Biopsychology

Nervous System & Brain
Endocrine System
Nervous System

• Divisions of the Nervous System
• Types of Nerves
• Reflexes
Divisions of the Nervous System

- **Central NS**: coordinates activity of all parts of the body
  - Brain and Spinal Cord

- **Peripheral NS**: carries sensory and motor info to and away from the CNS
  - **Somatic**: stimulate skeletal muscle (voluntary)
  - **Autonomic**: stimulate smooth and heart muscles (involuntary)
    - **Sympathetic**: pumps you up; “flight or flight”
    - **Parasympathetic**: calms you down; “rest & digest”
Types of Nerves

- **Afferent Neurons/Sensory Nerves**
  - Take info from the sensory receptors to CNS

- **Efferent Neurons/Motor Nerves**
  - Take info from CNS to muscles and glands

- **Interneurons/Association Neurons**
  - Neurons within the CNS
  - Middlemen between Afferent & Efferent

- **Remember “SAME”**
Types of Nerves

- **Neurons vs. Glial Cells**
  - Neurons send electrochemical messages
  - Glial cells support and nourish neurons
Reflexes

- Normal nervous system transmissions
  - Afferent → Spinal Cord → Brain → Spinal Cord → Efferent

- Reflexes
  - Afferent → Interneurons in Spinal Cord → Efferent
  - Brain gets message after spinal cord acts
The Neuron

• Structure of the Neuron
• Neurotransmitters
• Synaptic Transmission
Structure of the Neuron

- Dendrites
- Cell body
- Nucleus
- Axon hillock
- Axon
- Signal direction
- Synapse
- Myelin sheath
- Synaptic terminals
- Presynaptic cell
- Postsynaptic cell
Structure of the Neuron

- **Dendrites**
  - Contain receptor sites which receive neurotransmitters from the presynaptic neuron
Structure of the Neuron

• **Soma**
  – aka cell body; contains cytoplasm; nucleus
Structure of the Neuron

- **Nucleus**
  - directs production of neurotransmitters; contains DNA
Structure of the Neuron

- **Axon**
  - what the neuron impulse travels down once threshold has been reached
Structure of the Neuron

- **Myelin Sheath**
  - fatty tissue which insulates the axon; speeds up the neural impulse; made by glial cells
Structure of the Neuron

• **Nodes of Ranvier**
  – the spaces on the axon which are not covered by myelin; where ion flow occurs for depolarization
Structure of the Neuron

- **Axon Terminal/Terminal Button**
  - contains neurotransmitters which are released after depolarization and neural impulse
Structure of the Neuron

- **Vesicles**
  - contained within the axon terminals, these contain neurotransmitters, they surface and release neurotransmitters after depolarization
Structure of the Neuron

- **Neurotransmitters**
  - contained in the vesicles, and are released into the synapse to stimulate their respective receptor sites on the postsynaptic neuron
Structure of the Neuron

• **Synapse**
  – fluid-filled gap between terminal buttons of the presynaptic neuron and the dendrites of the postsynaptic neuron
Neurotransmitters

• **Excitatory vs. Inhibitory**
  - **Excitatory**: makes receiving neuron MORE likely to meet threshold and have an action potential
  - **Inhibitory**: makes receiving neuron LESS likely to meet threshold and have an action potential
Neurotransmitters

• **Serotonin**
  – Sleep and dreaming
  – Mood
  – Appetite
  – Sexual behavior
  – Related to Depression (too little)
Neurotransmitters

- Acetylcholine (ACh)
  - Learning
  - Memory
  - Voluntary motor activity
  - Related to Alzheimer’s Disease (too little)
Neurotransmitters

• **Dopamine**
  – Involuntary motor activity
  – Reward pathway
  – Motivation
  – Cognition
  – Related to Schizophrenia (too much) and Parkinson’s Disease (too little)
Neurotransmitters

• Gamma-Aminobutyric Acid (GABA)
  – The primary inhibitory neurotransmitter in the body
  – Related to anxiety and mood disorders (too little)
Neurotransmitters

- **Endorphins**
  - Body’s natural painkiller
  - Pleasure
  - Lowered levels result from opiate use
Neurotransmitters

• **Glutamate**
  – The primary excitatory neurotransmitter in the body
  – Learning
  – Memory
Neurotransmitters

• **Noradrenaline**
  – Aka: Norepinephrine
  – Stress Response
  – Blood pressure
  – Heart rate
  – Also a hormone
Synaptic Transmission

- **Resting Potential**
  - possible for the neuron to fire; axon has negative charge inside and outside is more positive; $K^+$ are on the inside of the axon, $Na^+$ is on the outside
Synaptic Transmission

• **Action Potential**
  – change in potential across the neuron’s membrane; the electrical impulse; depolarization of ions down the axon
Synaptic Transmission

• **Threshold**
  
  – minimum stimulation required to trigger a neural impulse
Synaptic Transmission

- **Depolarization**
  - $\text{Na}^+$ ions rush into the cell, changing the polarity on each side of the membrane, occurs on Nodes of Ranvier
Synaptic Transmission

• Repolarization
  – after Na\(^+\) ions have rushed into the cell, K\(^+\) ions rush out of the cell to restore the balance and the original polarity
Synaptic Transmission

• **Refractory Period**
  – period in which the cell cannot fire while the Na\(^+\) ions and the K\(^+\) ions return to their original locations via Na\(^+\)/K\(^+\) pumps
Synaptic Transmission

- **Hyperpolarization**
  - when axon is repolarizing, more $K^+$ ions leave the cell, causing the cell to become MORE negative than before it started
Synaptic Transmission

• All-or-None Principle
  – a neuron will fire with its full intensity or not at all
Synaptic Transmission

• Electrochemical Reaction
  – Electrical *within* the neuron (impulse)
  – Chemical *between* the neurons (neurotransmitters)
The Brain

• Examining the Brain
• Structures of the Brain
• Hemispheric Specialization
Studying the Brain

• Accidents & Case Studies
  – When people acquire some sort of brain damage, psychologists learn about the functions of the brain
  – Famous Example: Phineas Gage
    • Tamping rod flew through his frontal lobe
    • Frontal lobe research was furthered because of this new information
Studying the Brain

• **Lesions**
  – Destruction of brain tissue lets us know the function of that part of the brain
  – Accidental or purposeful
Studying the Brain

• **Electroencephalography (EEG)**
  – creates image of brain wave activity by eliciting evoked potentials
  – Function only
Studying the Brain

- **Positron Emission Tomography (PET)**
  - creates image which looks at glucose usage in the brain after injection of radioactive form of glucose
  - Function only
Studying the Brain

• **Computerized Axial Tomography (CAT/ CT)**
  – provides image of brain structure including soft tissue and bones; specialized type of x-ray
  – Structure only
Examining the Brain

• Magnetic Resonance Imaging (MRI)
  – uses magnetic fields in order to examine structure of brain tissues
  – Structure only
Examining the Brain

- **Functional Magnetic Resonance Imaging (fMRI)**
  - brain imaging technique which provides information about both structure and function
Examining the Brain

- **Transcranial Magnetic Stimulation (TMS)**
  - Stimulation of areas of the brain using magnetic field to influence activity of neurons (to depolarize or hyperpolarize)
Structures of the Brain

• **Hindbrain**
  – Brainstem
    • Medulla
      – in charge of respiration, blood pressure, heart rate
  • Pons
    – helps relay sensory info., has a role in controlling arousal and dreaming
• **Reticular Formation**
  – controls awareness and arousal
Structures of the Brain

- Hindbrain
  - Cerebellum
    - coordinates motor control and maintains balance and posture
Structures of the Brain

- **Forebrain**
  - Thalamus
    - sensory switchboard of the brain for all senses except olfaction
Structures of the Brain

- **Forebrain**
  - Limbic System
    - Hippocampus
      - converts info from STM to LTM
    - Hypothalamus
      - homeostasis, regulates hunger and thirst, and sexual behavior, controls pituitary gland
  - Amygdala
    - role in emotions, especially anger and fear
Structures of the Brain

• Forebrain
  – Cerebral Cortex - Association Areas
    • Frontal Lobe
      – personality, problem-solving, initiation, judgment, impulse & emotion control, speech (L)
    • Temporal Lobe
      – auditory perception, memory, facial recognition (R), language comprehension (L)
    • Parietal Lobe
      – spatial processing (R), math (L), sensory organization
    • Occipital Lobe
      – visual perception
Structures of the Brain

- Forebrain
  - Cerebral Cortex - Association Areas

exterior of the cerebrum from the left side
Structures of the Brain

• Forebrain
  – Cerebral Cortex - Sensorimotor Areas
    • Motor Cortex
      – controls voluntary movement (frontal)
    • Somatosensory Cortex
      – skin sense, tactile sensation (parietal)
    • Visual Cortex
      – visual processing (occipital)
    • Auditory Cortex
      – Auditory processing (temporal)
Structures of the Brain

- Forebrain
  - Cerebral Cortex - Sensorimotor Areas
Structures of the Brain

Motor cortex
Somatic sensory cortex

Motor cortex (precentral gyrus)

Somatic sensory cortex (postcentral gyrus)
Structures of the Brain

• Forebrain
  – Cerebral Cortex – Language Areas
    • Broca’s Area
      – part of the frontal lobe on left side; controls the ability to form words
    • Wernicke’s Area
      – part of the temporal lobe on left side; controls the ability to comprehend language
    • Angular Gyrus
      – related to reading, turns visual symbols to auditory code
  – Aphasia
    • damage to area responsible for language
Structures of the Brain

- Forebrain
  - Cerebral Cortex
  - Language Areas

Speech Areas:
- motor cortex
- Wernicke's area
- angular gyrus
- visual cortex
- Broca's area
- auditory cortex
Structures of the Brain

• Gyri vs. Sulci
  – Gyrus
    • peak in cerebral cortex
  – Sulcus
    • valley of cerebral cortex
  – Wrinkles provide more surface area for cerebral cortex
Structures of the Brain

• White vs. Grey Matter
  – White Matter
    • neural tissue containing mostly myelinated axons
    • relays info. to cerebral cortex
  – Grey Matter
    • closely packed neuron cell bodies on the surface of the brain
The Brain

• **Corpus Callosum**
  – White matter structure which connects left and right hemispheres
  – Allows communication between hemispheres
Hemispheric Specialization

- **Longitudinal Fissure**
  - separates left and right hemispheres

- **Contralaterality**
  - one side of brain controls the other side of the brain
Hemispheric Specialization

• **Left vs. Right Brain**
  
  – **Left**
    
    • analytical, speech (frontal), language comprehension (temporal), sequential, logical, interprets what is in right visual field (occipital), controls right side of body
  
  – **Right**
    
    • intuitive, holistic, language emphasis, facial recognition (temporal), spatial interpretation (Parietal), creativity, art, music appreciation, interprets what is in left visual field (occipital), controls left side of body
Hemispheric Specialization

- Split Brain Research
  - Michael Gazzaniga & Roger Sperry’s Research
The Brain

- **Brain Plasticity**
  - Ability for brain to make up for damage by having neurons of brain take on functions of damaged areas
  - Age-dependent (doesn’t occur as well in older brains)
Endocrine System

- Glands
- Hormones
Glands

• Pineal Gland
  – Produces melatonin (according to lightness or darkness of environment)
  – Helps modulate sleep/wake cycle
Glands

• **Pituitary Gland**
  – Produces Human Growth Hormone (HGH)
  – Regulates homeostasis
  – Regulates sexual development & functioning
  – Contributes to physical growth
  – Regulates water in the body
Glands

• **Thyroid Gland**
  – Produces Thyroxine
  – Controls metabolism
Glands

• Parathyroid Glands
  – Regulate calcium levels in the body
    (remember, calcium is necessary for neurons
to fire)
Glands

- **Adrenal Glands**
  - Produce noradrenaline, adrenaline and cortisol
  - Regulate responses to stress and “fight or flight”
Glands

- **Pancreas**
  - Produces insulin and glucagon
  - Regulates blood glucose level
  - Aids in digestion
Glands

• Ovaries
  – Produce estrogen and progesterone
  – Produce ova (eggs) for reproduction
  – In charge of the production of secondary sex characteristics (i.e. breasts, hips)
  – The female counterpart of the testes (male gonads)
Glands

• Testes
  – Produce testosterone
  – Produce sperm for reproduction
  – In charge of the production of secondary sex characteristics (i.e. facial hair, deep voice)
  – The male counterpart of the ovaries (female gonads)
Glands

• **Hypothalamus**
  – Controls pituitary gland
  – Secretes hormones related to hunger
  – Link between the endocrine & nervous systems
Hormones

• Melatonin
  – Produced by the pineal gland
  – Helps control sleep/wake cycle
  – Production is inhibited by light and facilitated by dark
Hormones

• **Human Growth Hormone (HGH)**
  – Produced by the pituitary gland
  – Stimulates growth and cell reproduction
Hormones

• Adrenaline
  – Aka epinephrine
  – Produced by the adrenal glands
  – Plays role in stress reactions & “fight or flight”
  – Pumps body up (Sympathetic NS activity)
Hormones

- **Noradrenaline**
  - Aka norepinephrine
  - Produced by the adrenal glands
  - Plays role in stress reactions & “fight or flight”
  - Pumps body up (Sympathetic NS activity)
  - Also a neurotransmitter
Hormones

• **Cortisol**
  – Produced by the adrenals
  – Released in stressful situations
  – Involved in “fight or flight” response
Hormones

• **Insulin**
  – Produced in the pancreas
  – Regulates glucose metabolism and blood glucose levels
  – Released when blood glucose is elevated, decreases glucose level
Hormones

• Glucagon
  – Produced in the pancreas
  – Released when blood glucose is low, increases glucose level
Hormones

• **Estrogen**
  – Produced by ovaries
  – Primary female sex hormone
  – Aids in sexual development and functioning
Hormones

• **Progesterone**
  – Produced by ovaries
  – Involved with menstrual cycle and pregnancy
Hormones

- **Testosterone**
  - Produced by the testes
  - Primary male sex hormone
  - Aids in sexual development and functioning
  - Linked to aggression
Hormones

- **Thyroxine**
  - Produced in thyroid
  - Controls rate of bodily metabolic processes