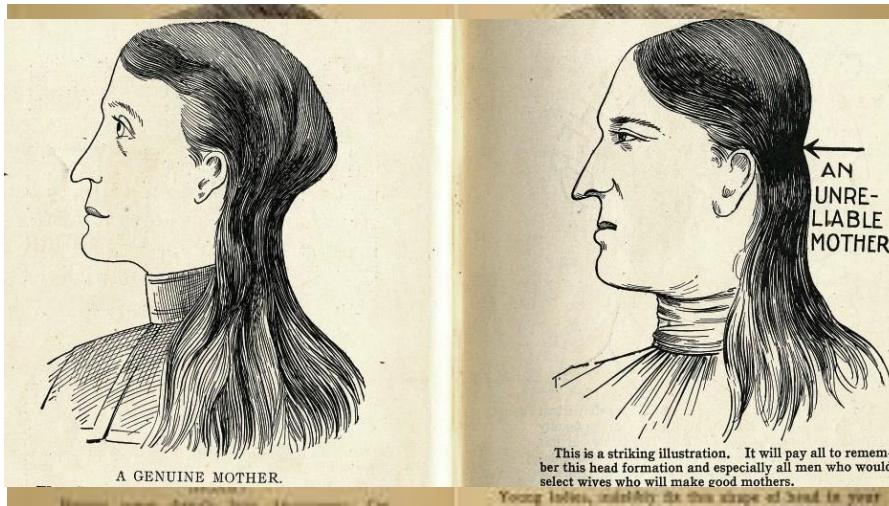
The Brain and the Nervous System

Overview

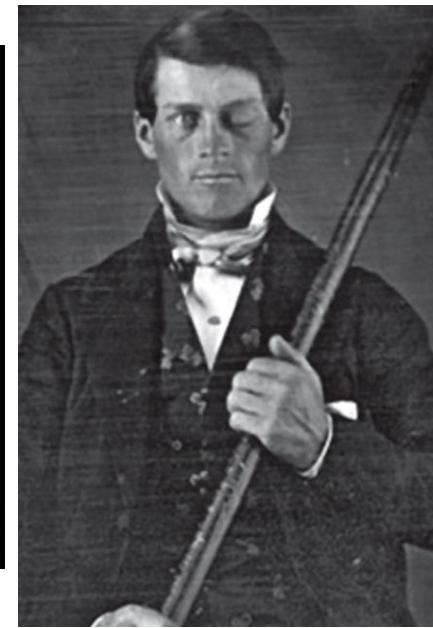
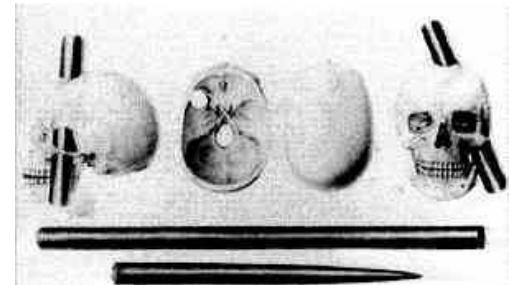
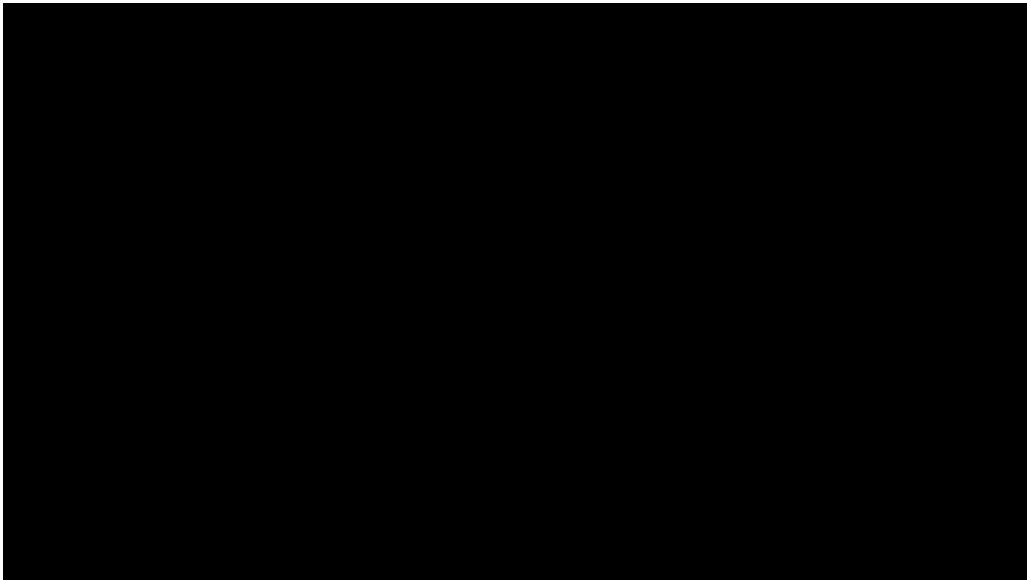
- Studying the brain
- Building blocks of the nervous system
- Communication among neurons
- Communication of the brain with the body
- The brain

Studying the brain

- 19th century -> Phrenology
 - Bumps on the skull were interpreted in terms of personality traits.



The Case of Phineas Gage



https://www.youtube.com/watch?v=yXbAMHzYGJ0&t=2s&ab_channel=HarvardUniversity



Studying the brain

- Methods for studying the brain
 - Clinical observation of patients with brain damage
 - Experimental techniques
 - Invasive: animal studies (e.g., lesions, single-cell recordings)

Studying the brain

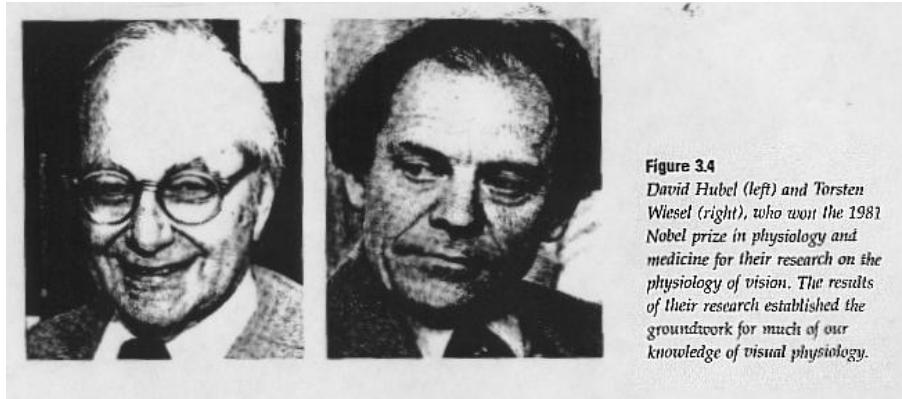


Figure 3.4
David Hubel (left) and Torsten Wiesel (right), who won the 1981 Nobel prize in physiology and medicine for their research on the physiology of vision. The results of their research established the groundwork for much of our knowledge of visual physiology.

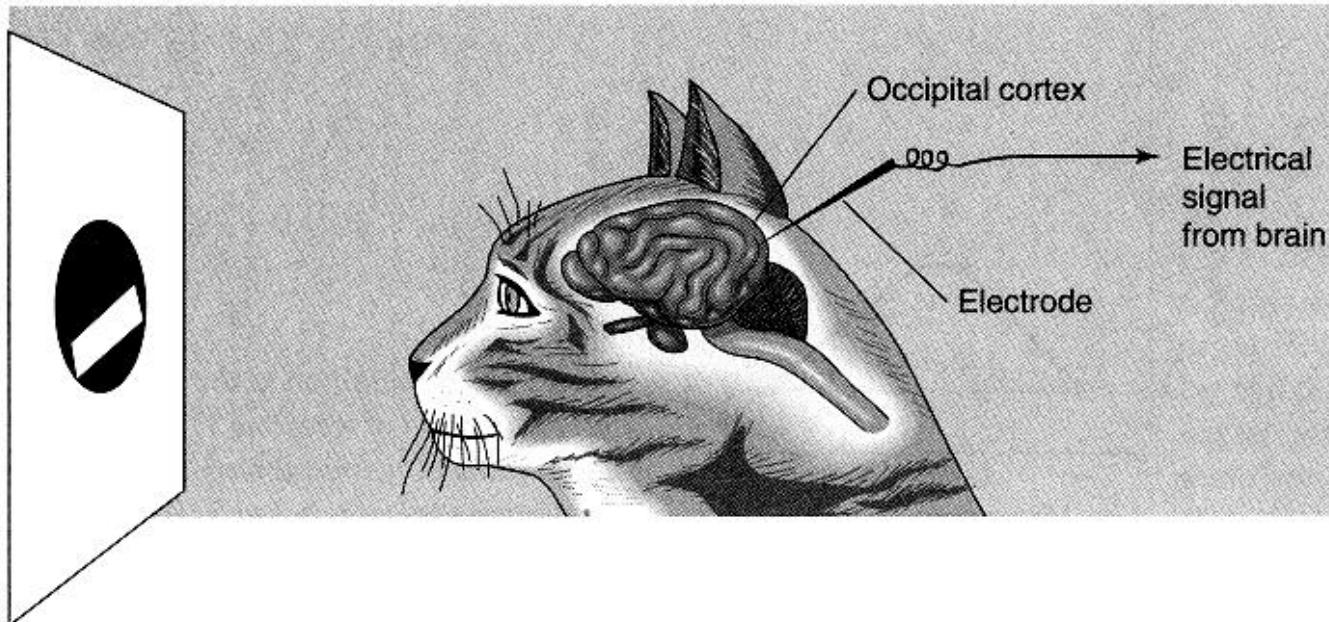


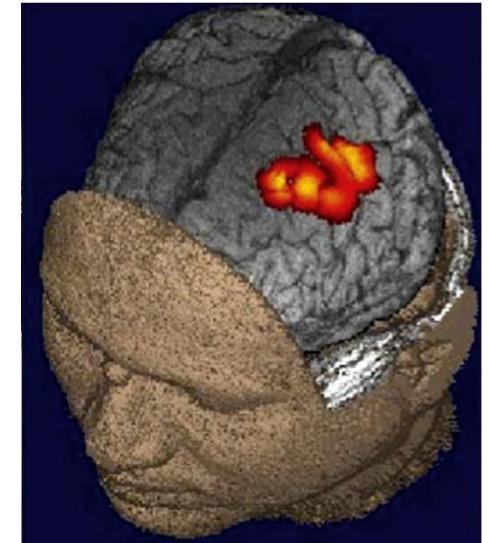
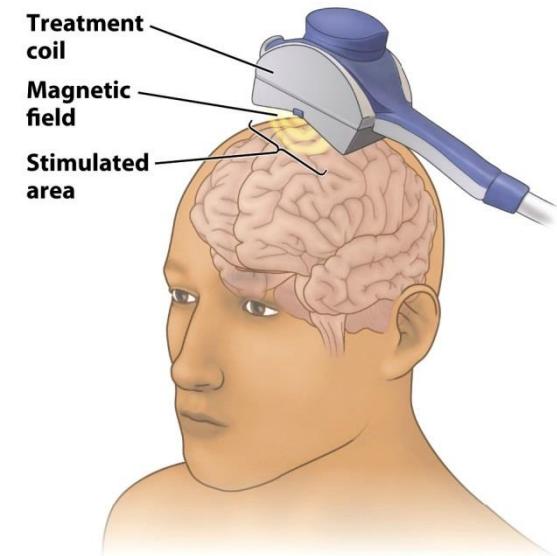
Figure 2.33
Recording electrical signals from a neuron in the visual cortex of an anaesthetized cat. The bar-shaped stimulus on the screen causes a nerve cell in the cortex to fire, and a recording electrode picks up the signals generated by this nerve cell. In an actual experiment, the cat is anesthetized and its head is held in place for accurate positioning.

Studying the brain

- Methods for studying the brain
 - Clinical observation of patients with brain damage
 - Experimental techniques
 - Invasive: animal studies (e.g., lesions, single-cell recordings)
 - TMS (Transcranial Magnetic Stimulation)

Studying the brain

TMS



Studying the brain

- Methods for studying the brain
 - Clinical observation of patients with brain damage
 - Experimental techniques
 - Invasive: animal studies (e.g., lesions, single-cell recordings)
 - TMS (Transcranial Magnetic Stimulation)
 - Other techniques
 - Electrophysiology
 - EEG (ERP)

Studying the brain

EEG

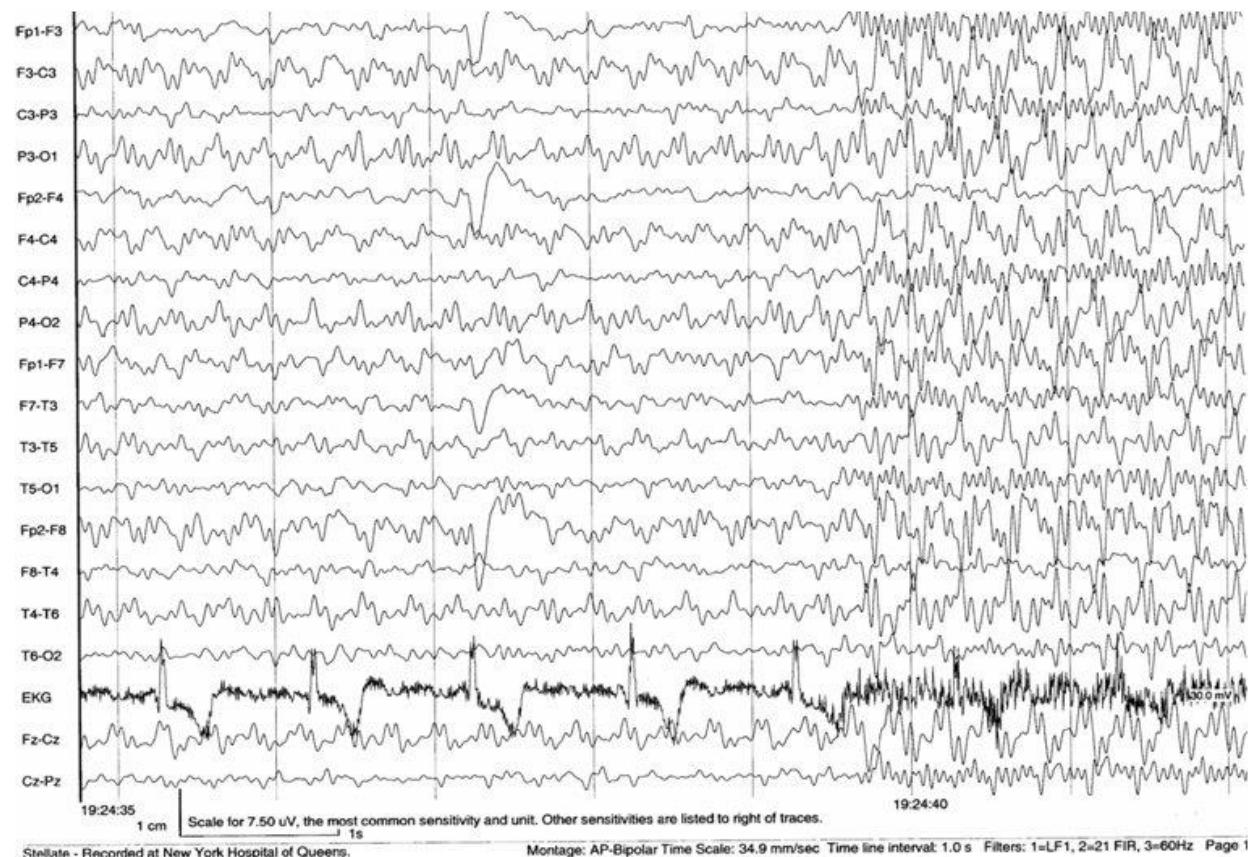
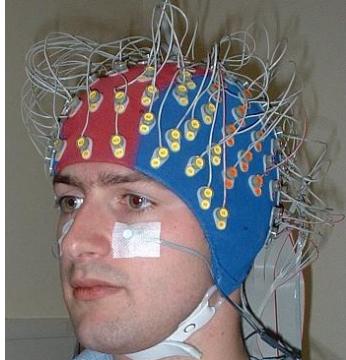


1 – 256 channels
common is 32, 64, 128



Studying the brain

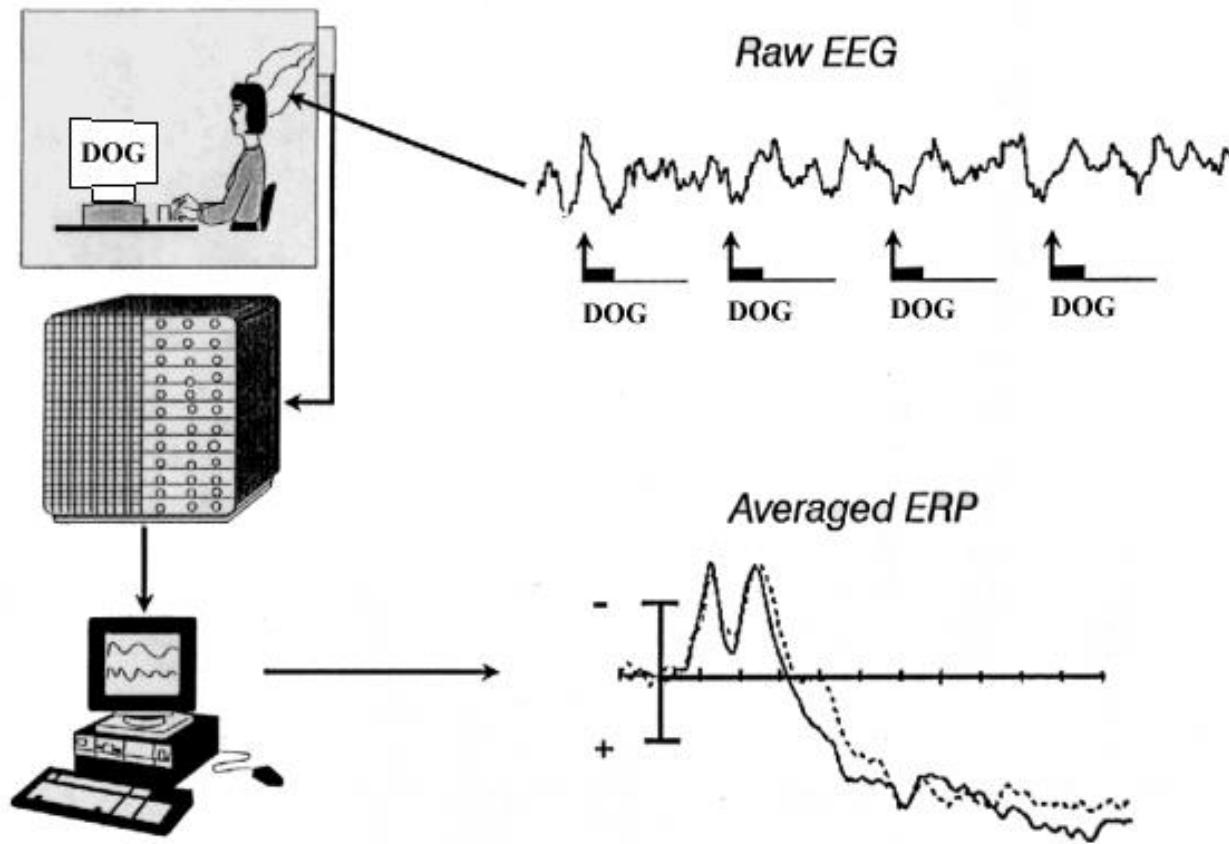
EEG



Studying the brain

ERP

Event-Related Potential Technique

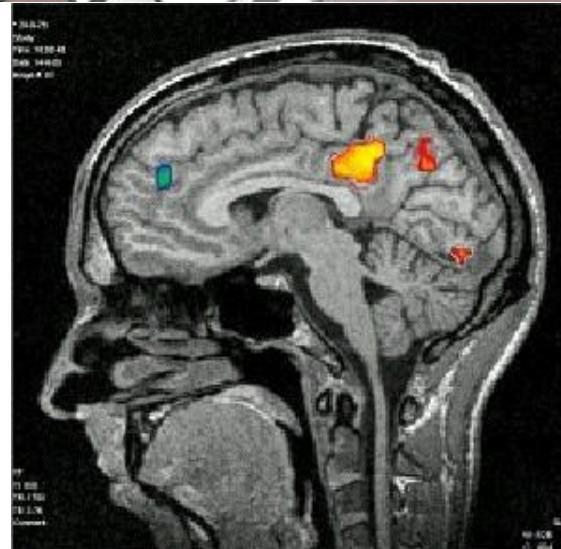
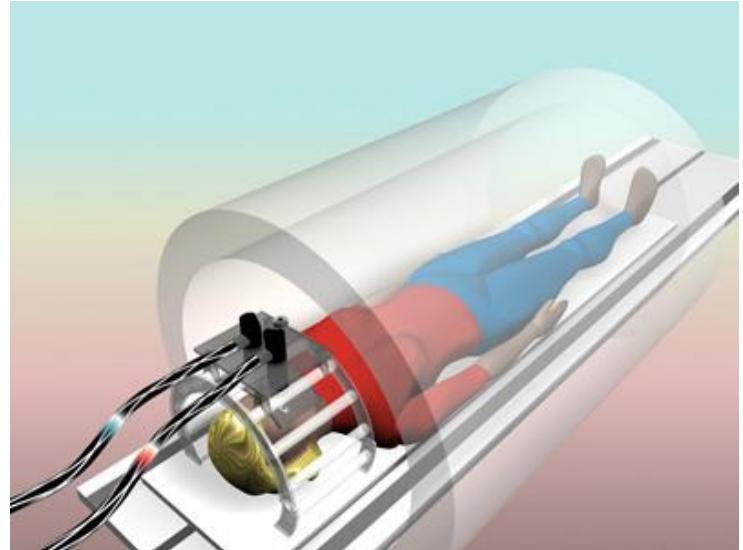


Studying the brain

- Methods for studying the brain
 - Clinical observation of patients with brain damage
 - Experimental techniques
 - Invasive: animal studies (e.g., lesions, single-cell recordings)
 - TMS (Transcranial Magnetic Stimulation)
 - Other techniques
 - Electrophysiology
 - EEG (ERP)
 - Brain imaging
 - (f)MRI scan
 - PET scan

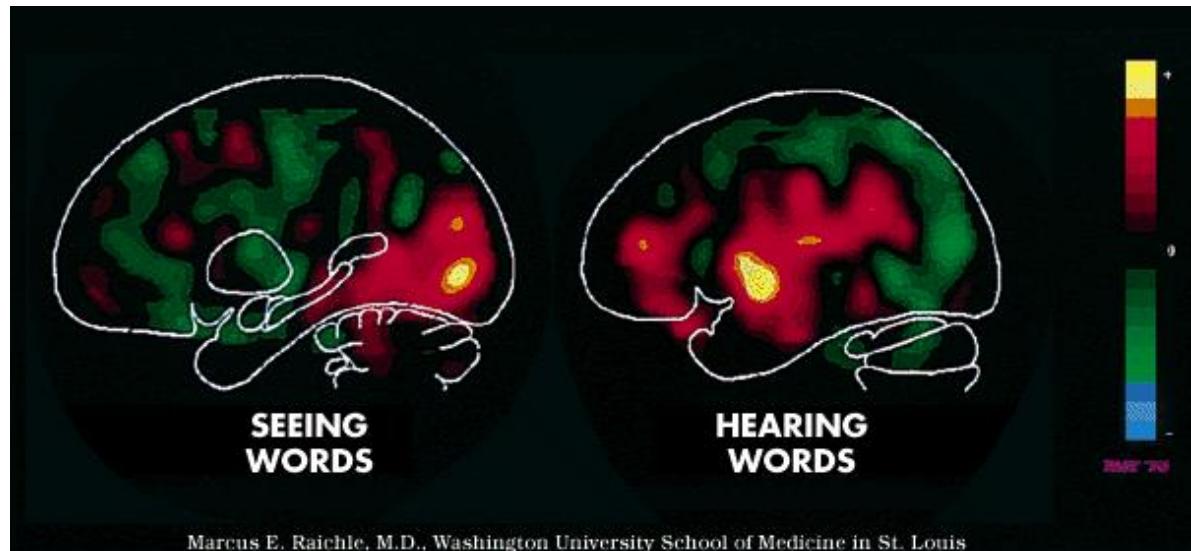
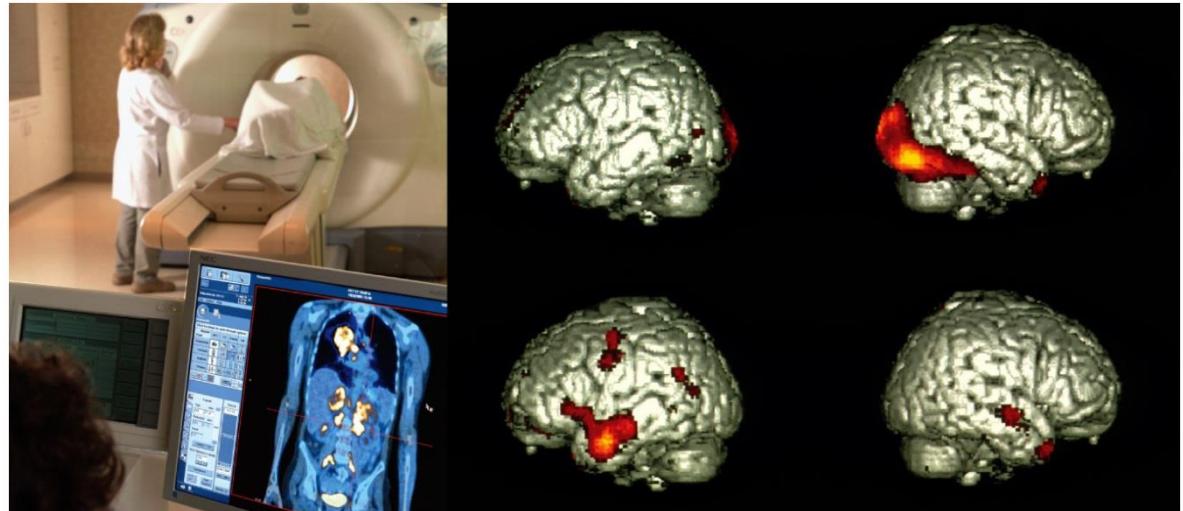
Studying the brain

fMRI



Studying the brain

PET



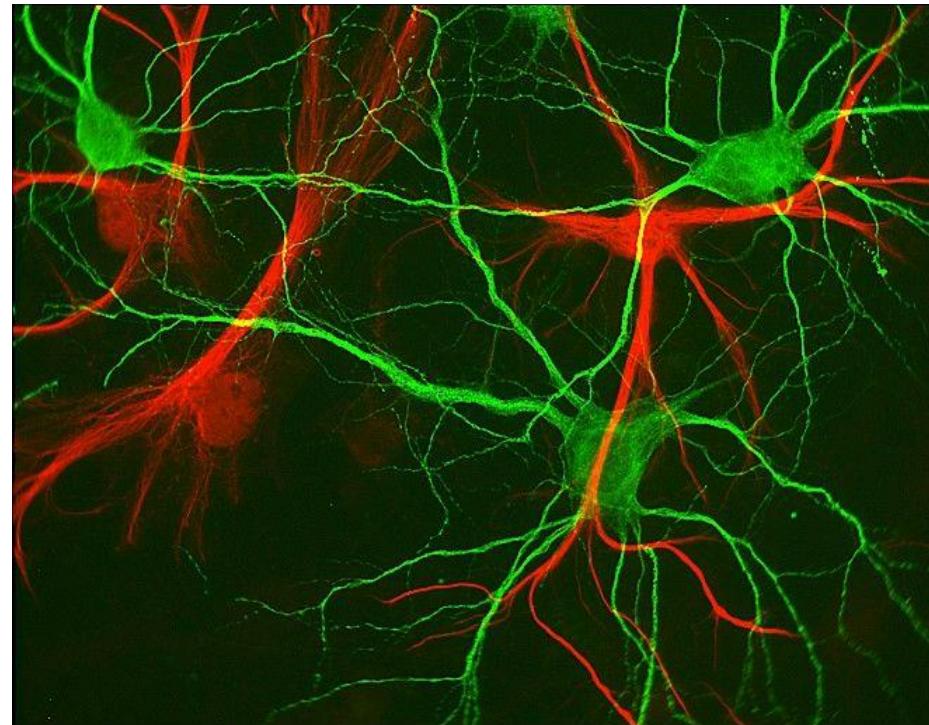
Think back to last lecture:

- Genes x environment → phenotype

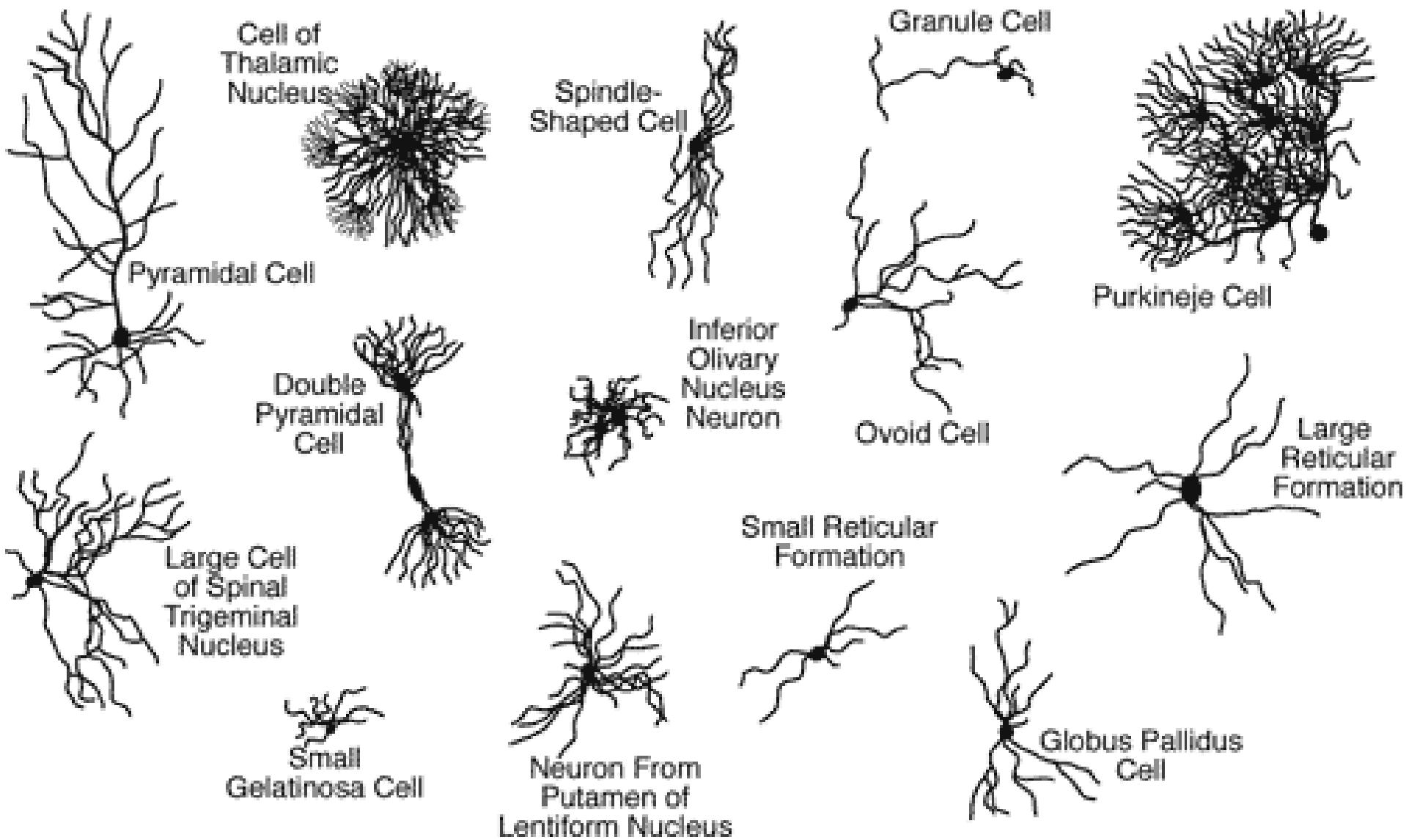


Building blocks of the nervous system

- The nervous system is made up of two basic kinds of cells
 - Glia
 - Neurons



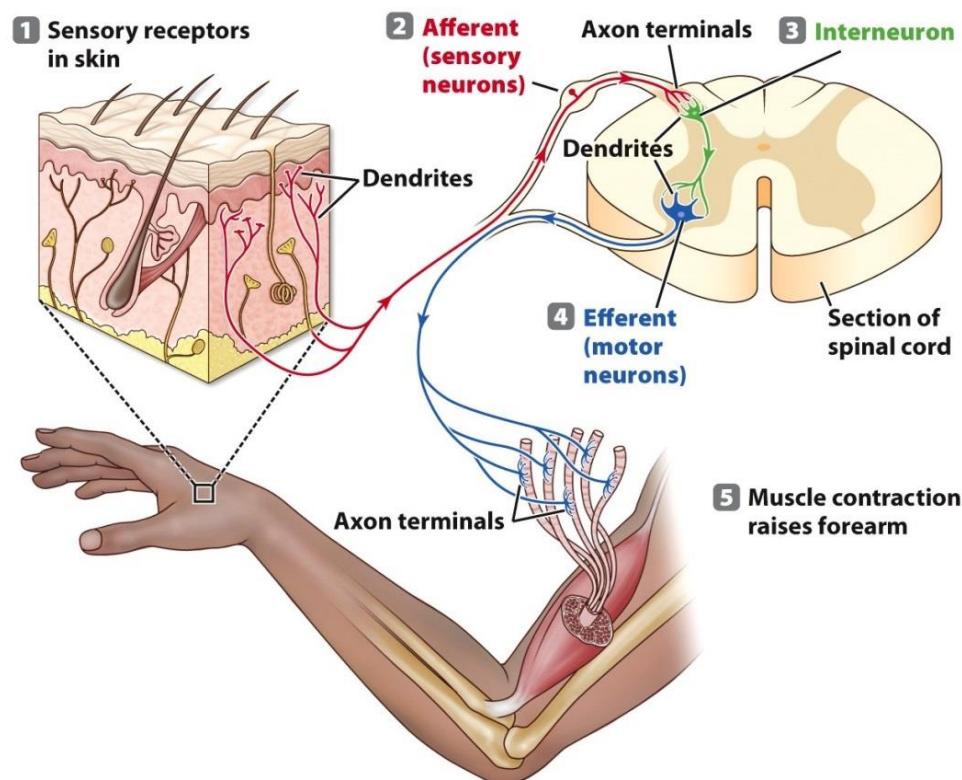
Building blocks of the nervous system



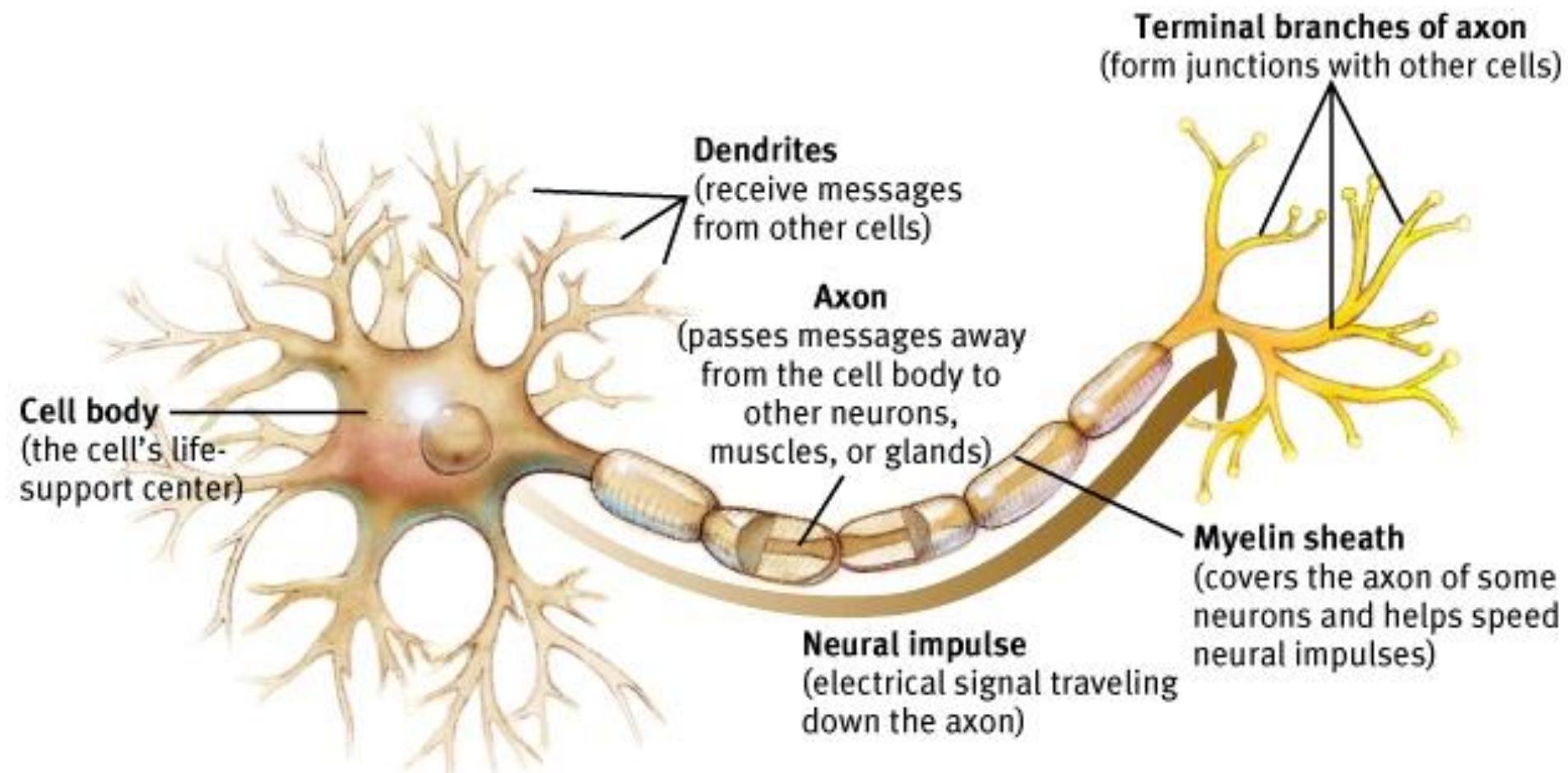
Building blocks of the nervous system

- Different types of neurons

- Sensory receptors
- Sensory (afferent) neurons
- Motor (efferent) neurons
- Interneurons

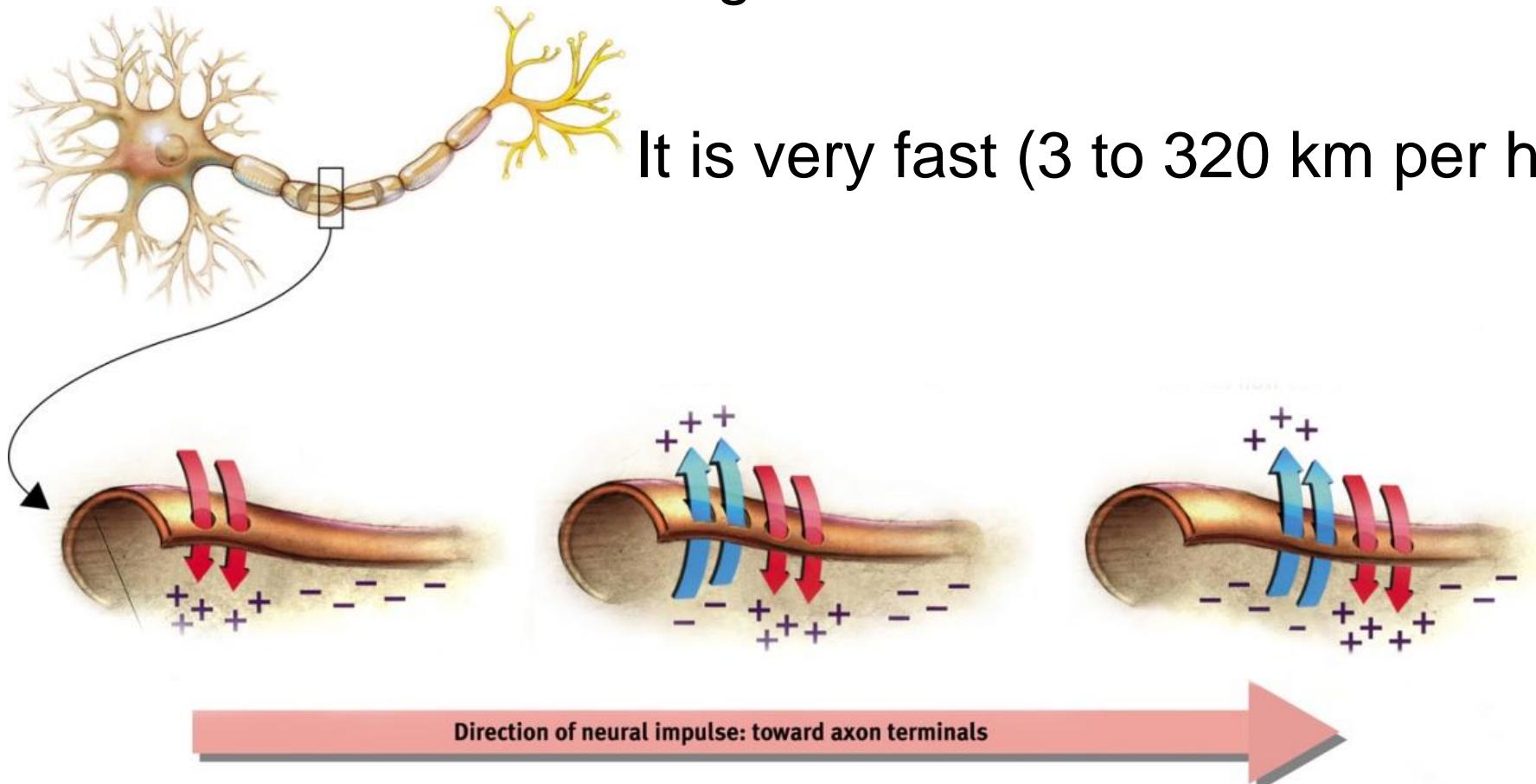


Building blocks of the nervous system: The neuron

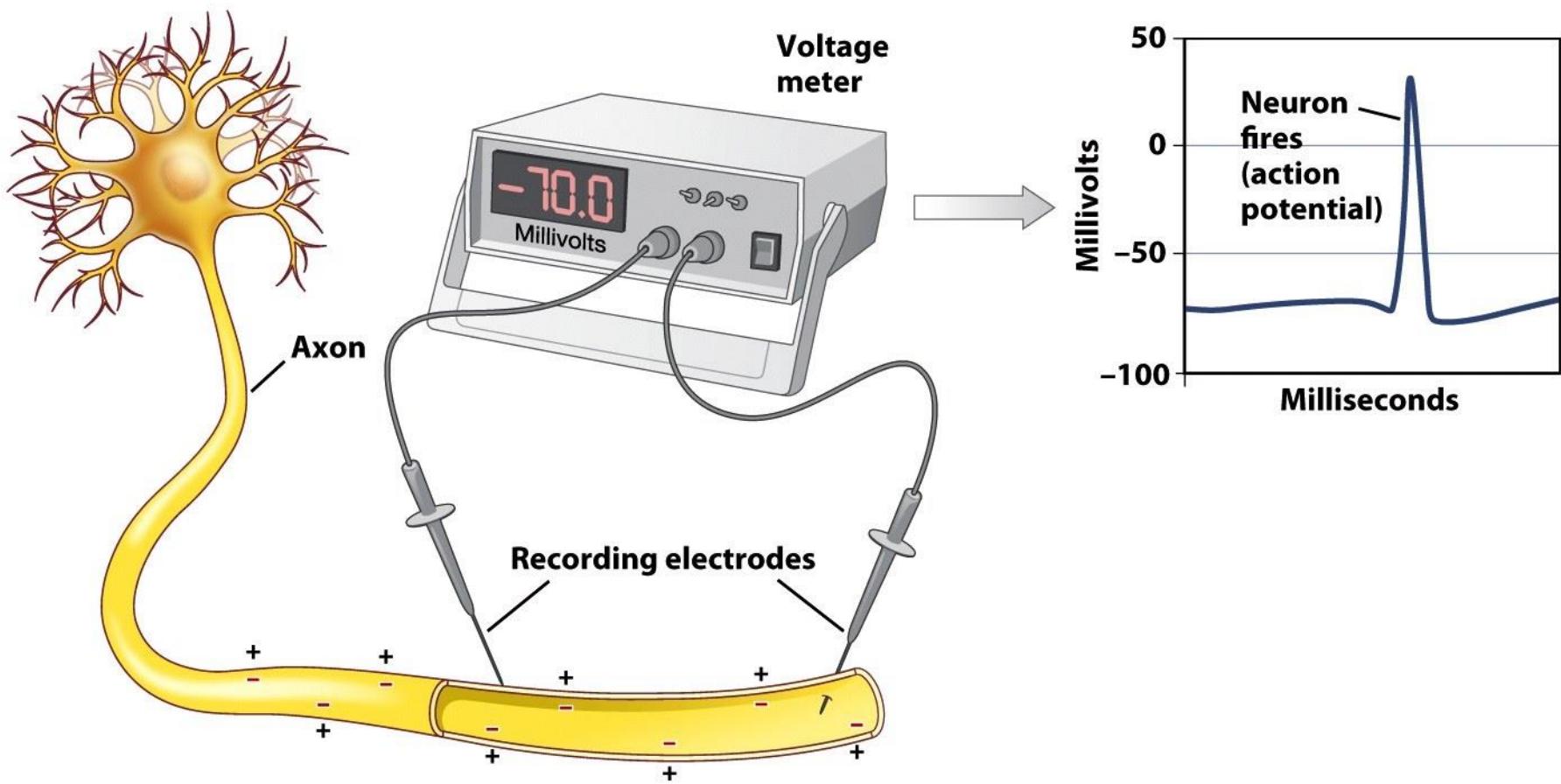


Communication among neurons

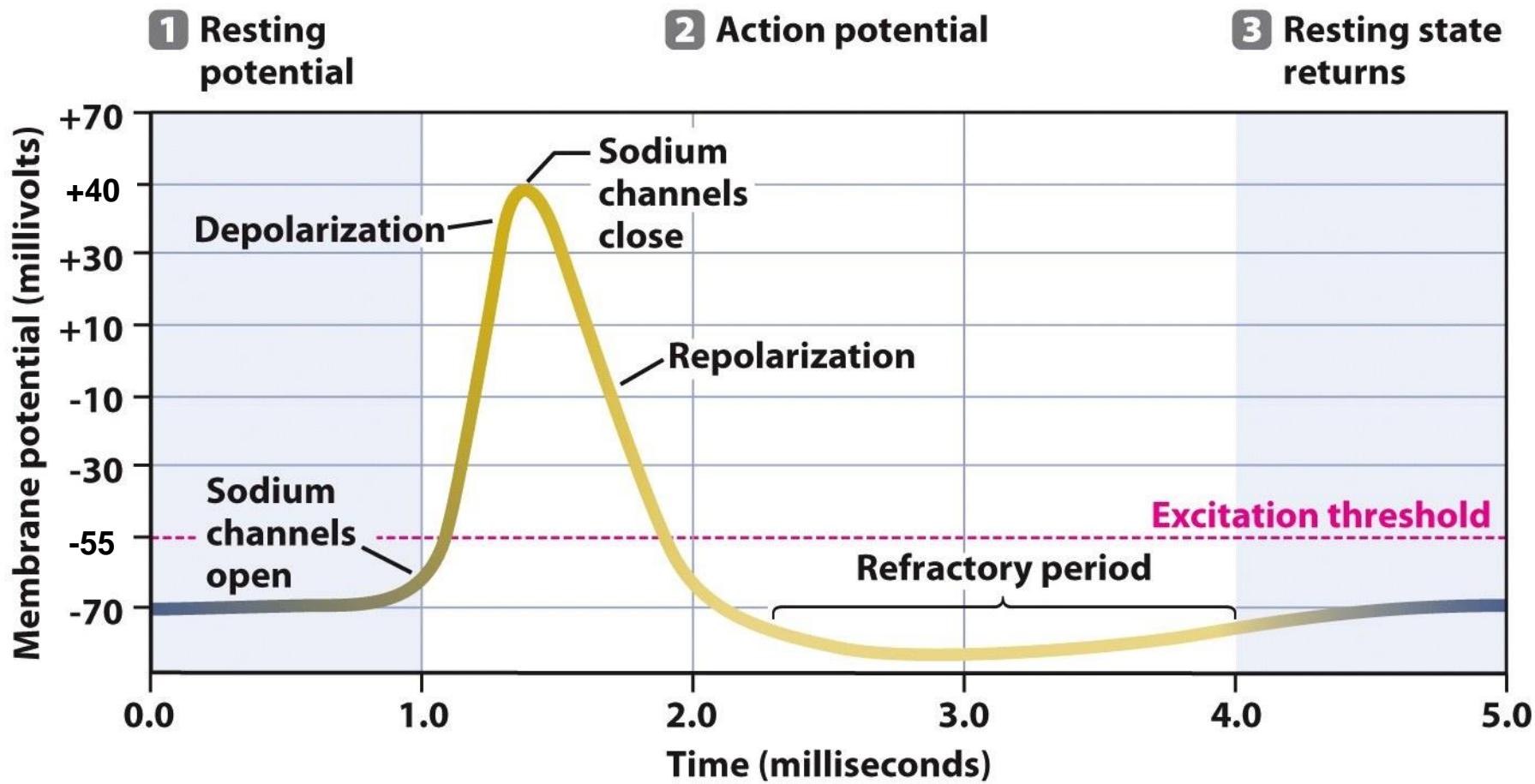
Action Potential: is a **neural impulse**, a brief electrical charge that travels down an axon.



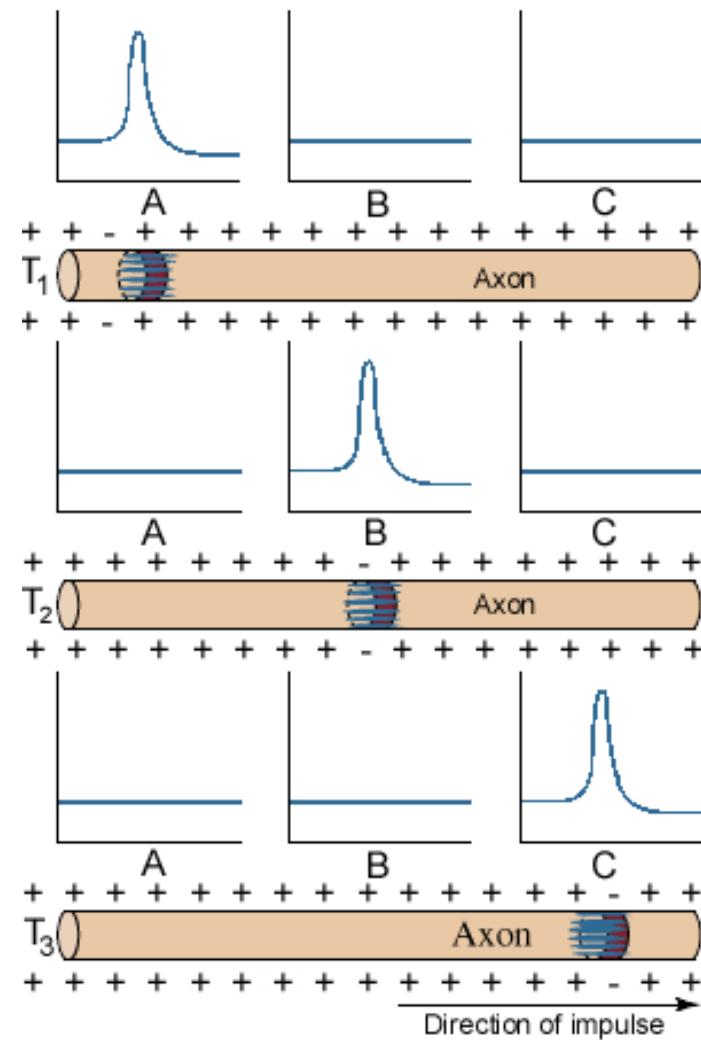
Communication among neurons



Communication among neurons

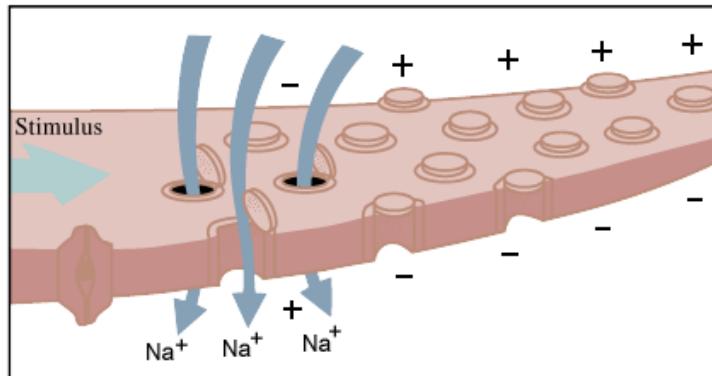


Communication among neurons

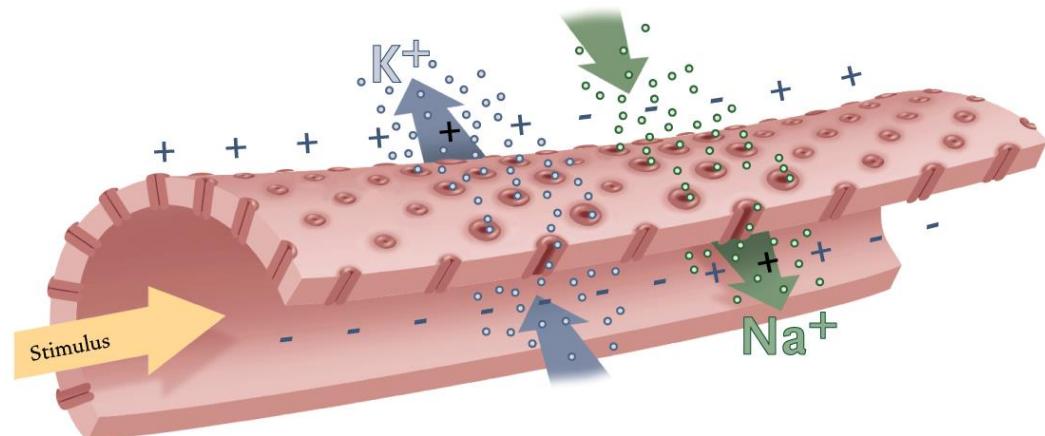
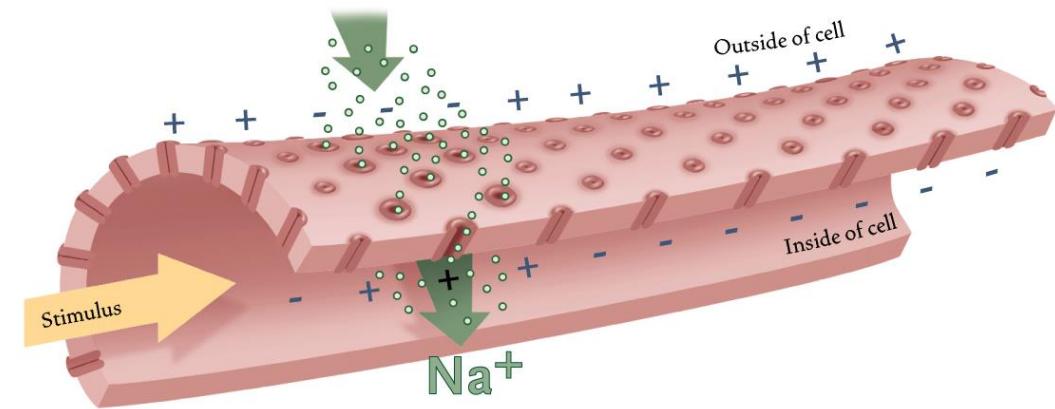
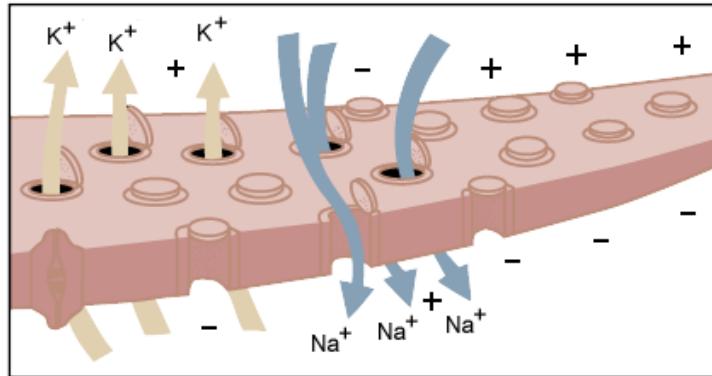


Communication among neurons

A

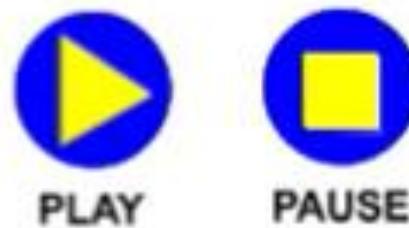


B

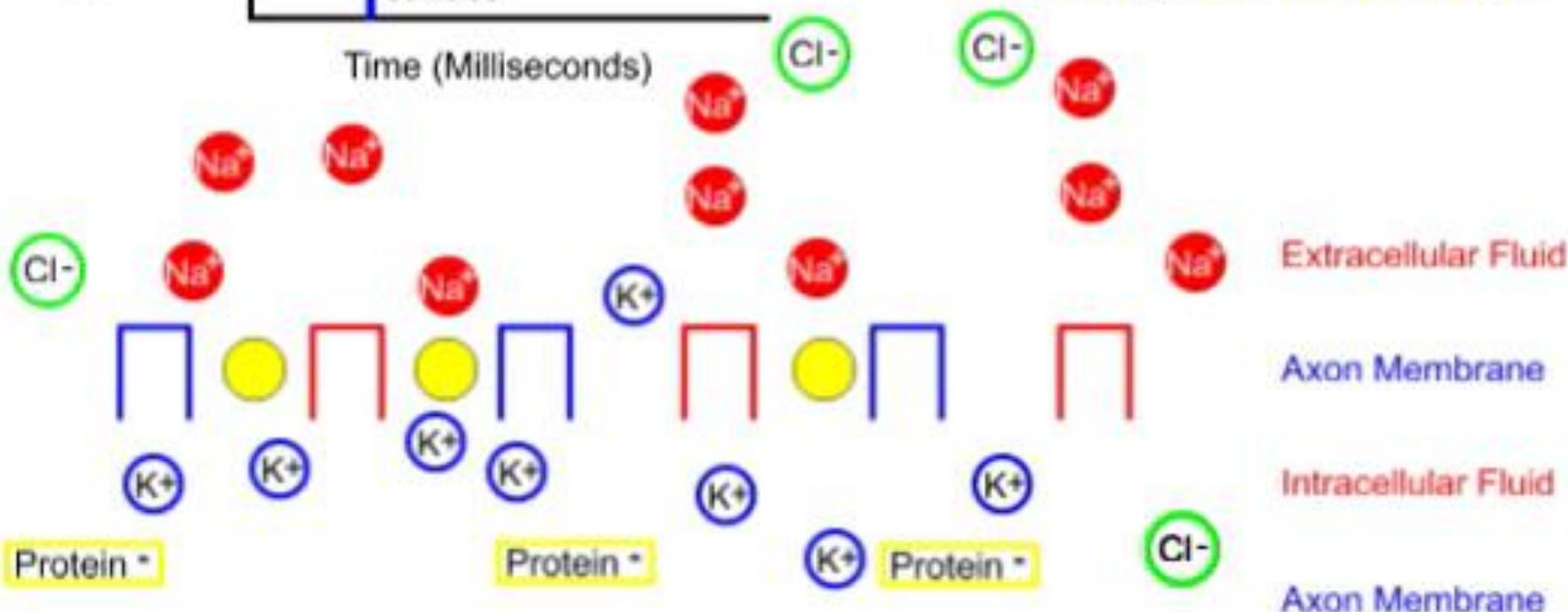
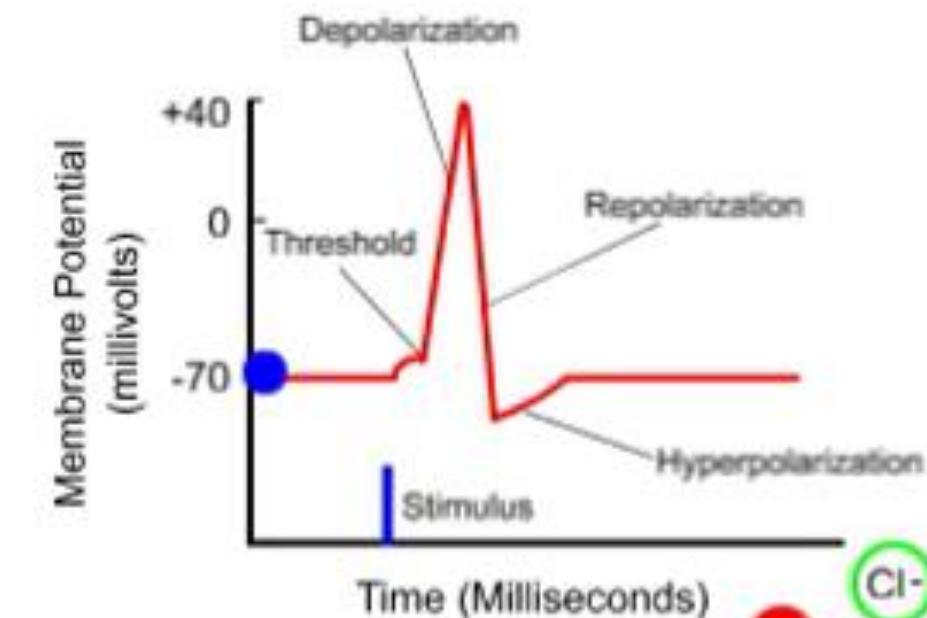


INSTRUCTIONS

Action Potential Animation



Press Play to Start Animation

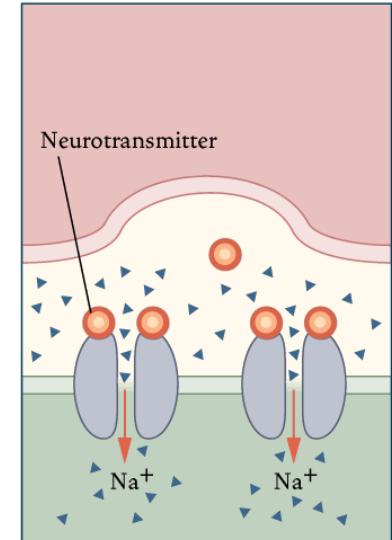
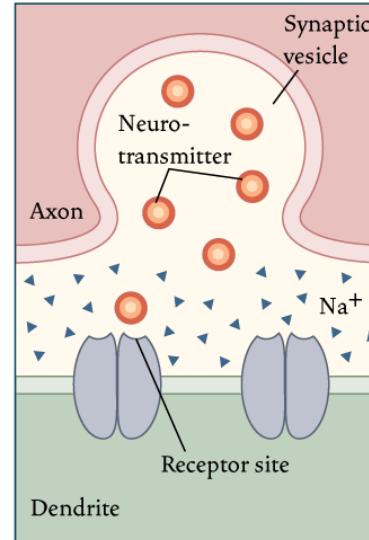
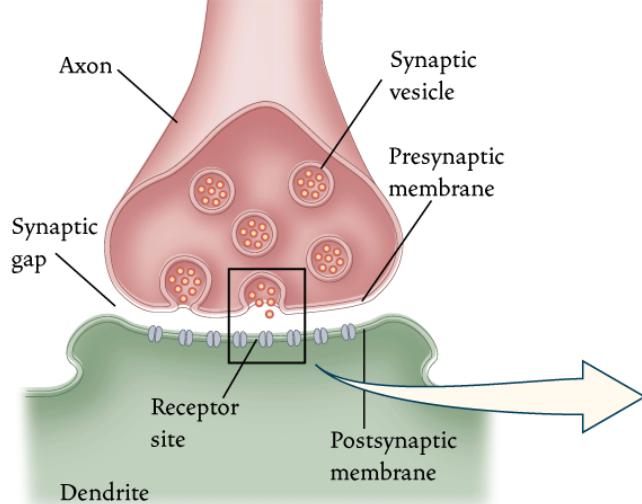
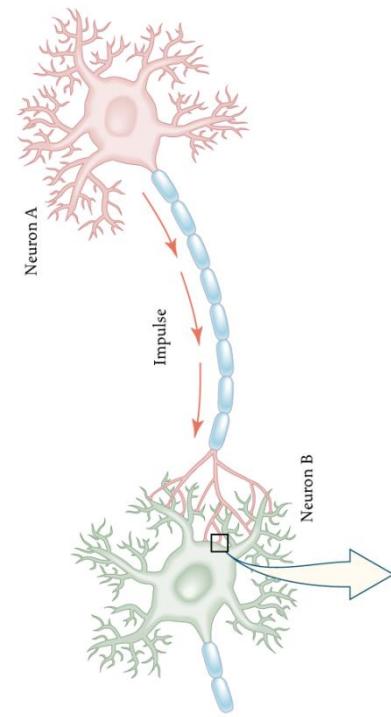


Communication among neurons

- Neurons either fire or do not fire
 - All-or-none law
 - Intensity variations by
 - variations in the number of neurons firing (number).
 - variations in firing rate (frequency).
- Neurons interact
 - via synapses.
 - through chemical substances.

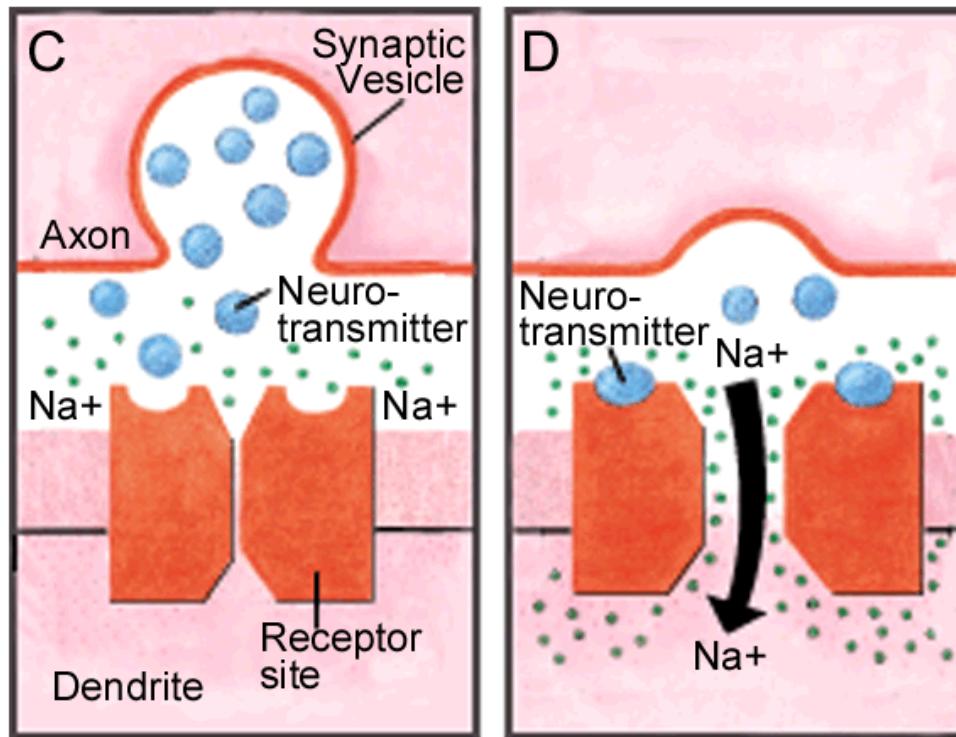
Communication among neurons

- Synapse
 - the place where a signal passes from one nerve cell to another



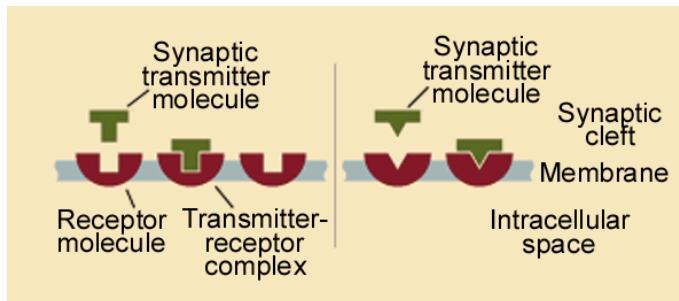
Communication among neurons

- Synapse
 - the place where a signal passes from one nerve cell to another

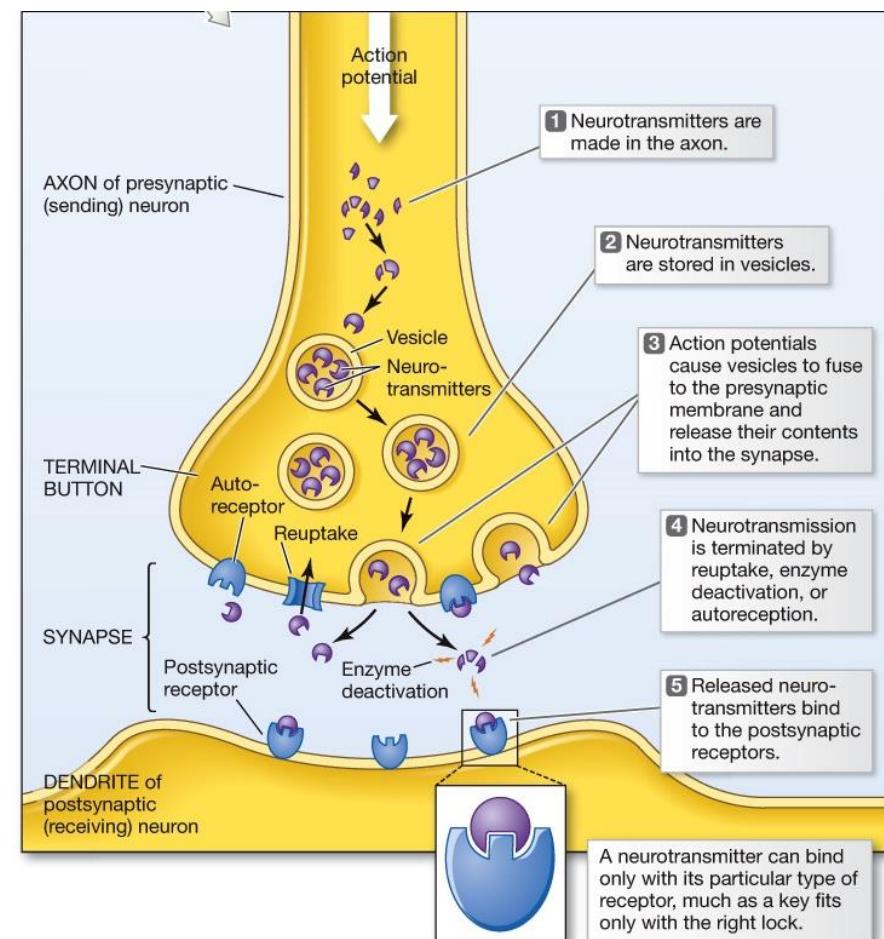


Communication among neurons

- Neurotransmitters
 - Chemical substances that transmit signals from one neuron to another
 - Lock-and-key Model

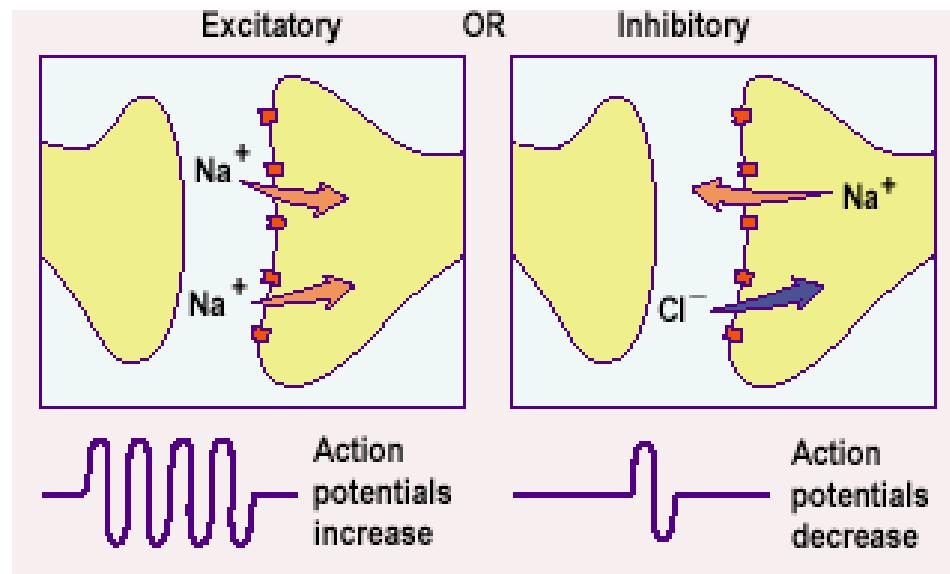


- Effect is terminated by
 - autoreceptors
 - synaptic reuptake
 - enzymes



Communication among neurons

- Neurotransmitters
 - Chemical substances that transmit signals from one neuron to another
 - The binding of a neurotransmitter with a receptor produces an excitatory or inhibitory signal.



Communication among neurons

- Neurotransmitters

NEUROTRANSMITTER	PSYCHOLOGICAL FUNCTIONS
Acetylcholine	Motor control over muscles Learning, memory, sleeping, and dreaming
Epinephrine	Energy
Norepinephrine	Arousal, vigilance, and attention
Serotonin	Emotional states and impulsiveness Dreaming
Dopamine	Reward and motivation Motor control over voluntary movement
GABA (gamma-aminobutyric acid)	Inhibition of action potentials Anxiety reduction
Glutamate	Enhancement of action potentials Learning and memory
Endorphins	Pain reduction Reward

Communication among neurons

- Drugs

- Agonists

- Increase of precursor
- counteracting the cleanup enzymes
- blocking the re-uptake
- mimicking the transmitter's action

- Antagonists

- decrease precursor (or neurotransmitter)
- increase effectiveness cleanup enzymes
- enhance the re-uptake
- blocking of receptors

Agonists

Agonist drugs can increase the release of neurotransmitters... the main effect of amphetamine.

They can counteract the cleanup enzymes that break down the transmitter.

They can block the reuptake of neurotransmitters ... the main effect of Prozac (SSRI) and cocaine.

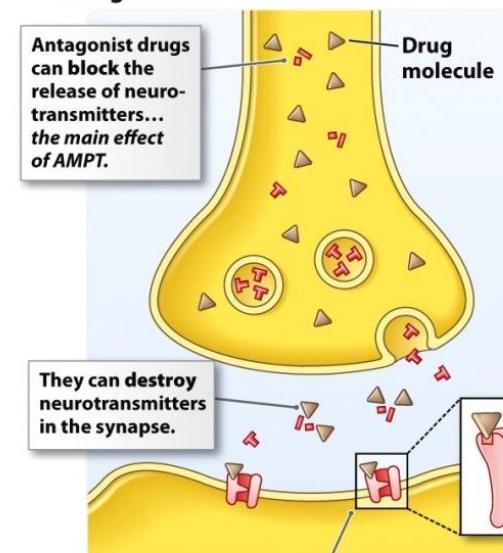
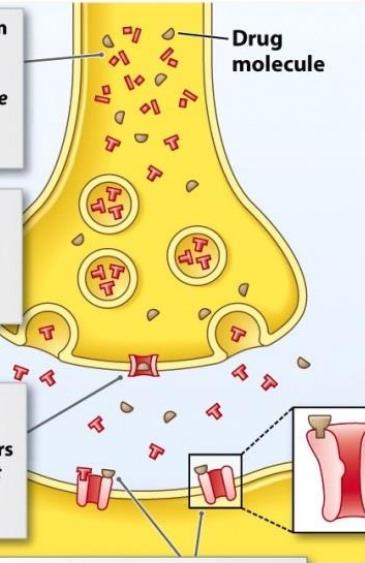
They can mimic a particular neurotransmitter, binding to postsynaptic receptors and either activating them or increasing the neurotransmitter's effects...the main effect of nicotine.

Antagonists

Antagonist drugs can block the release of neurotransmitters... the main effect of AMPT.

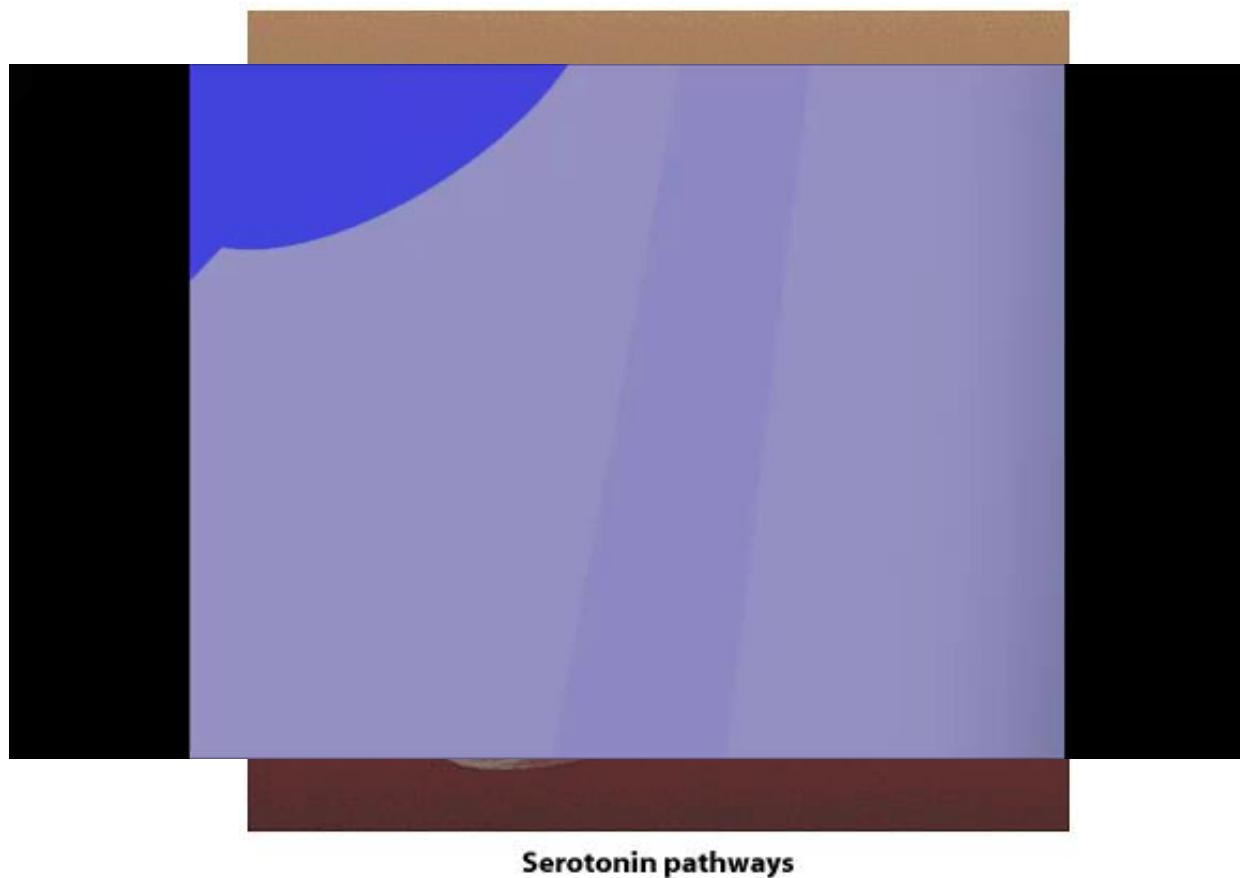
They can destroy neurotransmitters in the synapse.

They can mimic a particular neurotransmitter, binding to postsynaptic receptors enough to block neurotransmitter binding... the main effect of propranolol (beta-blocker) and Haldol (antipsychotic drug).



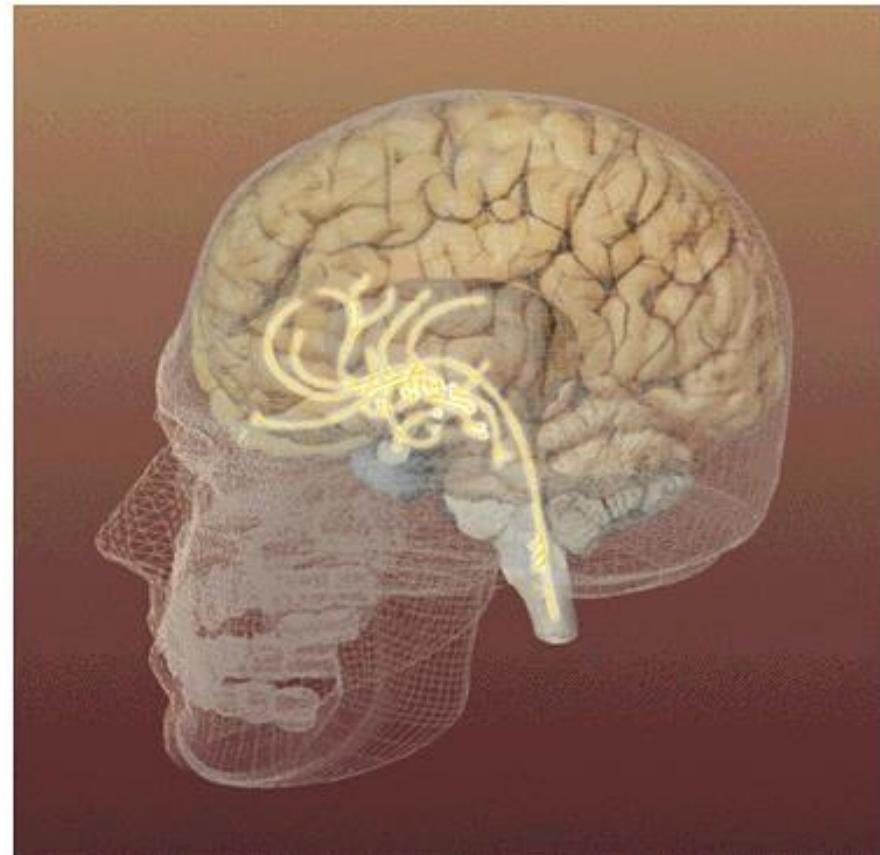
How Neurotransmitters Influence Us

Serotonin pathways are involved with mood regulation.

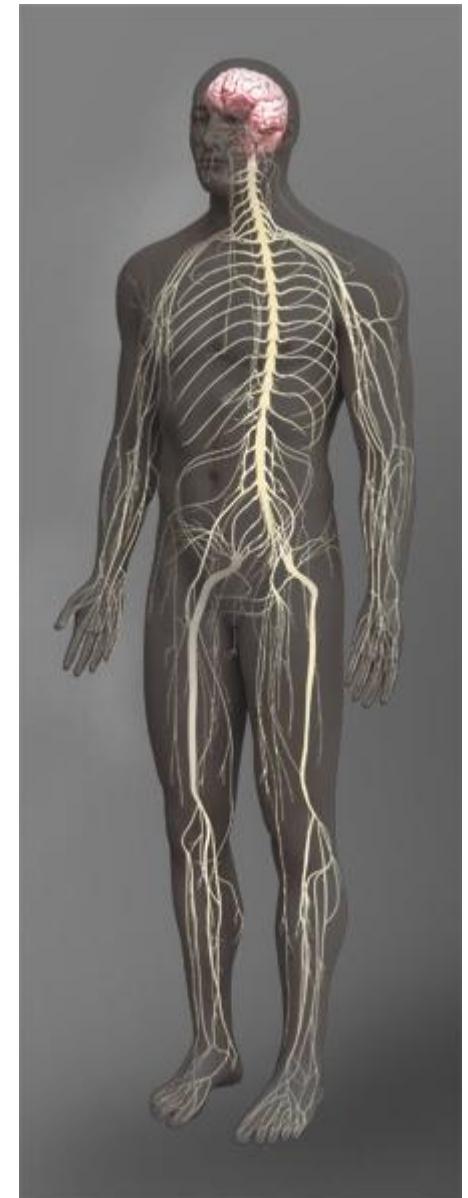


How Neurotransmitters Influence Us

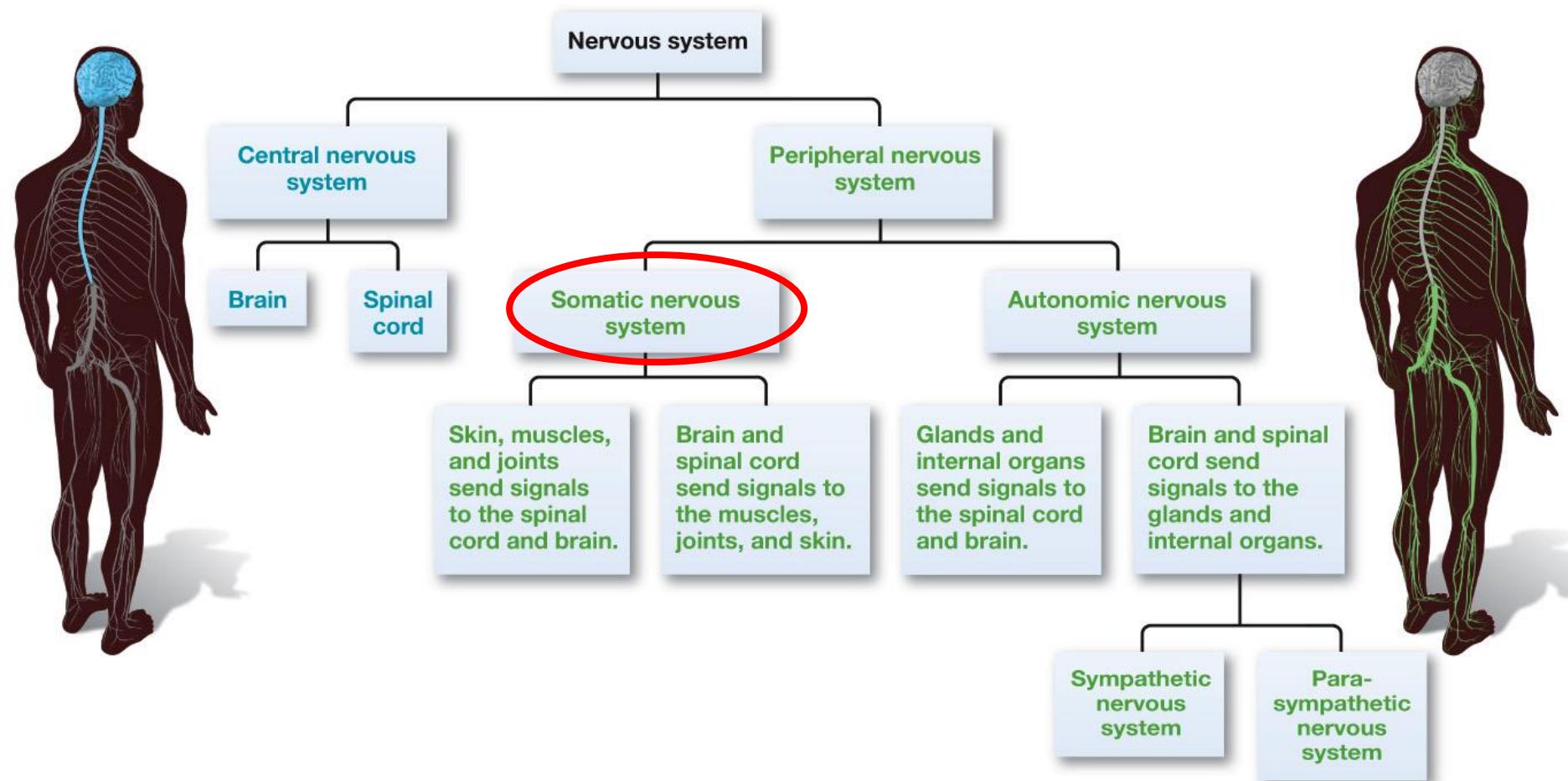
Dopamine pathways are involved with diseases such as schizophrenia and Parkinson's disease.



Communication of the brain with the body

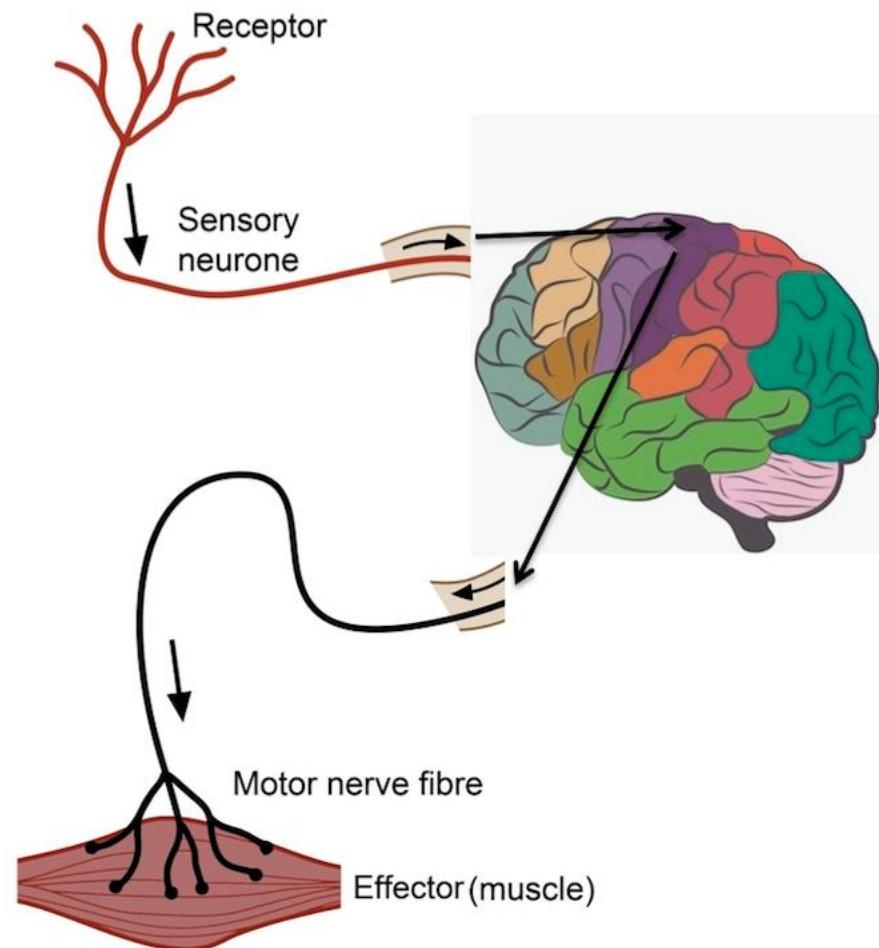


Communication of the brain with the body

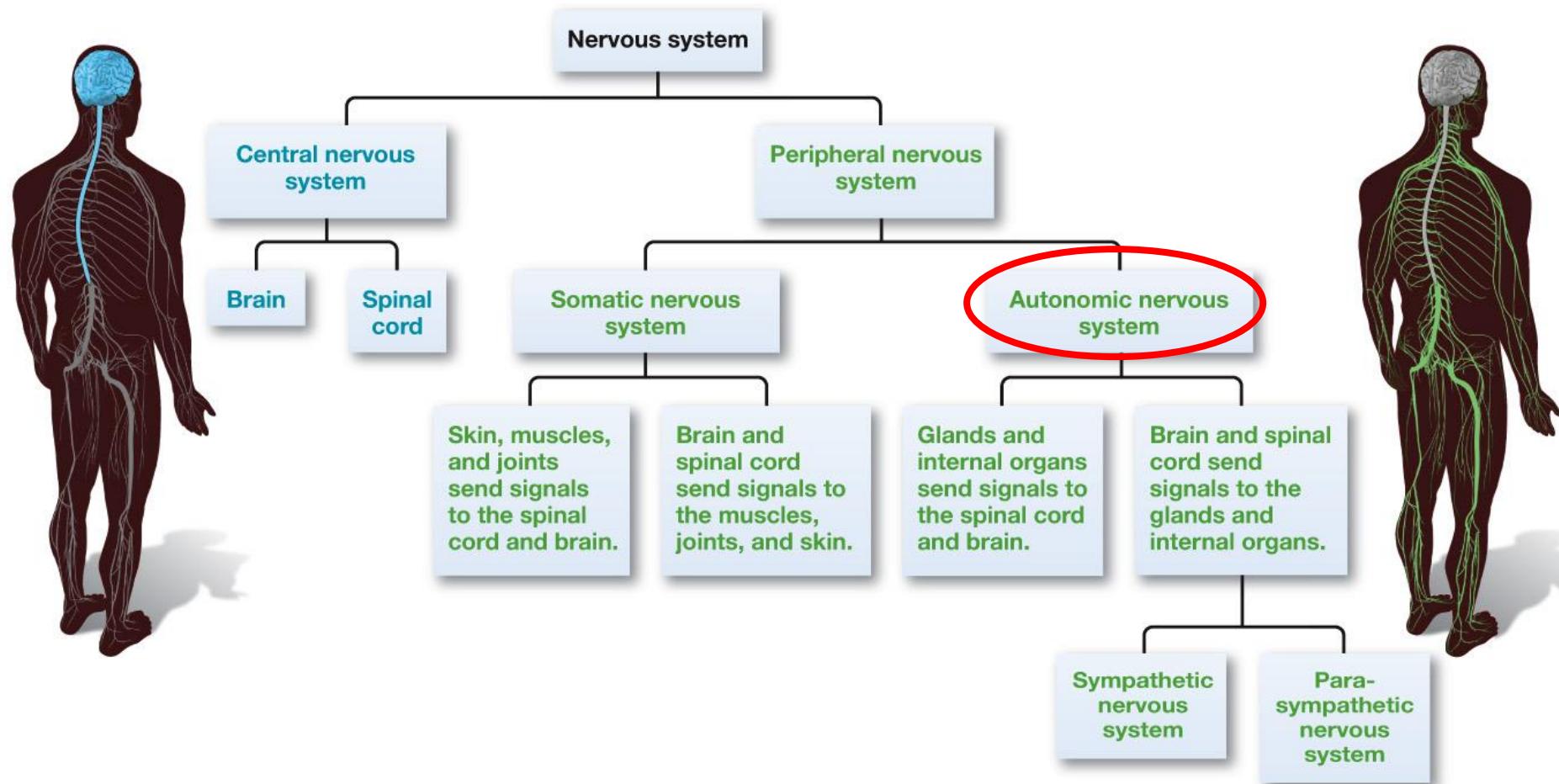


Communication of the brain with the body

- Somatic NS

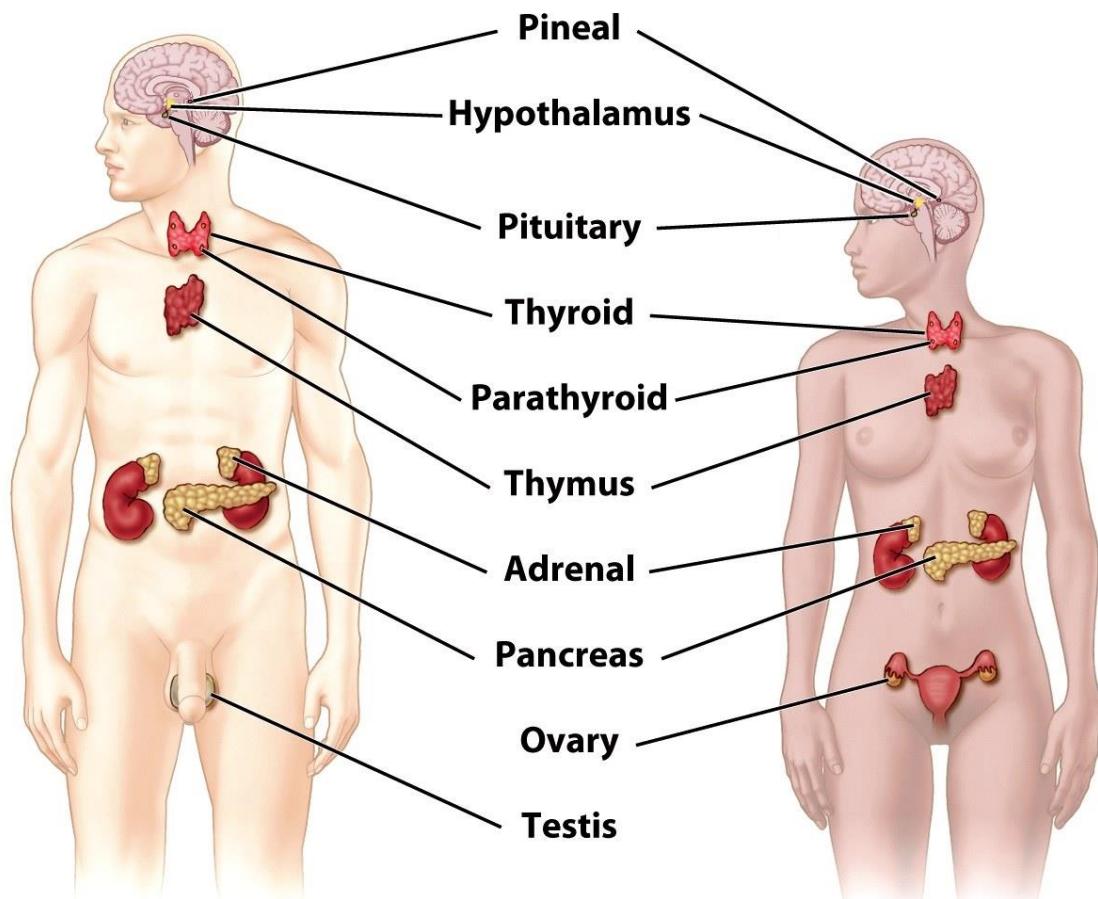


Communication of the brain with the body



Communication of the brain with the body

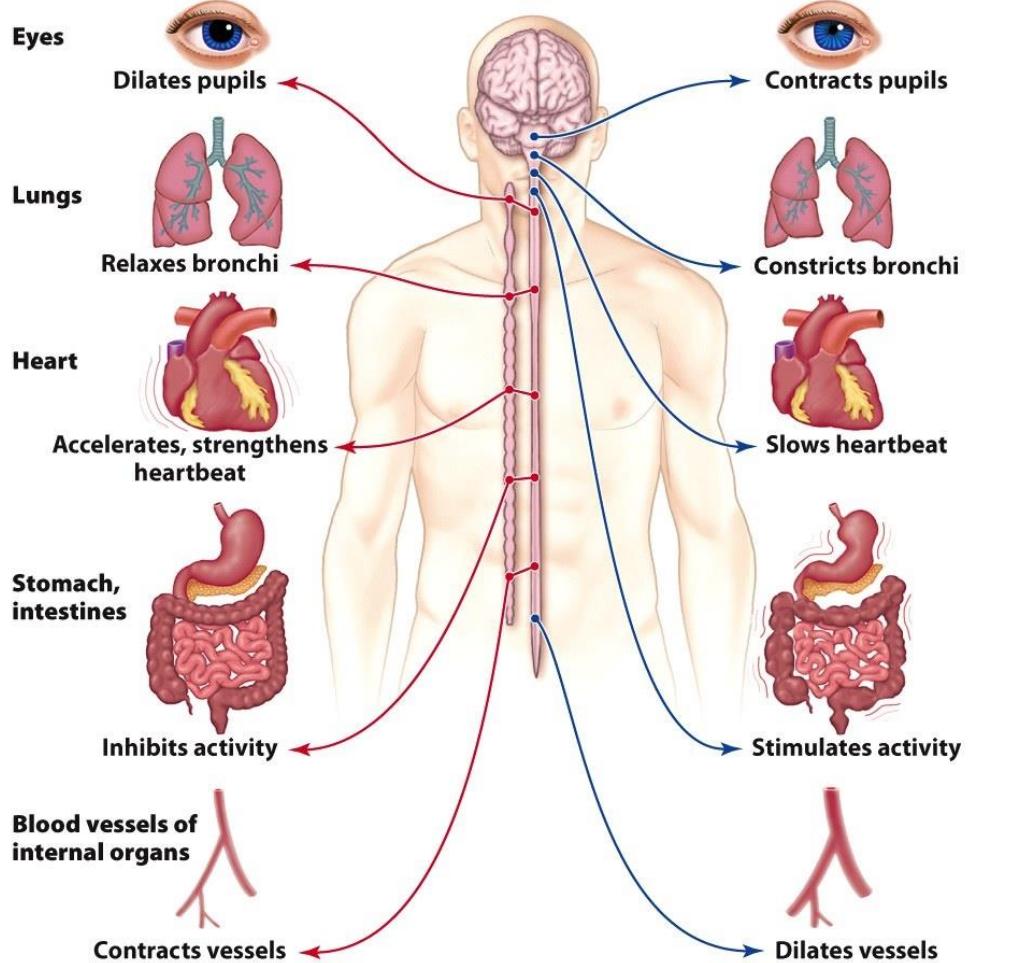
- Endocrine system



Communication of the brain with the body

- Autonomic NS

The **sympathetic** division of the nervous system prepares the body for action.



Autonomic Nervous System (ANS)

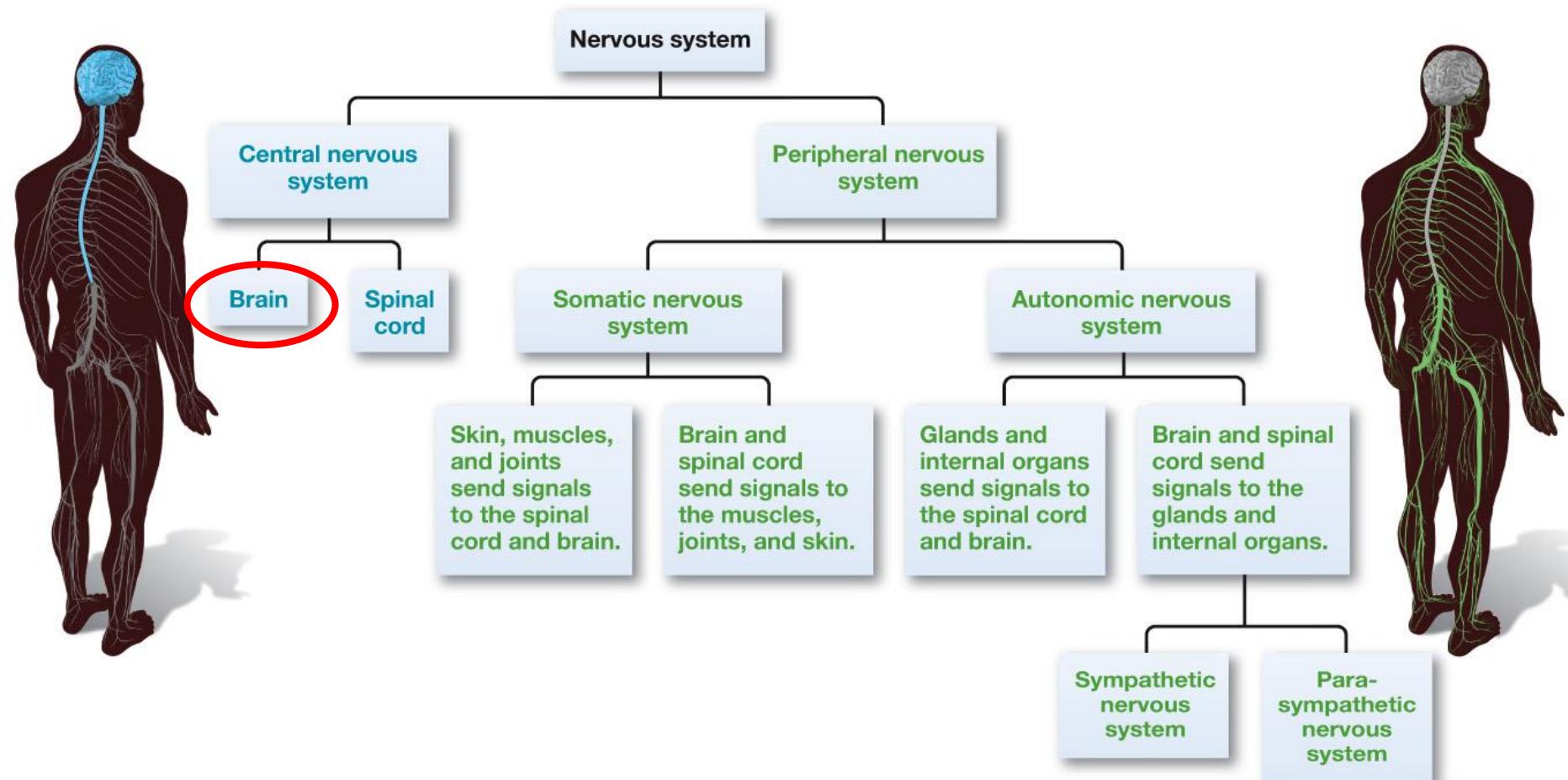
Sympathetic Nervous System:

- **Arouses** the body
 - mobilizing its energy in stressful situations
 - Uses energy
- In defensive situations
 - the heart rate increases
 - the lungs expand to hold more oxygen
 - the pupils dilate
 - blood flows to the muscles.

Parasympathetic Nervous System:

- **Calms** the body
 - conserving its energy
- Bodily functions that occur in normal, non-stressful situations.
- After eating
 - the digestive process begins:
 - nutrients are taken from the food and stored in the body

Studying the brain



The brain



The brain

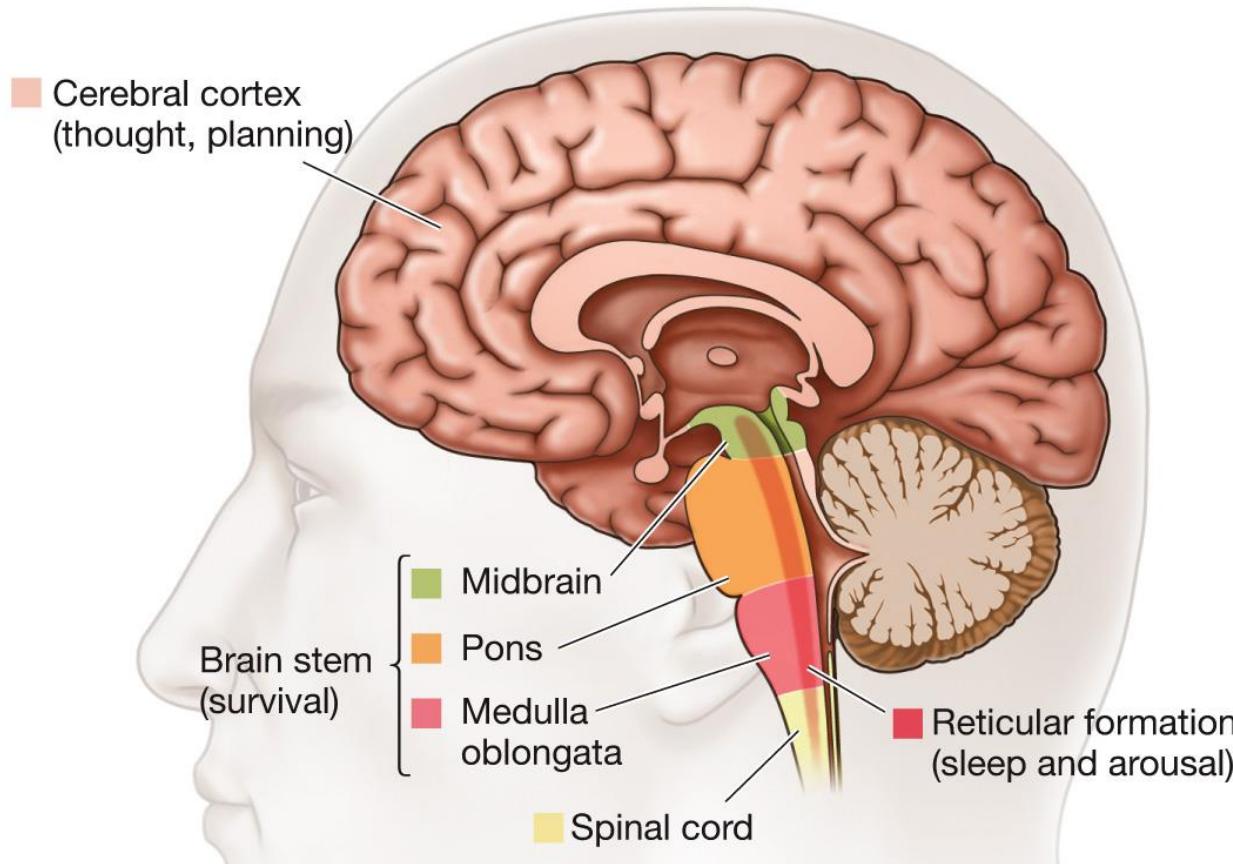
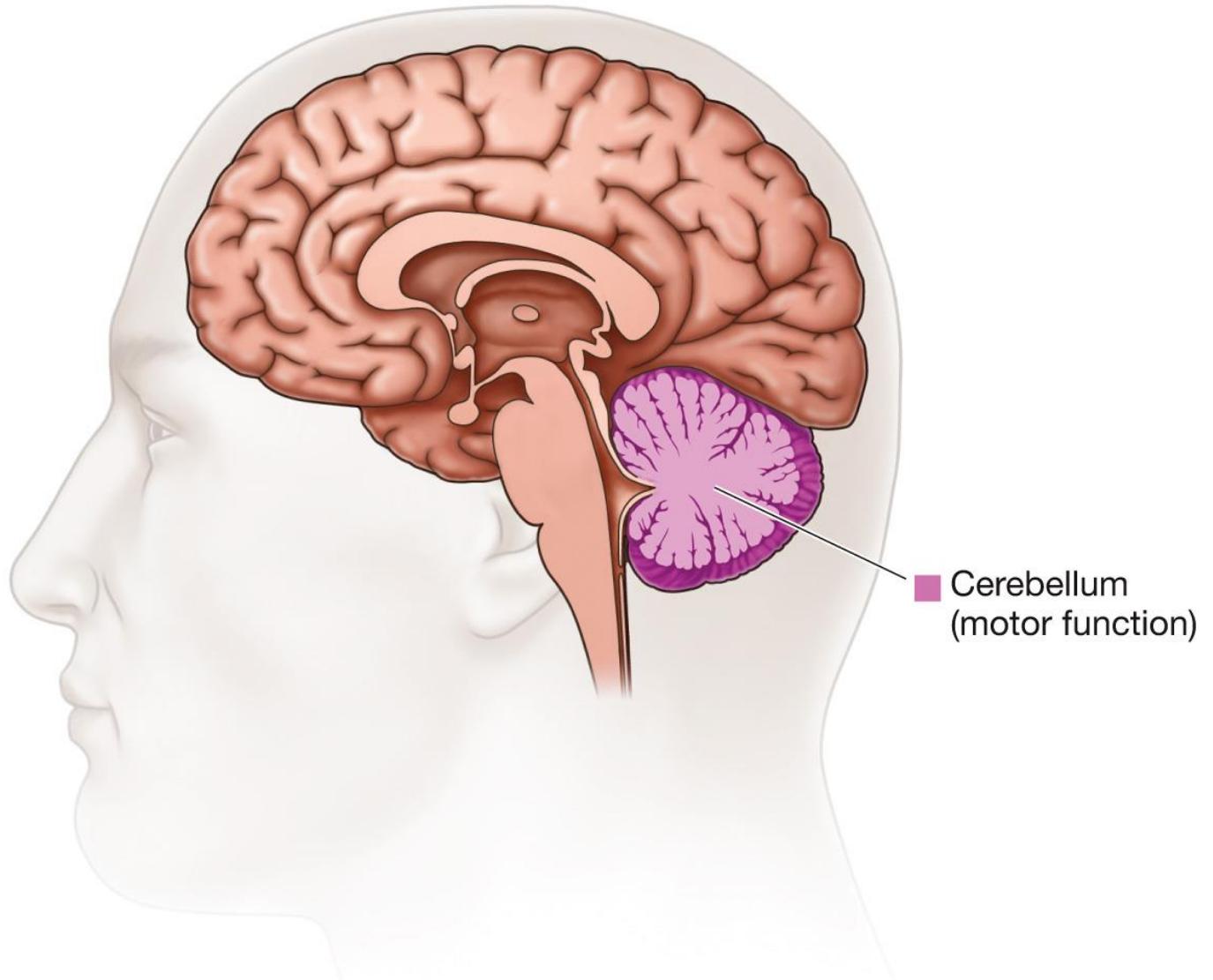
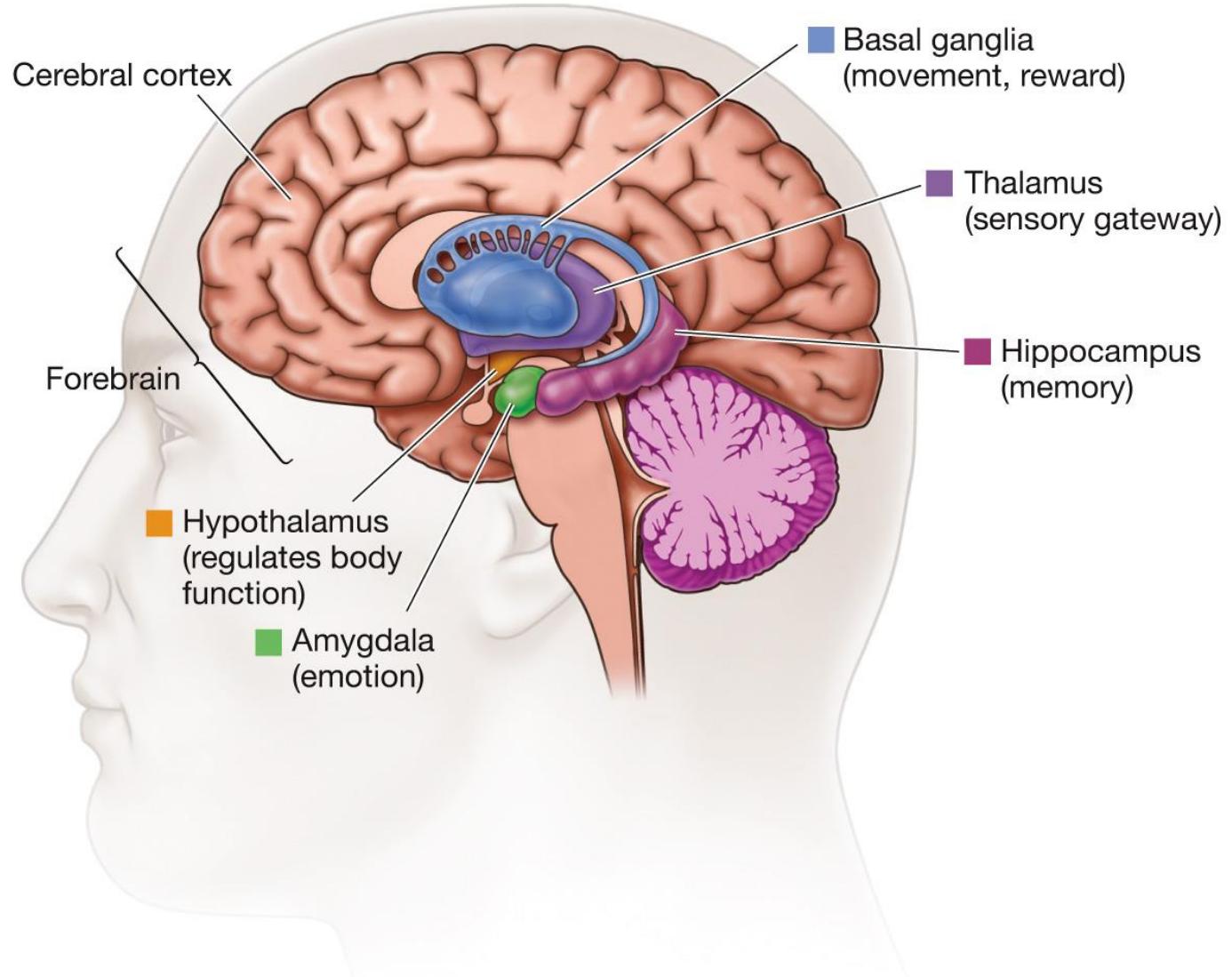


FIGURE 2.15 Myers/DeWall,
Psychology, 12e,
© 2018 Worth Publishers
Andrew Swift

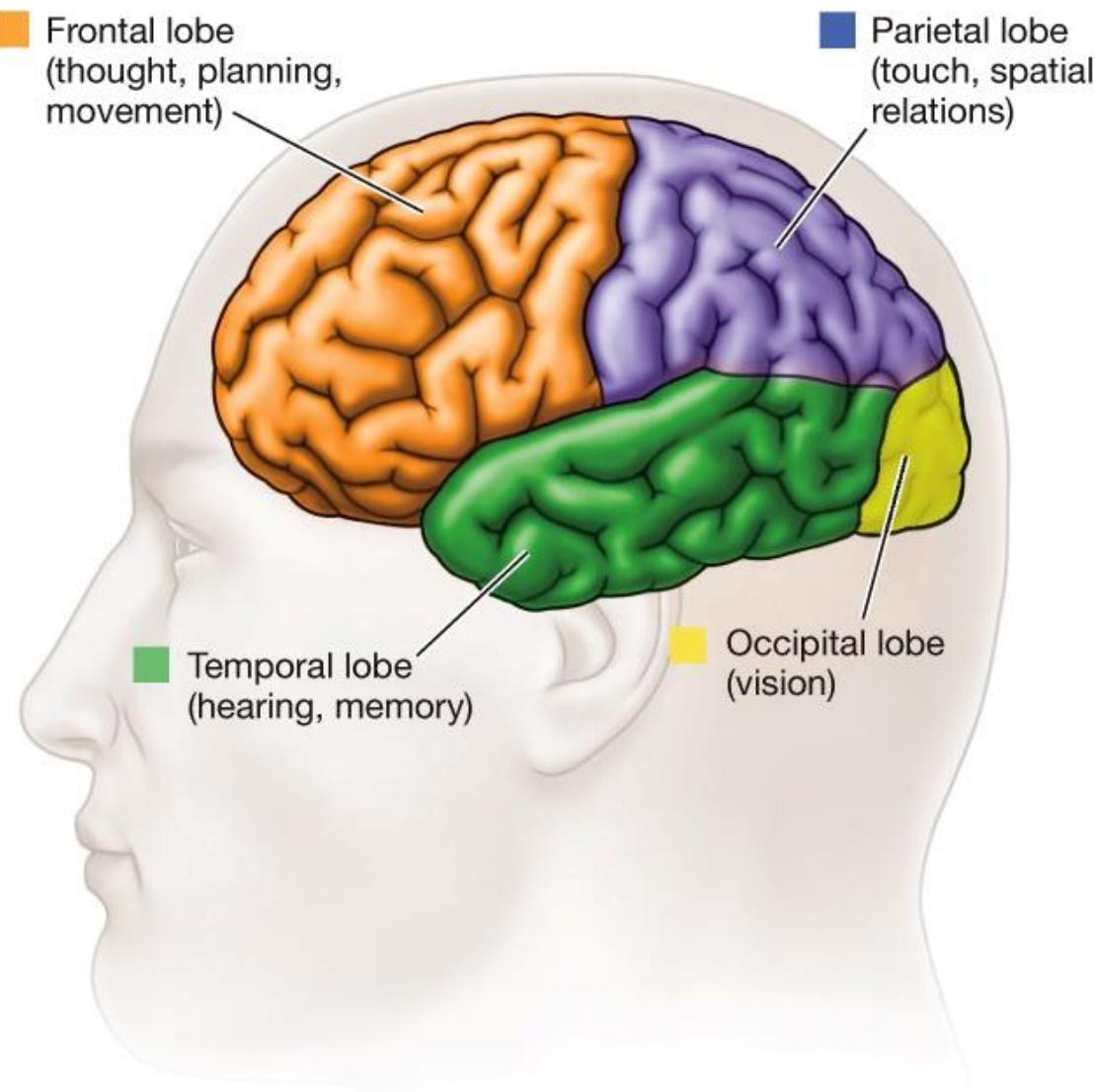
The brain



The brain



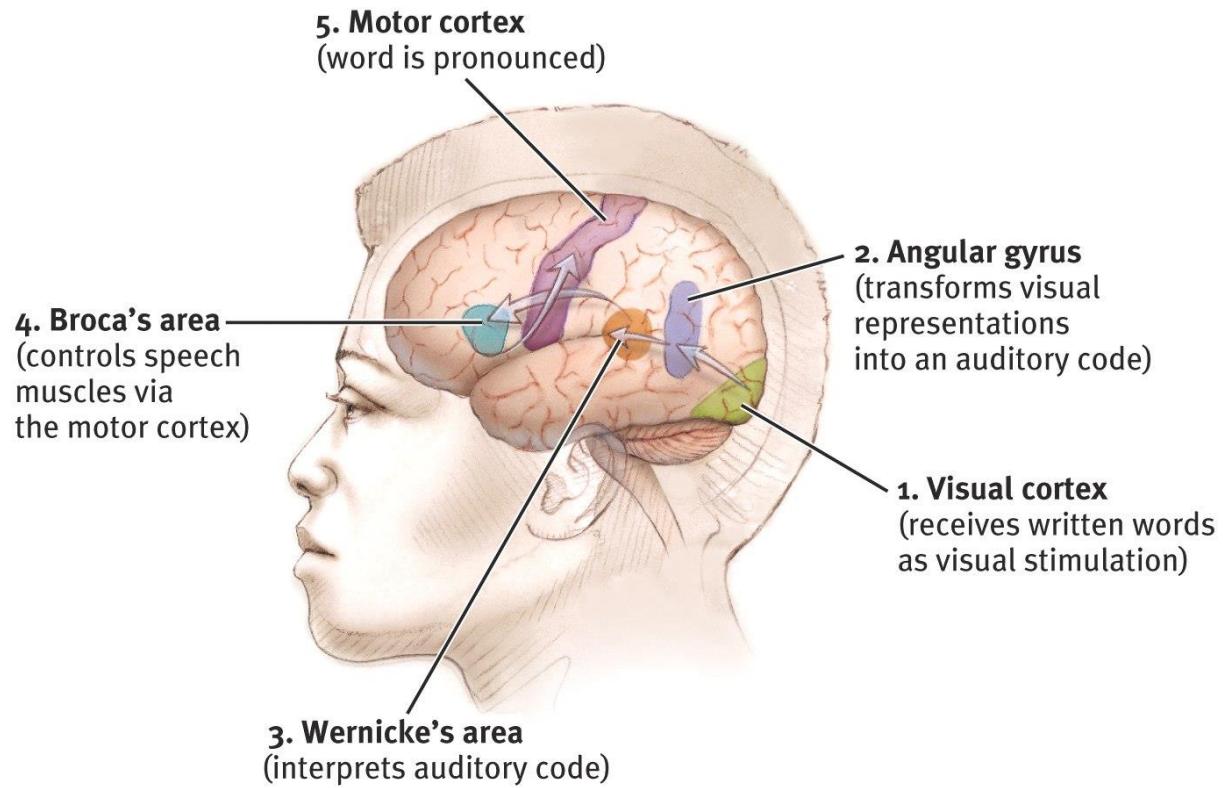
The brain



Language

Broca's area:
impaired speaking

Wernicke's area:
impaired
understanding

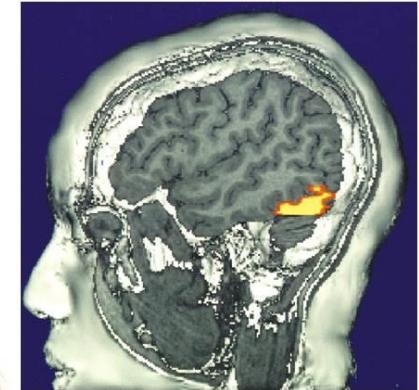
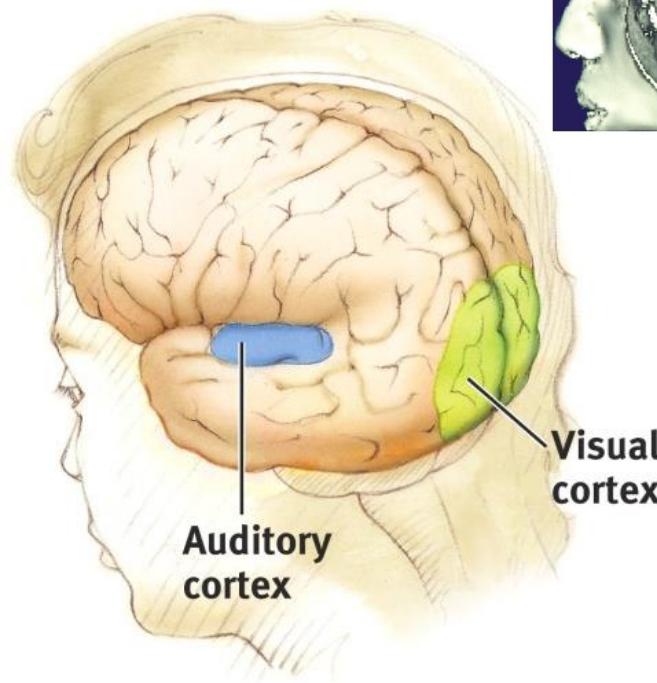


Other Cortex Areas

The cortex also receives input from senses other than touch (visual and auditory)

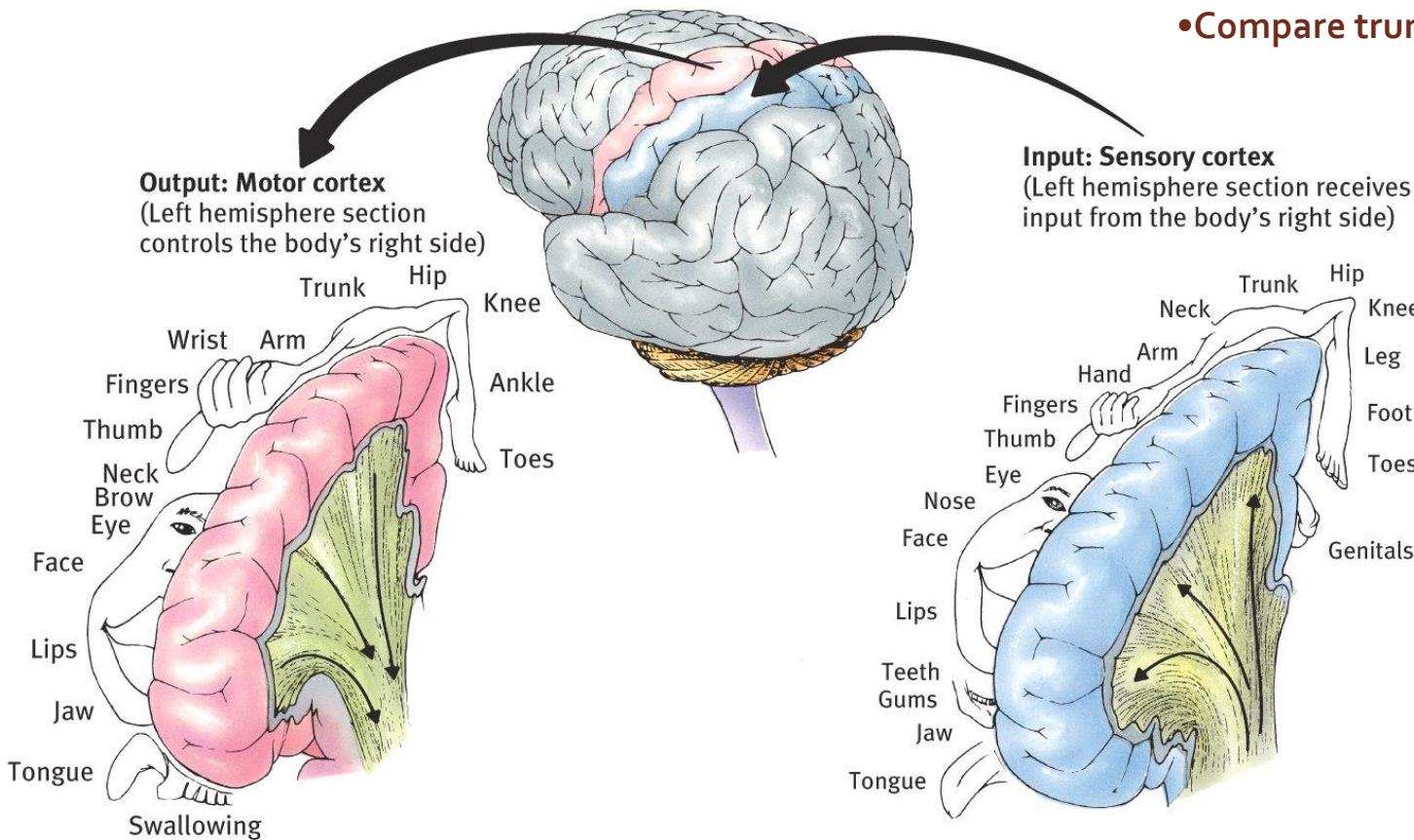
- **Visual Cortex**

- The fMRI scan shows the visual cortex is active as the subject looks at faces.
- Occipital lobe receives information from eyes and visual cortex gets activated



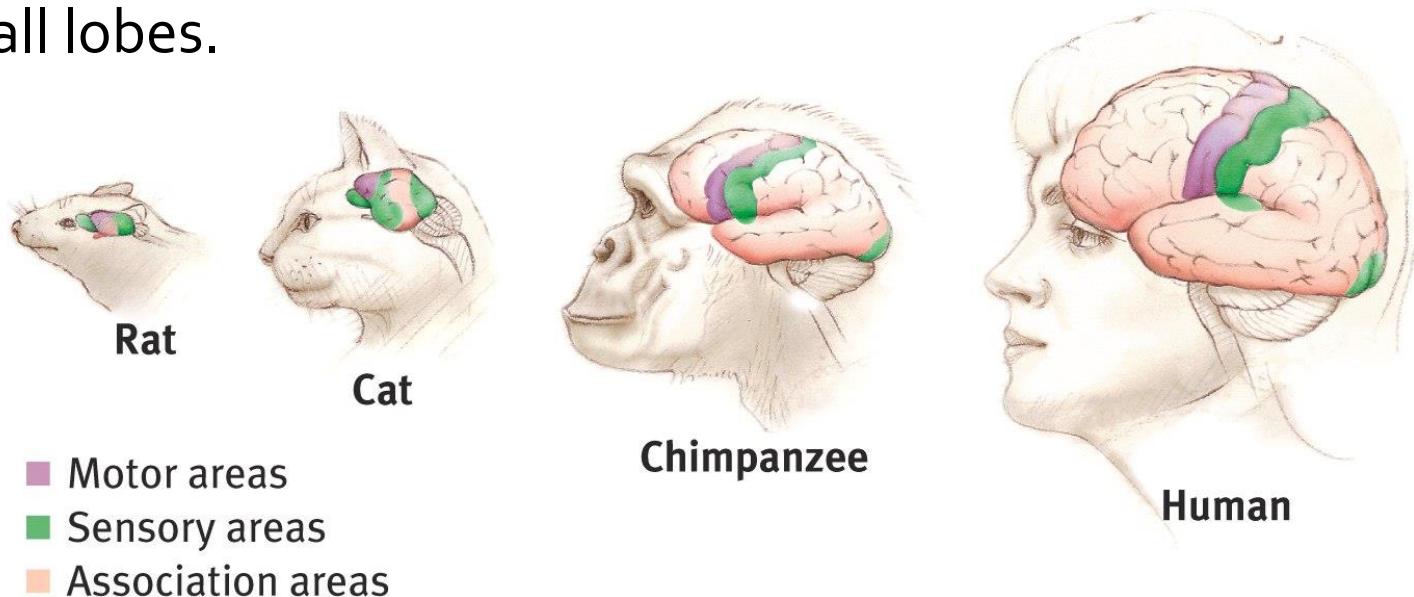
Motor Cortex & Sensory Cortex

- Larger sensory cortex is devoted to more sensitive body parts.
- Compare trunk and face.



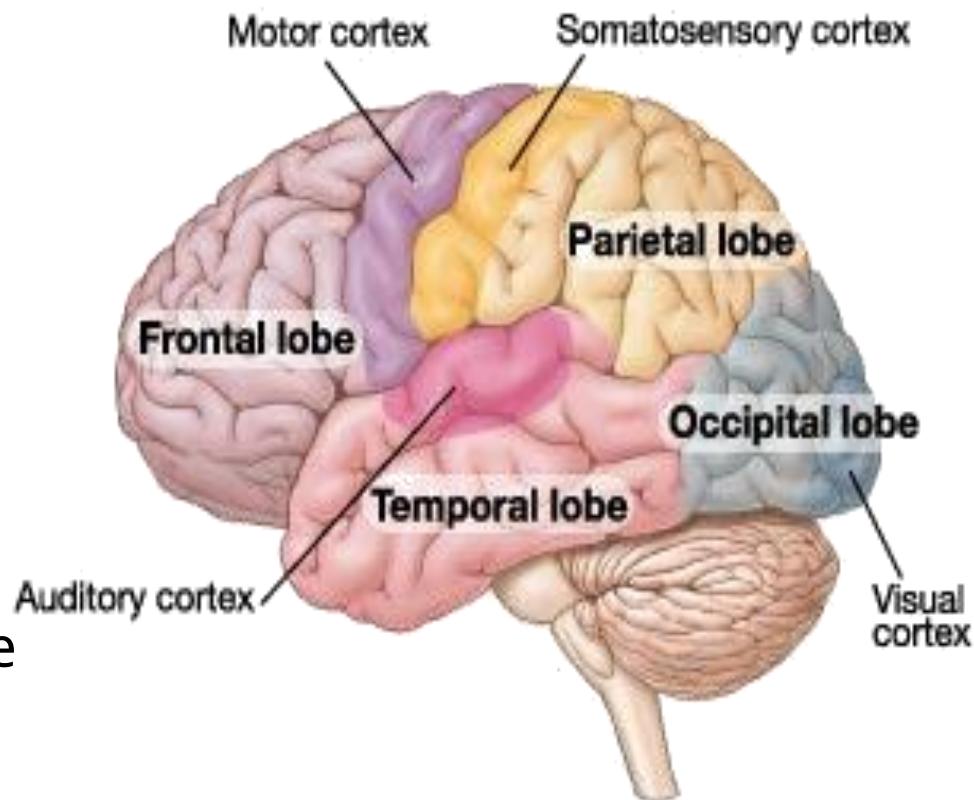
Association Areas

- More intelligent animals have increased association areas of the cortex: integrate and link inputs with stored memories.
- $\frac{3}{4}$ of the human cortex.
- Found in all lobes.



Lobes of the Brain and Problems

- **Frontal Lobe** – personality, planning, emotion, problem solving
 - Motor cortex - movement
 - **Broca's area** – speech production
- **Parietal Lobe** - touch
- **Temporal Lobe** – hearing
 - **Wernicke's area** – language comprehension
- **Occipital Lobe** - vision



Brain Re-organization

- Plasticity
 - the brain's capacity for modification, as evident in brain reorganization following

The message: "The brain is sculpted by our genes but also by our experiences."

Our Divided Brain

Our brain is divided into two hemispheres.

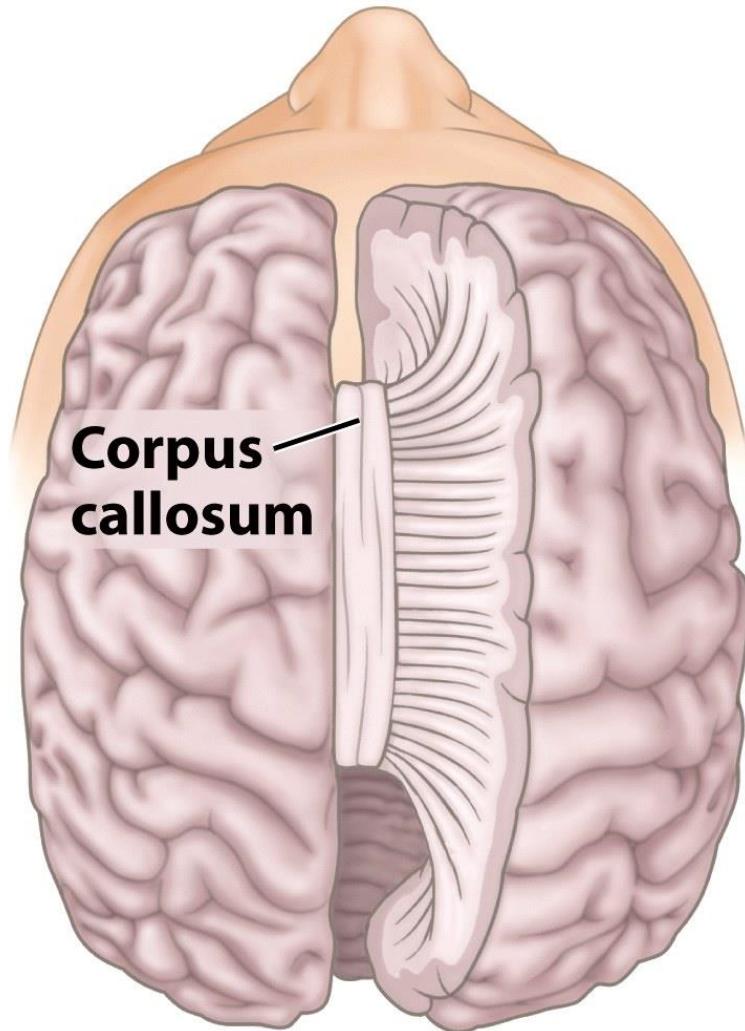
The left hemisphere processes reading, writing, speaking, mathematics, and comprehension skills.

In the 1960s, it was termed as the dominant brain.

Hemispheric Specialization: Lateralization of Function

- **Left Hemisphere**
 - Language
 - Logic
 - Complex motor behavior.
- **Right Hemisphere**
 - Spatial ability: matching 3-D image with 2-D
 - Emotion: perceiving facial expressions and mood.
 - Musical ability: perception of melodies.
 - Some memory tasks: Learning tasks where context doesn't matter.

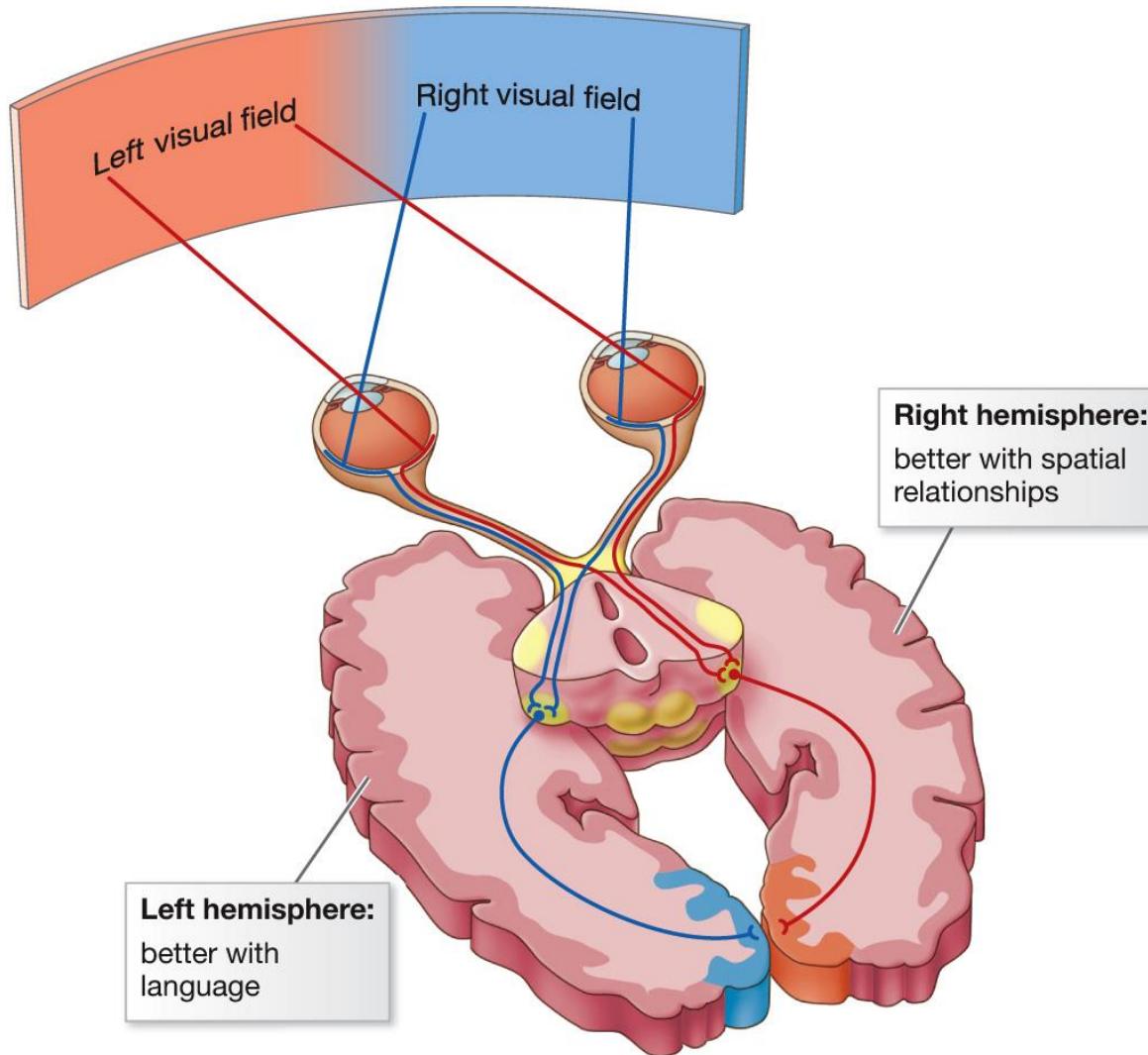
The brain



The brain



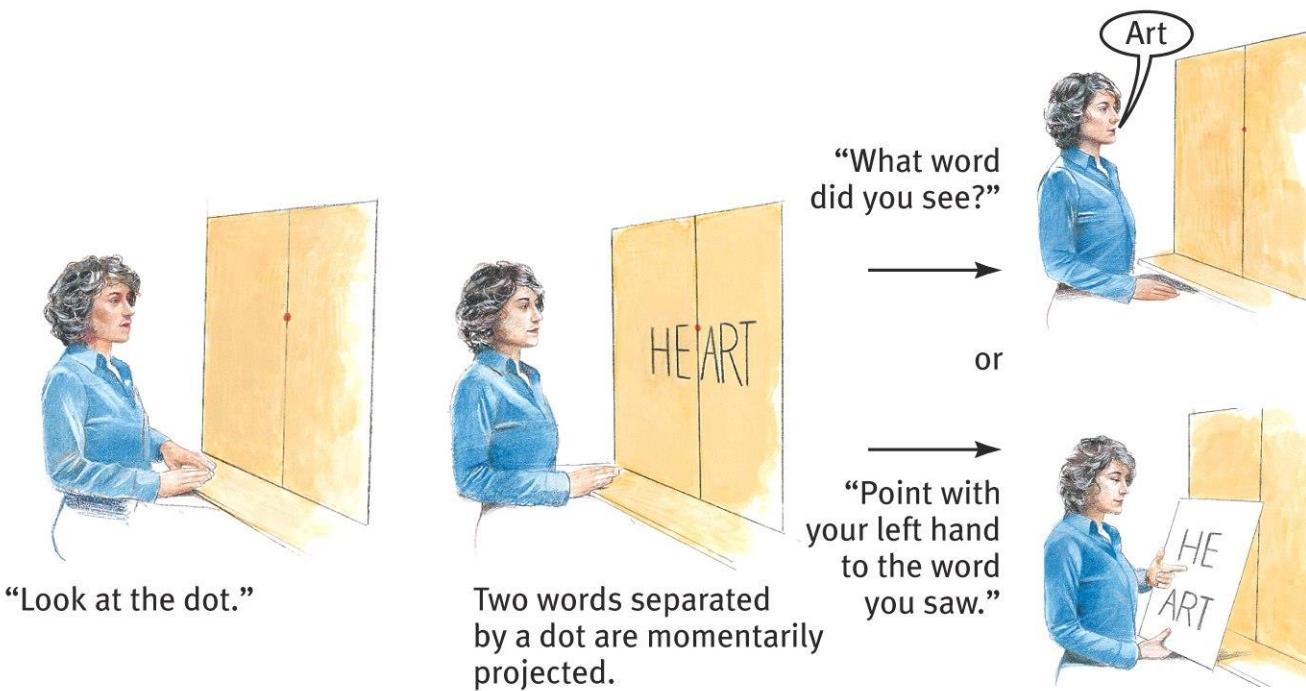
The brain



Split-Brain Experiment (Sperry & Gazzaniga)

- Subjects were presented information to one or the other side of their brains.
- **Left** hemisphere can tell what it has seen, right hemisphere can show it.
- Studies of split-brain patients:
 - a. **Present a picture to the right visual field (left brain)**
 - Left hemisphere can tell you what it was.
 - Right hand can show you, left hand can't.
 - b. **Present a picture to the left visual field (right brain)**
 - Subject will report that they do not know what it was.
 - Left hand can show you what it was, right can't.

Divided Consciousness



The brain

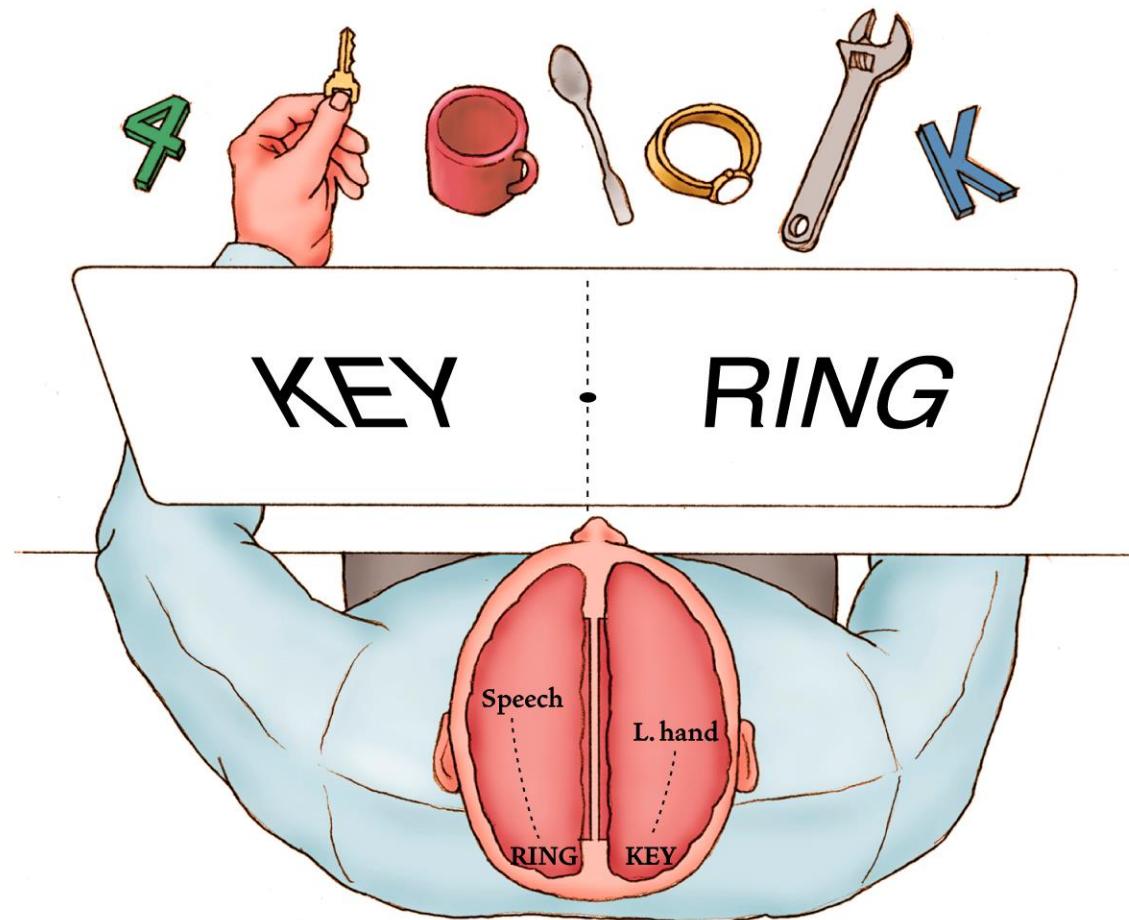


Figure 2.18: A setup sometimes used in split-brain studies

Psychology, Sixth Edition
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SUMMARY

- Brain, the most complex structure of the human body, is the master of all neural processes took place in the body.
- Brain is capable of reorganizing itself in response to damage.
- Each hemisphere makes unique contributions to the integrated functioning of the brain.