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Neural Communication

Biological Psychology

- Discipline of psychology concerned with physical ways neurons cooperate to compose mental processes
- Names:
  - Behavioral Neuroscientists
  - Neuropsychologists
  - Behavior Geneticists
  - Physiological Psychologists
  - Biopsychologists

Phrenology

- The study of the shape of skull and the making of inferences based off of that shape
  - Bumps on head indicate abilities or traits
- Developed by Franz Gall

The Neuron

- Anatomy
  - Soma = body of the cell
    - Receives action potentials from dendrites
  - Dendrites = branching bodies that connect to other dendrites or axon terminals
    - Receive action potentials via **neurotransmitters**
  - Axon = long, thin barrel with myelin sheath that uses electrotonic potential to relay signals from soma to axon terminals
    - Covered with myelin sheath to split transmission into brief, fast electrotonic potentials and connecting action potentials to keep voltage high
  - Myelin sheath = waxy layer composed of **Schwann Cells**
    - Serves to insulate stretches of the axon so that electrotonic potential can happen, speeding up transmisison

  - *Nodes of Ranvier* = gaps inbetween the myelin sheathing that allows an action potential to happen, keeping the voltage within the cell high enough to ensure the signal isn't lost
  - Synapse
    * The area where two neurons come near to each other
    * Cite of neurotransmitter release and intake

Action Potential

- Begin at resting potential(-70mV inside neuron)
- Stimulus opens Na+ channels and tons of sodium ions flow in
  - **Polarization**
- After a threshold is reached, K+ gates open, letting K+ out. Voltage drops as a result
  - **Depolorization**
- After a while, Sodium-Potassium pumps begin to create the gradient
  - **Repolarization**

Drugs that Target Neurotransmitters

- Action potential at dendrite is stimulated by neurotransmitter, typically
- Drugs can fit in those receptors
- **Antagonist**
  - The drug fits, but poorly; as a result, the *real* neurotransmitter can't fit
  - **Inhibits** the targetted neurotransmitter
- **Agonist**
  - The drug fits *really* well and simulates the neurotransmitter
  - **Excites** the neurotransmitter or increases activity

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Neurotransmitters

- Dopamine
  - Used in movement, attention, and learning

  - Schizophrenia thought to be related to dopamine imbalance
    - Thought to be a surplus of dopamine
  - Parkinson's disease thought to be related to loss of dopamine-releasing neurons
    - Symptoms:
      - Movements are difficult to control
      - Shaking while at rest
      - Stooping posture or rigidity
      - Unbalance
    - Treatments
      - L-dopa = agonist that immitates dopamine
      - Fetal tissue transplants
      - Adrenal gland transplants
      - Electrical stimulation of thalamus = stops shaking
  - Part of "reward system" or limbic system
- Serotonin
  - Regulates sleeping patterns
  - Thought to be related to depression
    - Especially low-serotonin
    - High-serotonin is thought to cause mania
    - *Prozac* excites serotonin
      - **SSRI** = Selective Serotonin Reuptake Inhibitor
      - Examples: Welbutrin, Zoloft, Celexa
- Acetylcholine
  - First neurotransmitter we discovered
  - Abbreviated "ACh"
  - Used in motor neurons–stimulates muscles to contract
  - Used in learning, memory, and muscle contraction
  - Nicotine is an agonist for Norepinephrine and ACh
  - Thought to be related to Alzheiumer's Disease
    - Decay of memory, reasoning, and lanugage
- Endorphins
  - Regulates pain/pleasure
  - Pain is a stimulus for release
  - Agonists
    - Morphine
    - Codeine
  - Explains "runners high"
- Norepinephrine

  - Excitatory neurotransmitter that causes "fight or flight" response
  - Also related to depression
  - Used in physical arousal, learning, and memory
- GABA
  - Inhibitory
  - Thought to be related to Huntington's disease = death of neurons in *stratium* that make use of GABA
    * Jerky movements
    * Cognitive deterioration
- Glutamate
  - Very prevelant
  - Excitatory neurotransmitter
  - Excess glutamate and lack of GABA is associated with epilepsy

Neurons can be Excitatory or Inhibitory

- Excitatory = stimulates post-synaptic neuron to carry an action potential
- Inhibitory = Causes post-synaptic neuron to be less likely to start an action potential
  - GABA

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Summary

- Stages
  - Relieved Dolby Rescued Harry = mneumonic for remembering stages of action potential
    * **R**elieved = **R**esting
    * **D**olby = **D**epolorization
    * **R**escued = **R**epolorization
    * **H**arry = **H**
- Ions
  - SIPO = mneumonic for remembering ions
    * **S**odium **I**n, **P**otassium **O**ut
- Agonists vs Antagonists

  - Agonists = mimic effect of neurotransmitter
    * Nicotine, Morphine
  - Antagonists = block or inhibit effect of neurotransmitter

The Nervous System

- Nerves = small strands of neurons that act as highways for action potentials
  - Serve to connect brain to peripheral sensory organs
- Nervous System = the organ system the body employs to communicate between organs
  - Composition
    * Nerve Cells
    * **Peripheral Nervous System(PNS)** = nerve framework that connects brain to peripheral sense organs
    * **Central Nervous System(CNS)** = the brain and spinal chord

Model of Nervous System

- Peripheral Nervous System
  - Autonomic Nervous System
    * Controls unconscious actions of organs
    * Sympathetic Nervous System = arousal
    * Parasympathetic Nervous System = calming effect
      · *Think of a parachute–slows you down*
  - Skeletal/Somatic Nervous System
    * Controls voluntary movement of skeletal muscle
- Central Nervous System
  - Brain
  - Spinal Chord

Types of Neurons

- Sensory Neurons
  - Serve as medium through which sensory information travels to brain
  - Sense Organs -> Brain
    * Uses **affarent neurons**
  - Brain -> Sense Organs
    * Uses **efferent neurons**

  - Mneumonic = SAME
    - **S**ensory **A**ffarent **M**otor **E**fferent
- Interneurons = linking neurons that connect other systems together
  - Only found in brain and spinal chord

Reflexes

- **Reflex** = a simple action undertaken via the **reflex arc**
- **Reflex Arc** = a pathway of nerves through which a reflex happens
  - Generally goes from sensory organ -> affarent neurons -> interneurons -> spinal chord -> interneurons -> efferent neurons -> motor neurons

Neural Networks

- Neural Networks = a web of inter-connected neurons that cooperate to process information
- Through experience and feedback, neural networks are modified

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Lesions

- Lesions = destruction of tissue cause either naturally or by purpose
- Walter Freeman = got Nobel Prize for procedure wherein he quickly caused damage to a part of the brain to cure depression or anxiety

Brain Scan

- Electroencephalogram(EEG)
  - Places 8 electrodes around the brain and records electric brain activity
- Computed Tomography Scan(CAT Scan)
  - X-ray photoraphs taken from different angles
  - A computer generates a composite image
- Positron Emission Tomography Scan(PET Scan)
  - A radioactive form of glucose is ingested and sensors detect where glucose goes

- Magnetic Resonance Imaging Scan(MRI Scan)
  - Large electromagnets and radio waves make water in the brain orient itself in line with the magnetic field
  - Can generate very high-detail images

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Brainstem

- Oldest part of the brain
- Where spinal chord meets brain
- Controls involuntary physical processes
- **Medulla**
  - Controls
    - Breathing
    - Heart rate
    - Digestion
    - Swallowing
    - Coughing
    - Vomiting
    - Sneezing
- **Pons**
  - Controls coordinated motion
- **Reticular Formation**
  - Also called **Reticular Activating System(RAS)**
  - Controls
    - Sleep
    - Arousal
    - Attention

Midbrain

- **Cerebellum**
  - Divided among the two hemispheres
  - Controls voluntary motions on a per-hemisphere basis
  - Lesions can result in
    - Jerky movements

        * Loss of balance

- **Thalmus**
    - Acts like a router for sense data
        * *Except* for smell
- **Hypothalmus**
    - Small control center
    - Controls
        * Sexual drive
        * Hunger
        * Thirst
        * Sleep
        * Regulating electrolyte concentration
        * Regulating body temperature
        * Circadian rythym
        * Hormone secretion
- **Amygdala**
    - Has a role in emotional processing
        * Especially recognizing facial expressions
    - Lesions can result in difficulty socializing
- **Hippocampus**
    - Primarily involved in forming new memories
        * **Anterograde amnesia** = inability to form new memories
    - Lesions associated with Alzheimer's Disease

Outer Brain

- **Cerebral Cortex**
    - Thin layer of tissue that covers each hemisphere
    - Processes information
    - **Glial Cells** = specialized neurons that provde support, nourishment, and protectiond for surrounding neurons
    - Composed of 4 **lobes**
        * **Frontal Lobes**
            · Contains **motor cortex** at rear
            · Speaking
            · Muscle movement
            · Planning/Judging
        * **Parietal Lobes**

        - Contains **sensory cortex** at front
        - Processes information from **Somatic Nervous System**
    - **Occipital Lobes**
        - Processes visual sense data
        - **Remember**: *Occ*ular
    - **Temporal Lobe**
        - Contains **auditory cortex**
        - Processes auditory sense data
- **Association Areas** = areas of the cerebral cortex not involved in motor or sensory functions

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The Cerebral Cortex Cont

- Aphasia = difficulty with language
    - Associated with damage to Broca's area or Wernicke's area
    - Broca's Area
    - Brain area on left frontal lobe–controls muscles associated with speech
    - Wernicke's Area
    - Brain area in left temporal lobe–processes and understands language
    - Mneumonic: *You broca, you no seaka*
- Neuroplasticity
    - the ability for neural networks to reform
    - Stronger the younger you are
- Corpus Callosum
    - a collection of many, many neural fibers
    - Serves to connect two brain hemispheres
    - Conveys messages between areas of both hemispheres
- Split Brain Procedure
    - Corpus Callosum is severed, seperating each hemisphere from one another