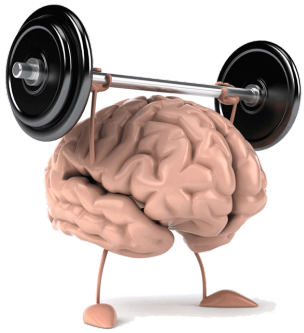
Psychology – Mr. Duez - LEARNING TARGETS
UNIT 2 - "The Biological Bases of Behavior"



Part I - The Brain, Nervous System, Neurons, & Behavior/Heredity

Major points to understand:

1. *The different methods for **peering into** the human brain*
2. *What the **areas does the brain control***
3. *The structure of the **neuron***
4. *The **action potential***
5. *The role of **neurotransmitters** in **neural transmission***

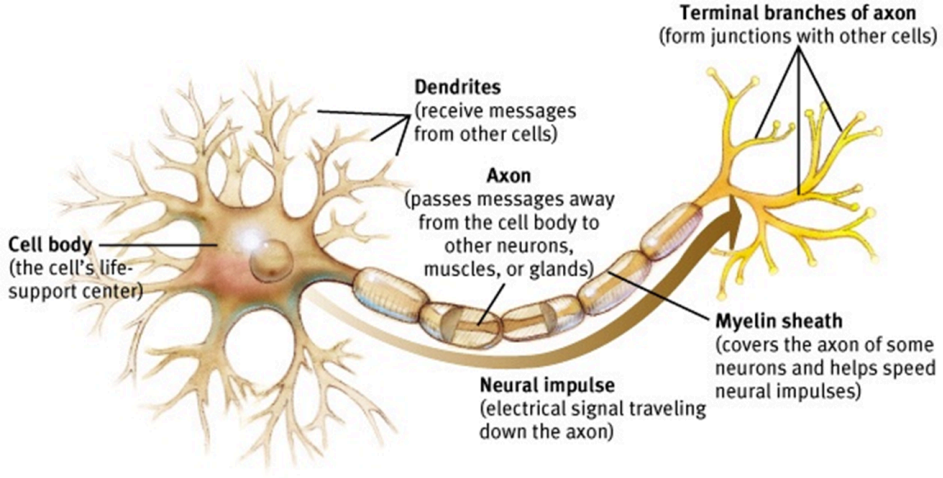
OBJECTIVES:

- ★ *Distinguish between the Central Nervous System (CNS) and the Peripheral Nervous System (PNS*
- ★ *Provide an overview of the peripheral nervous system, including its subdivisions.*
- ★ *Describe the main functions of the two types of nervous tissues.*
- ★ *Identify the location and various parts of the neuron and discuss their functions.*
- ★ *Describe the neural impulse and absolute refractory period.*

Overview

The influence of **biology** (sometimes called the neuroscience or biopsychological perspective) is growing. Some researchers predict that someday psychology will be a specialty within the field of biology. An understanding of the biological principles relevant to psychology is needed for any real understanding of current psychological thinking.

Neuroanatomy: refers to the study of the **parts and functions of neurons** (individual nerve cells). These cells make up our entire nervous system, from the brain to the neurons that fire when you stub your toe. Every neuron is made up of discrete parts (see diagram/pic below).



****It has been estimated that there are **1 quadrillion synapses** in the human brain. That's 1015 or 1,000,000,000,000,000 synapses! **This is equal to about a half-billion synapses per cubic millimeter.**

Glial Cells – Cells in Nervous System that provides various support for neurons. Glial cells supply nourishment to neurons, remove neurons waste products, and provide insulation around many axons.

Dendrites - rootlike parts of the cell that branch out from the cell body. They grow to make synaptic connections with other neurons.

Cell Body - also known as the Soma - contains the nucleus and other parts of the cell needed to sustain its life.

Axon - wirelike structure ending in the terminal buttons that extends from the cell body.

Myelin Sheath - a fatty covering around the axon of some neurons that speeds neural impulses.

Terminal Buttons (also called end buttons, terminal branches of axon, and synaptic knobs) - the branched end of the axon that contains neurotransmitters.

Synapse - the space between the terminal buttons of one neuron and the dendrites of the next neuron.

Afferent/sensory neuron - Takes information from the senses to the brain.
Interneuron - Takes the messages from afferent neurons in the brain or spinal cord and sends them elsewhere in the brain or on to efferent neurons.
Efferent/motor neuron - Takes information from the brain to the rest of the body.

Communication in the Nervous System

Neurons are the basic communication links in the nervous system. They transmit a neural impulse along an **axon** to a **synapse** with another neuron. This **all-or-none event** is a change in the electrical charge that moves along an axon.

Action potentials trigger the release of chemicals called **neurotransmitters** that diffuse across a **synapse** to communicate with other **neurons**.

Transmitters bind with receptors in the **postsynaptic** cell membrane, causing **excitatory** or **inhibitory** PSPs. ACh plays a key role in muscle movement.

Disturbances in the activity of the **monoamine transmitters** have been related to the development of **depression** and **schizophrenia**.

Endorphins contribute to the relief of **pain** and perhaps experience of **pleasure**.

How a Neuron "Fires"

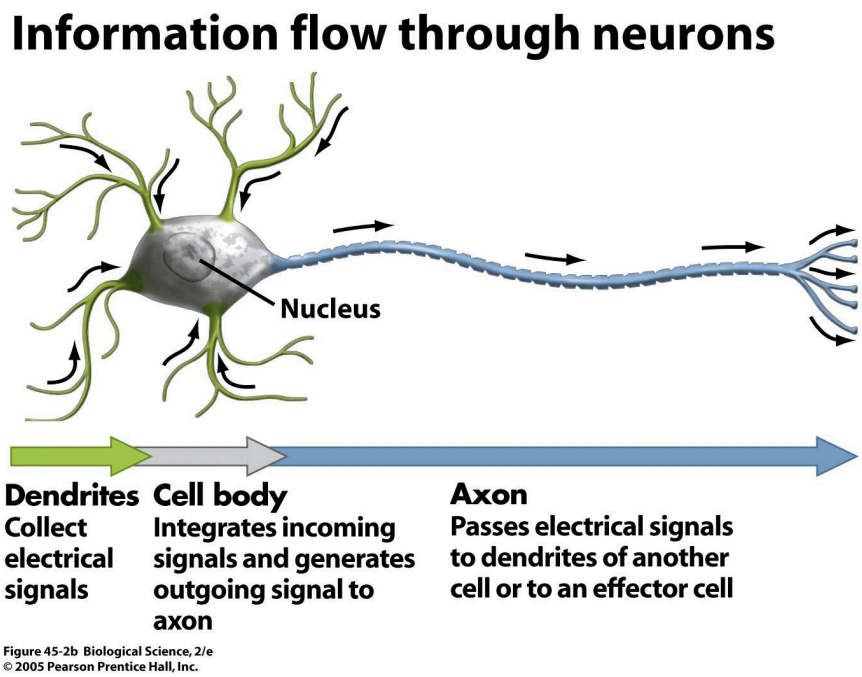
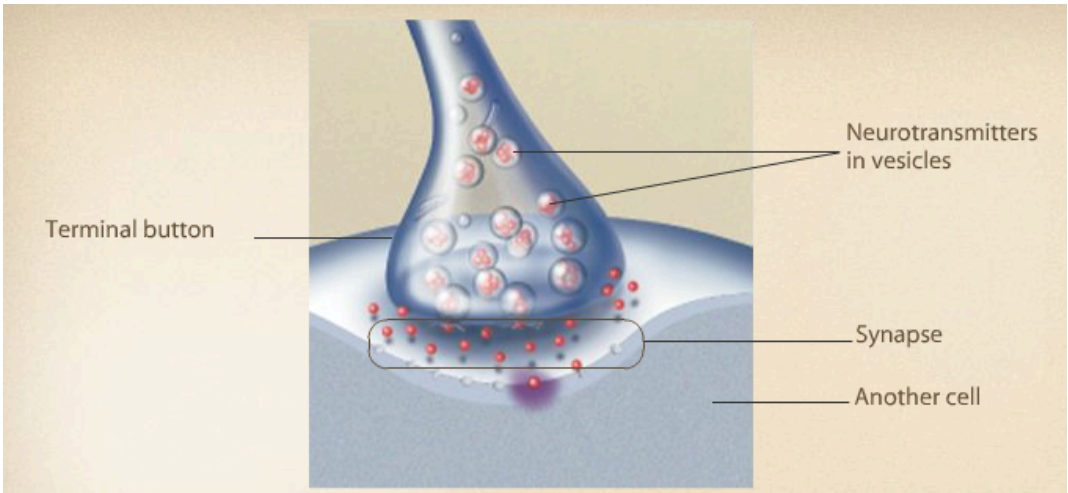


Figure 45-2b Biological Science, 2/e
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All of the different parts of the neuron work in sequence when a **neuron transmits a message**. In its resting state, a neuron has an overall slightly negative charge because mostly negative ions are within the cell and mostly positive ions are surrounding it. The cell membrane of the neuron is selectively permeable and prevents these ions from mixing.

Visualize a two-neuron chain. The reaction begins when the terminal buttons of a neuron A are stimulated and release neurotransmitters into the synapse. These neurotransmitters fit into receptor sites on the dendrites of neuron B. If enough neurotransmitters are received (this level is called the *threshold*), the cell membrane of neuron B becomes permeable and positive ions rush into the cell. The change in the charge spreads down the length of the neuron B **like a bullet from a gun**. This electronic message firing is called an **action potential**. It travels quickly: 120 meters per second. When the charge reaches the terminal buttons of neuron B, the buttons release their neurotransmitters into the synapse.

The process may begin again if enough neurotransmitters are received by that next cell to pass the threshold. **Notice that a neuron either fires completely or it does not fire; this is the so called "all-or-none principle."** If the dendrites of a neuron receive enough neurotransmitters to push the neuron past its threshold, the neuron will fire completely every time. **A neuron cannot fire a little or alot; the impulse is the same every time.**



Neurotransmitters and Behavior

Neurotransmitters - chemicals contained in the terminal buttons that enable neurons to communicate. They fit into receptor sites on the dendrites of neurons like a key fits into a lock.

OBJECTIVES:

- ★ *Identify the location of key anatomical structures in the terminal button and the synapse.*
- ★ *Describe how the neurons communicate at chemical synapse.*
- ★ *Describe the two types of postsynaptic potentials and how cells integrate these signals.*
- ★ *Discuss some of the functions of acetylcholine and serotonin.*
- ★ *Discuss some of the functions of dopamine and norepinephrine.*
- ★ *Discuss how GABA regulates behavior.*

Key neurotransmitters

Agonist – Chemical that mimics the action of a Neurotransmitter.

Antagonist – Chemical that opposes the action of a Neurotransmitter.

The **Agonist** causes PSP's, while the **Antagonist** Blocks PSP's.

Monoamines – 3 Neurotransmitters: Dopamine, Norepinephrine, and Serotonin.

Dopamine: associated with motor movement and alertness. Used by Neurons that Control Voluntary Movement. Degeneration of Dopamine leads to Parkinson's disease. Effects of Drugs like Cocaine and Amphetamines are caused by temporary increased activity at Dopamine and Norepinephrine Synapses.

norepinephrine - noradrenaline; chemical which is excitatory, similar to adrenaline, and affects arousal and memory; raises blood pressure by causing blood vessels to become constricted, but also carried by bloodstream to the anterior pituitary which relaxes ACTH thus prolonging stress response.

Serotonin: mood control. "mood molecule"; chemical that affects regulation asleep, dreaming, mood, hunger, pain, and aggressive behavior; and attaches to many receptors (receptor sites)

Dopamine – **Serotonin** – Plays a prominent role in sleep, wakefulness, and eating Behavior. Abnormal levels of Monoamines lead to Psychological Disorders.

Depression = Low activation of Norepinephrine and Serotonin Synapses.

Schizophrenia – Over activation of Dopamine Synapses. Schizophrenia affects 1% of Population, and causes Hospitalization more than any Psychological Disorder.

Acetylcholine: associated with motor movement. Transmitter between Motor Neurons and Voluntary Muscles.

Endorphins: pain control. Internally produced chemicals that resemble Opiates in structure and effects. Candace Pert & Solomon Snyder: Morphine exerts its effects by binding to specialized receptors in the Brain. (Endorphin Receptors) Endorphins contribute to modulation of Pain and a variety of other things.

GABA – GABA and Glycine acts as inhibitory effects at all synapses. Plays in Anxiety, Seizures, and Sleep.

Organization of the nervous system (Central Nervous System & Peripheral Nervous System)

Central Nervous System (CNS)- brain and spinal cord

Peripheral System (**PNS)** - somatic nervous system (connects to muscles & sensory receptors) & **autonomic** nervous system (connects to blood vessels, smooth muscles, and glands.)

- **Somatic Nervous System** - controls voluntary movements
- **Autonomic Nervous System** - controls involuntary movements

Sympathetic Nervous System - speeds things up- prepares body for fight or flight. Sympathetic nervous system

mobilizes our body to respond to stress.

Parasympathetic nervous system - Brings the body back to normal; responsible for slowing down our body after a stress response.

Peripheral Nervous System - all other nerves

The Endocrine System: *Another Way to Communicate*

Endocrine system – system of all the glands and their chemical messages taken together, which are chemicals involved in regulation of basic bodily processes. Control centers for **endocrine** system are **hypothalamus** and **pituitary gland**. System of glands that secrete hormones that affect many different biological processes in our body; controlled by the **hypothalamus**.

Hormones – chemical regulators that control bodily processes such as emotional responses, growth, and sexuality

- **Pituitary gland** – the master gland of the body that activates other glands and controls the growth hormone
- **Growth hormone** – hormone that regulates the growth process
- **Thyroid gland** – controls and regulates the speed of bodily processes called metabolism
- **Metabolism** – the speed at which the body operates of the speed at which it uses up energy
- **Adrenal glands** – glands that release the hormone that causes excitement in order to prepare the body for an emergency. Produce adrenaline, which signals the rest of the body to prepare for fight or flight.
- **Adrenaline** – chemical that prepares the body for emergency activity by increasing blood pressure, breathing rate, and energy level

Brain Research/Imaging Techniques

OBJECTIVES:

- ★ *Describe the EEG and four common brain wave patterns.*
- ★ *Describe how lesioning and ESB are used to investigate brain function.*
- ★ *Describe the new brain imaging methods that are used to study brain structure and function.*

Recording/ Neuroimaging techniques

Electrode Recording- insert an electrode into a part of the brain and record neural firing

EEG (Electroencephalogram) - Detects brain waves; shows researchers the types of brain waves produced during different stages of consciousness. Measure overall brain electrical activity (measured in waves); Record broad patterns of electrical activity in the brain.

Computerized Axial Tomography (CAT/CT) scan - A sophisticated X-ray that uses several X-ray cameras that rotate around the brain and combine the pictures into a detailed three-dimensional picture of the brain's structure.

Magnetic Resonance Imaging (MRI) - Uses magnetic fields to measure the density and location of brain material and creates a detailed image of the brain.

Positron emission tomography (PET) scan - Lets researchers see what areas of the brain are most active during certain tasks; measures how much of a certain chemical parts of the brain are using.

Functional MRI (fMRI) - Combines elements of the MRI and PET scans to show details of brain structure with information about blood flow in the brain, tying brain structure to brain activity during cognitive tasks.

The Brain and Behavior

Lesioning involves destroying a piece of the brain.

Stimulation occurs from the usage electrodes, magnetics, and or chemicals causing the firing in a certain part

of the body. *ex: If you stimulate the hypothalamus of a rat they will continuously keep eating.*

Patient H.M. - **Henry Molaison, H.M.**, was an American memory disorder patient whose hippocampi, parahippocampal gyrus, and amygdalae were surgically removed in an attempt to cure his epilepsy. **H.M. was influential not only for the knowledge he provided about memory impairment and amnesia, but also because it was thought his exact brain surgery allowed a good understanding of how particular areas of the brain may be linked to specific processes hypothesized to occur in memory formation.** His apparent ability to complete tasks that require recall from short-term memory and procedural memory but not long-term episodic memory suggests that recall from these memory systems may be mediated, at least in part, by different areas of the brain. Similarly, his ability to recall long-term memories that existed well before his surgery, but inability to create new long-term memories, suggests that encoding and retrieval of long-term memory information may also be mediated by distinct systems.

Brain Lobes

Cerebral Cortex - The cerebral cortex is the thin layer on the top of your brain.

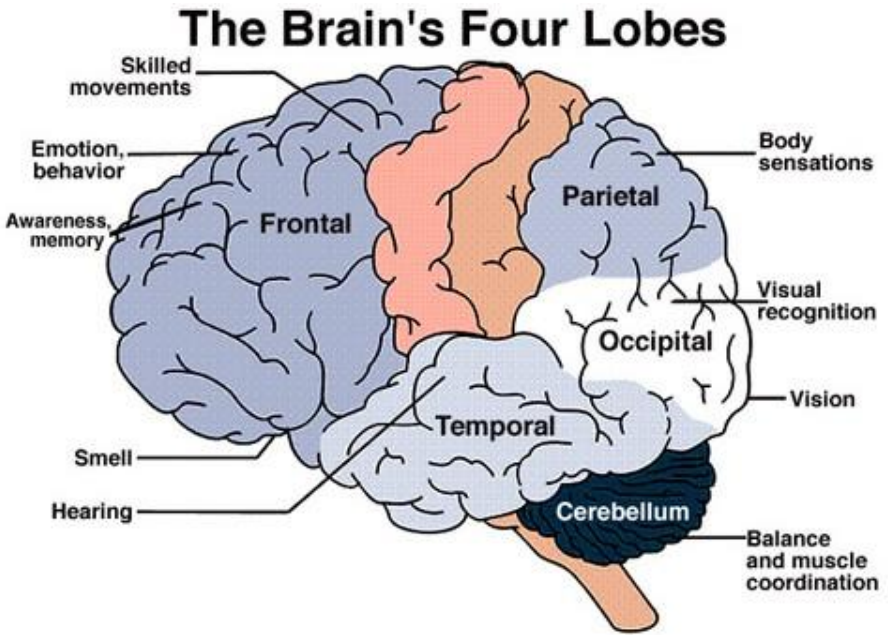
The cerebral cortex can be divided into 4 regions called (lobes). Each lobe has been associated with different functions of the body but we are still far away from understanding them completely. Lobes include: *frontal, parietal, occipital, and temporal.*

Frontal lobe (motor cortex): associated with speech. muscle movement, planning, and personality.

Parietal lobe (sensory cortex): associated primarily with sensations.

Temporal lobe (auditory cortex): primarily associated with hearing.

Occipital Lobe (visual cortex): primarily vision.



Phineas Gage - Spike through the left frontal lobe of his head; he survived, but the damage changed his personality. Medical community learned that one could do brain surgery and the patient could survive the surgery. Also that personality is connected to the frontal lobe in meaningful ways.

Broca's Area - Located in the frontal lobe and is responsible for controlling the muscles involved in producing speech; damage to in might leave us unable to make the muscle movements needed for speech.

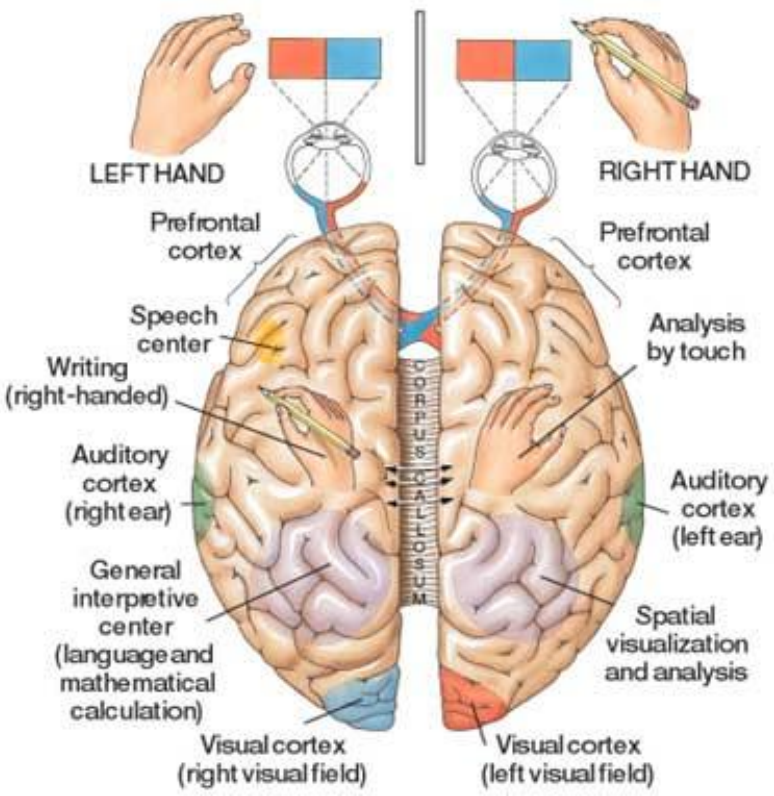
Wernicke's Area - Damage within the left temporal lobe. Controls the understanding and meaning of words. Responsible for interpreting both written and spoken speech; damage to it would affect our ability to understand language.

Neuroplasticity- Refers to changes in neural pathways and synapses which are due to changes in behavior, environment and neural processes, as well as changes resulting from bodily injury. Neuroplasticity has replaced the formerly-held position that the brain is a physiologically static organ, and explores how - and in which ways - the brain changes throughout life.

Hemispheres of the brain:

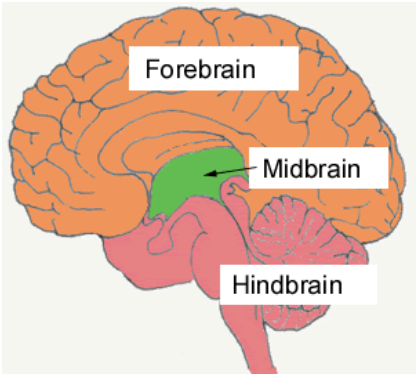
Left and right - each hemisphere controls the opposite side of the body

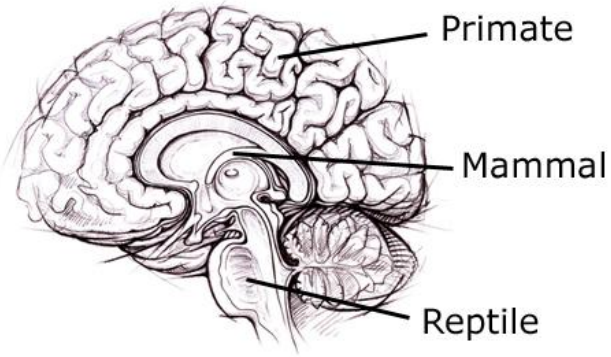
Left Brain: logic, problem solving, math, language
Right Brain: emotions, art, music, creativity



Right Brain/Left Brain: Cerebral Laterality
Studies of split-brained patients and perceptual asymmetries have revealed that the right and left halves of the brain each have unique talents. *Severe Epilepsy can be controlled by cutting the corpus callosum- SPLIT BRAIN patients.
Split-brain patients - Patients whose corpus callosum has been cut to treat severe epilepsy; cannot orally report information only presented to the right hemisphere since the spoken language centers of the brain are usually located in the left hemisphere.
Possible side effects of split brain surgery:
- **Antagonistic Hands**- are at odds over what to do
- **Alien Hand Syndrome**- hands have "mind of their own"
- **Left Brain Rationalization**- when an action is taken that was product of the right brain. The left brain will make up a reason why it happened

Cerebrum is divided into right and left hemispheres connected by the corpus callosum.
<u>3 Major regions</u>: hindbrain, **midbrain**, and **forebrain**. Hindbrain develops first and both hindbrain and midbrain handle essential functions.

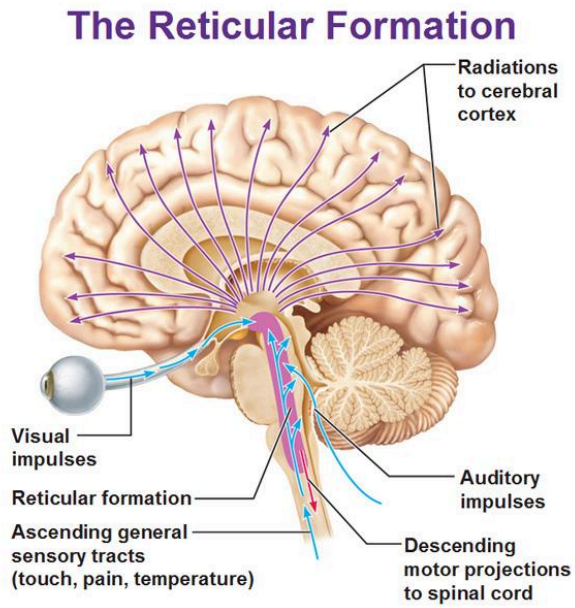




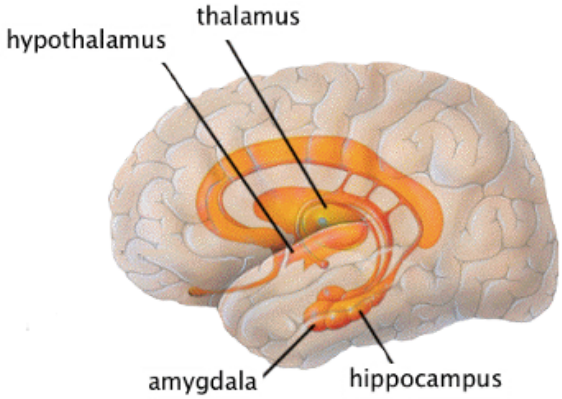
1. Hindbrain - Consists of structures in the top of the spinal cord; the life support system; controls the basic biological functions that keep us alive; consists of the medulla, pons, and cerebellum.
Medulla - Involved in the control of our blood pressure, heart rate, and breathing; located above the spinal cord; part of the hindbrain.
Pons - Connects the hindbrain with the midbrain and the forebrain; also involved in the control of facial expressions; located just above the medulla and toward the front; part of the hindbrain.
Cerebellum - Coordinates some habitual muscle movements; located on the bottom rear of the brain; part of the hindbrain.



2. Midbrain - Consists of structures just above the spinal cord but still below areas categorized as the forebrain; in general, coordinates simple movements with sensory information; most important part is the reticular formation.



3. Reticular formation - A netlike collection of cells throughout the midbrain that controls general body arousal and the ability to focus our attention; if this does not function, we fall into a deep coma; part of the midbrain. The alertness control center of the brain that regulates the activity level of the body



3. Forebrain - Control what we think of as thought and reason; consists of the thalamus, hypothalamus, amygdala, and hippocampus.

Limbic system (Emotion, Motivation, & Memory) - Consists of the thalamus, hypothalamus, hippocampus, and amygdala; deals with aspects of emotion and memory.

Thalamus - (Relay Station) Responsible for receiving the sensory signals coming up the spinal cord and sending them to the appropriate areas in the rest of the forebrain; located on top of the brain stem; part of the forebrain.

Hypothalamus - (Hunger/Sex/Drive) Controls several metabolic functions including body temperature, sexual arousal (libido), hunger, thirst, and the endocrine system; located right next to the thalamus; part of the forebrain.

Amygdala - Vital to our experiences of emotion; located near the end of each hippocampal arm; part of the forebrain.

Hippocampus - Vital to our memory system - memories are processed through this area and then sent to other locations in the cerebral cortex for permanent storage; consists of two arms surrounding the thalamus; part of the forebrain.

Lobe - major division of the brain

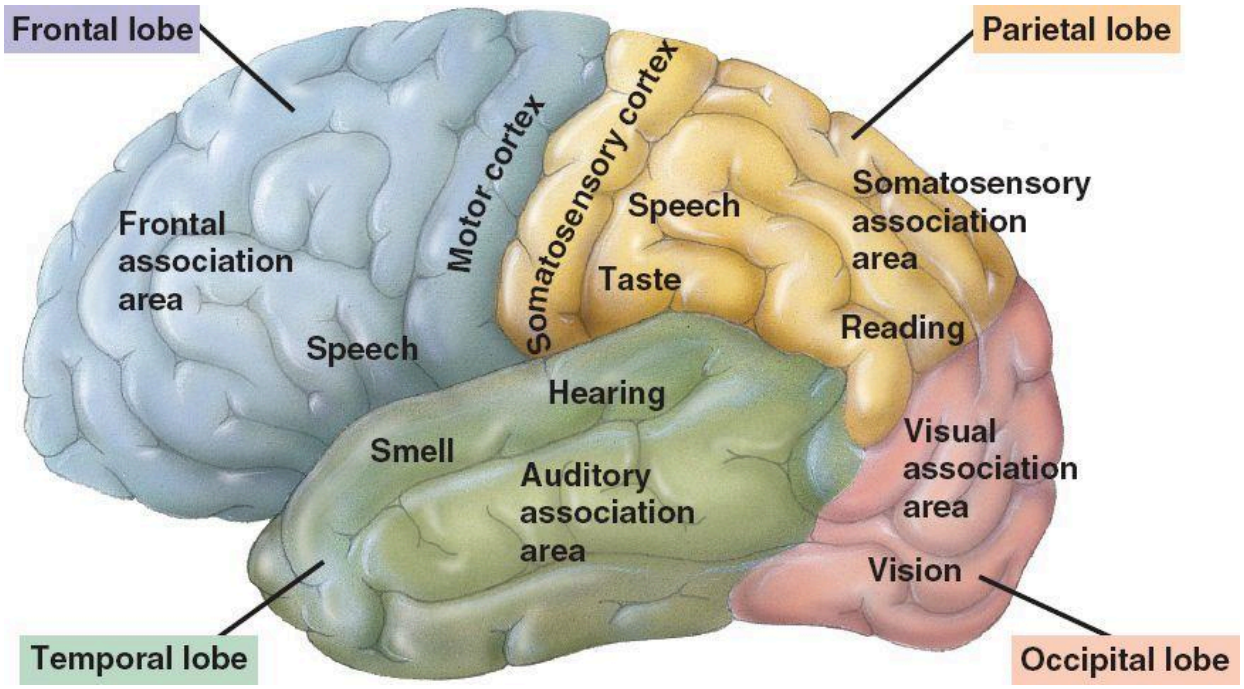
Hemispheres - one-half of the two halves of the brain; controls the opposite side of the body

Hemispheric specialization - The specialization of function in each hemisphere of the brain.

Contralateral control - Ability of the right hemisphere to control the left side of the body and vice versa.

Corpus callosum - bundle of nerve fibers that transfers info. From one hemisphere to the other

Fissure - a lengthy depression marking off an area of the brain



Cerebral cortex - The collection of the frontal, parietal, temporal, and occipital lobes. The gray wrinkled surface of the brain which is actually a thin (1 mm) layer of densely packed neurons; covers the rest of the brain. **Cortex** is **cerebrum's** convoluted outer layer, which is subdivided into **occipital**, **parietal**, **temporal**, and **frontal lobes**. Covers the lower brain and controls mental processes such as thought

- **Frontal lobes -** Large areas of the cerebral cortex located at the top front part of the brain behind the eyes. Contains the motor strip and frontal association area.
- **Frontal association area** – plays an important part in integrating personality and in forming complex thoughts
- **Prefrontal cortex -** The anterior or front of the frontal lobe that is thought to play a critical role in directing thought processes; said to act as the brain's central executive and is believed to be important in foreseeing consequences, pursuing goals, and maintaining emotional control; researchers believe this part of the brain is responsible for abstract thought and emotional control.
- **Motor cortex (or strip) -** Thin vertical strip at the back of the frontal lobe; sends signals to our muscles, controlling our voluntary movements.
- **Parietal lobes** – Area that contains the sensory strip. Located behind the frontal lobe but still on the top of the brain.
- **Sensory Cortex (or strip) -** Thin vertical strip that receives incoming touch sensations from the rest of our body; located behind the motor cortex in the parietal lobe. Sensory strip - band running down the side of the parietal lobe that registers and provides all sensation.
- **Occipital lobes** - area that interprets visual information. Located at the very back of the brain, farthest from the eyes; interpret messages from our eyes in our visual cortex.
- **Temporal lobes** - area responsible for hearing and some speech functions. Process sound sensed by our ears.

Heredity and Behavior: *Is it all in the genes?*

Genes are the basic units of genetic transmission housed in **chromosomes**. Most behavior qualities appear to involve **polygenic inheritance**.

Researches access inheritance through **family studies**, **twin studies**, **adoption studies**, and **genetic mapping**.

The Evolutionary Bases of Behavior

Darwin argued that if a heritable trait contributes to an organism's survival or reproductive success, organisms with that trait should produce more offspring than those without the trait & prevalence of that trait should gradually increase over generations due to **natural selection**.

Turner's syndrome - People born with only a single X chromosome in the spot usually occupied by the twenty-third pair; causes some physical characteristics, lie shortness, webbed necks, and differences in physical sexual development.

Klinefelter's syndrome - People born with an extra X chromosome, resulting in an XXY patter; causes minimal sexual development and personality traits.

Down syndrome - People born with an extra chromosome on the twenty-first pair; causes some physical characteristics like a rounded face, shorter fingers and toes, slanted eyes set far apart, and some degree of mental retardation.

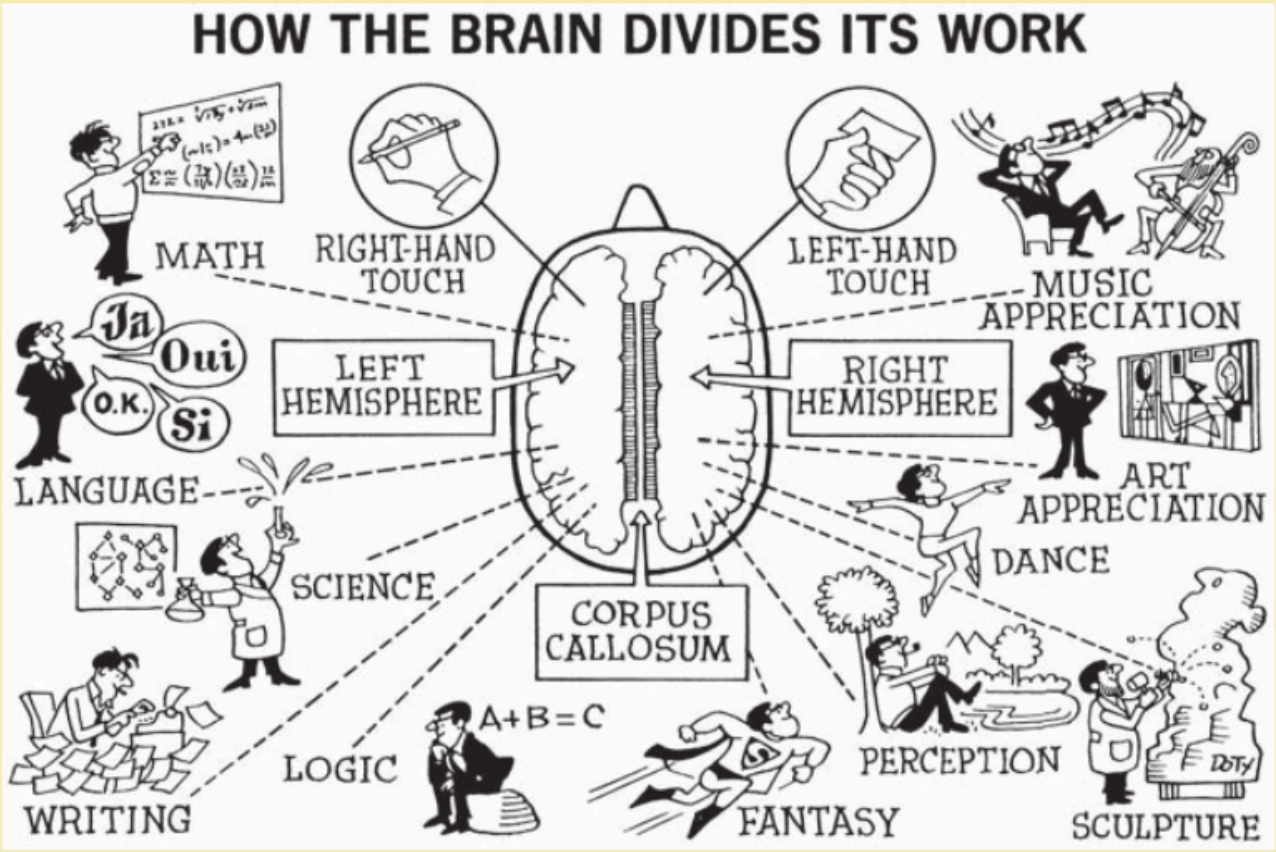


Figure 3.31

Popular conceptions of hemispheric specialization. As this *Newsweek* diagram illustrates, depictions of hemispheric specialization in the popular press have often been oversimplified.

Questions to consider:

1. Blindness could result from damage to which cortex and lobe of the brain?

A. visual cortex in the frontal lobe - B. visual cortex in the temporal lobe - C. sensory cortex in the parietal lobe

D. visual cortex in the occipital lobe - E. cerebral cortex in the occipital lobe

2. Paralysis of the left arm might be explained by a problem in the

A. motor cortex in the frontal lobe in the left hemisphere. - B. Motor cortex in the frontal lobe in the right hemisphere. - C. Sensorimotor cortex in the temporal lobe in the left hemisphere. - D. Motor cortex in the parietal lobe in the left hemisphere. - E. Motor cortex in the occipital lobe in the right hemisphere.

3. Deafness can result from damage to the inner ear or damage to what area of the brain?

A. Connections between the auditory nerve and the auditory cortex in the frontal lobe. - B. Connections between the auditory nerve and the auditory cortex in the temporal lobe. - C. Connections between the areas of the sensory cortex that receive messages from the ears and the auditory cortex. - D. Connections between the hypothalamus and the auditory cortex in the temporal lobe. - E. Connections between the left and right sensory areas of the cerebellum.

4. According to the theory of evolution, why might we call some parts of the brain the old brain and some parts of the new brain?
A. Old brain parts are what exist in very young children, and the new brain develops later
B. The old brain developed first according to evolution. - C. The old brain becomes more active as we grow older.
D. The new brain deals with new information, while the old brain deals with information gathered when we were children.
E. The old brain is most affected by age deterioration (dementias) while the new brain remains unaffected.

5. Which chemicals pass across the synaptic gap and increase the possibility the next neuron in the chain will fire?
A. synaptic peptides - B. inhibitory neurotransmitters - C. adrenaline-type exciters -
D. excitatory neurotransmitters - E. potassium and sodium

6. You eat some bad sushi and feel that you are slowly losing control over your muscles. The bacteria you ingested from the bad sushi most likely interferes with the use of
A. Serotonin - B. Dopamine - C. acetylcholine - D. thorazine - E. adrenaline

7. The three major categories researchers use to organize the entire brain are the
A. old brain, new brain, cerebral cortex - B. lower, middle, upper brain. C. Hindbrain, midbrain, forebrain -
D. Brain stem, limbic system, cerebral cortex E. Neurons, synapses, cerebral cortex.

8. A spinal reflex differs from a normal sensory and motor reaction in that
A. a spinal reflex occurs only in response to extremely stressful stimuli.
B. In a spinal reflex, the spine moves the muscles in response as soon as the sensory information reaches the spine while usually the impulse must reach the brain before a response.
C. In a normal sensory/motor reaction, the spine transmits the information through afferent nerve fibers, while reflex reactions are transmitted along special efferent nerves.
D. Spinal reflexes are part of the central nervous system response, while normal sensory/motor reactions are part of the peripheral nervous system.
E. Spinal reflexes occur only in animals because humans are born without instinctual responses.

9. Antidepressant drugs like Prozac are often used to treat mood disorders. According to what you know about their function, which neurotransmitter system do these types of drugs try to affect?
A. serotonin - B. adrenaline - C. acetylcholine - D. endorphins - E. morphine

10. Which sentence most closely describes neural transmission?
A. An electric charge is created in the neuron, the charge travels down the cell, and chemicals are released that cross the synapse to the next cell.
B. A chemical change occurs within the cell, the change causes an electric charge to be produced, and the charge jumps the gap between the nerve cells.
C. Electric charge produced chemically inside a group of neurons causes chemical changes in surrounding cells.
D. Neurotransmitters produced in the hindbrain are transmitted to the forebrain, causing electric changes in the cerebral cortex.

E. Neural transmission is an electrochemical process both inside and outside the cell.

11. Dr. Dahab, a brain researcher, is investigating the connection between certain environmental stimuli and brain processes. Which types of brain scans is he most likely to use?
A. MRI and CAT - B. CAT and EKG - C. PET and EEG - D. EKG and CAT - E. Lesioning and MRI

12. Split-brain patients are unable to
A. coordinate movements between their major and minor muscle groups.
B. Speak about information received exclusively in their right hemisphere.
C. Speak about information received exclusively in their left hemisphere.
D. Solve problems involving integrating logical (left-hemisphere) & spatial (right hemisphere) information
E. Speak about information received exclusively through their left ear, left eye, or left side of their bodies.

13. When brain researchers refer to brain plasticity, they are talking about
A. the brain's ability to regrow damaged neurons. - B. The surface texture and appearance caused by the layer known as the cerebral cortex. - C. The brain's versatility caused by the millions of different neural connections.
D. Our adaptability to different problems ranging from survival needs to abstract reasoning.
E. New connections forming in the brain to take over for damaged sections.

14. Veronica is having trouble balancing as she walks, and her muscles see, to have lost strength and tone. A neuroanatomist looking into her condition would most likely suspect a problem with the?
A. medulla oblongata - B. right cerebral hemisphere - C. cerebellum - D. occipital lobes - E. thalamus

15. In most people, which one of the following is a specific function of the left hemisphere that is typically not controlled by the right hemisphere?
A. producing speech - B. control the left hand - C. spatial reasoning - D. hypothesis testing - E. abstract reasoning

16. Damage to the Broca's area in the left cerebral hemisphere on the brain would likely result in which of the following?
A. A repetition of the speech of others - B. A loss of ability to speak - C. A loss of the ability to comprehend speech - D. A loss of in the ability to comprehend speech - E. An inability to solve verbal problems

17. The part of the neuron that receives information from neighboring cells is called the
A. membrane - B. axons - C. vesicle - D. nucleus - E. dendrites

18. Underproduction of _____ has been associated with Alzheimer's disease, whereas underproduction of _____ has been associated with Parkinson's disease.
A. Dopamine; acetylcholine -- B. Serotonin; GABA -- C. Acetylcholine; dopamine D. Norepinephrine; dopamine
---
E. Acetylcholine; serotonin

19. The deterioration of myelin, causing leakage of electrical activity within the axon, has been associated with which neurological disorder?
A. Parkinson's --B. Alzheimer's -- C. Muscular dystrophy --D. Multiple sclerosis -- E. Huntington's disease

20. Brain plasticity refers to the
A. Feel of healthy human brain tissue
B. Ability of the brain to transfer information from one hemisphere to the other

C. Way a brain gets larger as a child grows
D. Wide variety of functions performed by the human brain --E. Ability of brain tissue to take on new functions

