

2016-09-21

## 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 transmission

- *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
  - \* Site of neurotransmitter release and intake

### Action Potential

- Begin at resting potential(-70mV inside neuron)
- Stimulus opens Na<sup>+</sup> channels and tons of sodium ions flow in
  - **Polarization**
- After a threshold is reached, K<sup>+</sup> gates open, letting K<sup>+</sup> out. Voltage drops as a result
  - **Depolarization**
- 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 Alzheimer’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 *striatum* that make use of GABA
    - \* Jerky movements
    - \* Cognitive deterioration
- Glutamate
  - Very prevalent
  - 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 = mnemonic for remembering stages of action potential
    - \* **R**elieved = **R**esting
    - \* **D**olby = **D**epolarization
    - \* **R**escued = **R**epolarization
    - \* **H**arry = **H**
- Ions
  - SIPO = mnemonic 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**

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

## 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 -> afferent neurons -> interneurons -> spinal cord -> 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 photographs 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
- **Thalamus**
  - Acts like a router for sense data
    - \* *Except* for smell
- **Hypothalamus**
  - Small control center
  - Controls
    - \* Sexual drive
    - \* Hunger
    - \* Thirst
    - \* Sleep
    - \* Regulating electrolyte concentration
    - \* Regulating body temperature
    - \* Circadian rythm
    - \* 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:** *Oc*cular
  - \* **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