Neuropsychology

Neural Communication, Hormones, and the Brain
Outline

- Introduction to neuropsychology
- Studying the brain: methodology
- Brain communication: Nervous system
  - Emotions
Neuropsychology

• **Neuropsychology**: Branch of psychology that deals with the relationship between the nervous system (especially the brain) and mental processes (such as language, memory, and perception)
Why do we care about neuropsychology?

• The brain controls or regulates most behavior
  ▫ Depression: Serotonin
  ▫ Aggression: Testosterone, Estrogen, & Amygdala
  ▫ Memory: Acetylcholine & Hippocampus
  ▫ Balance: Cerebellum
  ▫ Insomnia: Reticular Formation
History of Neuropsychology

• **Phrenology**
• Early 1800’s - Franz Gall
• Theorized that bumps on the skull reflected mental abilities and character traits
W. Mattieu Williams, A Vindication of Phrenology. London, 1894
History of Neuropsychology

• **Phrenology**
  • Early 1800’s - Franz Gall
  • Theorized that bumps on the skull reflected mental abilities and character traits
  • Early attempt to identify how psychological characteristics relate to brain structure
Studying the Brain: Methodology
Methodology: Outline

- Case studies
- Lesion studies
- Electrical stimulation
- EEG
- MRI/fMRI
- (MEG, CT, PET)
Methods of Studying the Brain

- Clinical observation or case study
  - Observe effects of surgery or brain damage on behavior
  - Form of descriptive research
- Example: Phineas Gage
Methods of Studying the Brain

• **Lesion studies**
  ▫ Invasive method
  ▫ Destruction of brain tissue in a specific area

• Ex. Lobotomy
Transorbital Dully Icepick Lobotomy performed for the first time.
Jan 17 1945

1945 to Now
Methods of Studying the Brain

• **Electrical stimulation:**
  ▫ Invasive method
  ▫ Insert electrodes into the brain to stimulate certain areas
Methods of Studying the Brain

• **EEG (Electroencephalography)**
  ▫ Non-invasive
  ▫ Records electrical activity via electrodes attached to the skull
  ▫ Measures brain **function**
Methods of Studying the Brain

• MEG (Magnetoencephalography)
  ▫ Uses sensors to detect magnetic indicators of brain activity
  ▫ Brain function
Methods of Studying the Brain

- **MRI (Magnetic Resonance Imaging)**
  - Uses a large magnet, radio frequencies, and a computer to produce detailed images
  - Reveals brain structure

- **fMRI (Functional MRI)**
  - Measures oxygen changes in blood flow (in the brain) as a response to specific tasks
  - Reveals brain function
fMRI mapped onto an MRI
Methods of Studying the Brain

• **CT (computed tomography)**
  ▫ X-rays of brain tissue to reveal brain structure

• **PET (positron emission tomography)**
  ▫ Measures radioactive
  ▫ glucose that has been injected into the brain
  ▫ Reveals brain function
Summary so far...

- **Introduction to neuropsychology**
  - What is neuropsychology?
  - History of neuropsychology (Phrenology)

- **Studying the brain: methodology**
  - Case studies (Phineas Gage)
  - Invasive methods: Lesion studies, electrical stimulation
  - Non-invasive methods: EEG, MEG, MRI, fMRI, CT, PET
Neurons
Outline

• The neuron
  ▫ Structures
  ▫ Neural communication
• Neurotransmitters
• Hormones
The Neuron

- **Neurons:** Information-carrying cells used for communication

- 100 billion
The Neuron

- **Soma** – cell body
- **Nucleus** – brain of cell
- **Dendrites** – sensors
- **Axon** – transmission
- **Bouton** – end of axon
- **Myelin Sheath** – insulation
- **Action Potential** – electric impulse within a neuron
The Neuron

- **Synapse**
  - Space between adjacent neurons

- **Neurotransmitter**
  - Chemicals that send messages across synapses
Communication between Neurons

• **Step 1:** Action potential releases Ca+
• **Step 2:** Ca+ causes exocytosis of neurotransmitter (NT)
• **Step 3:** NT diffuses across synapse to receptors
• **Step 4:** Feedback loop starts
• **Step 5:** Excitation or inhibition
Summary

• The neuron
  ▫ Structures
  ▫ Neural communication
• Neurotransmitters
• Hormones
1. Electrical impulses (action potentials) travel down a neuron's axon until reaching a tiny junction known as a synapse.

2. When an action potential reaches an axon terminal, it stimulates the release of neurotransmitter molecules. These molecules cross the synaptic gap and bind to receptor sites on the receiving neuron. This allows electrically charged atoms to enter the receiving neuron and excite or inhibit a new action potential.

3. The sending neuron normally reabsorbs excess neurotransmitter molecules, a process called reuptake.
Neurotransmitters
Outline: Neurotransmitters

• Definition
• Types of NTs
  ▫ Serotonin
  ▫ Dopamine
  ▫ Others
Neurotransmitters

- Chemical messengers released by neurons
- Affect behavior and emotions
Serotonin

- Mood regulation
  - Low levels = depression
  - SSRIs (Selective Serotonin Reuptake Inhibitors)

- Also hunger, sleep, and arousal

Serotonin Pathways
Dopamine

• Movement and emotion
  ▫ Low level = Parkinson’s Symptoms
  ▫ High level = Schizophrenia Symptoms

• Also, learning & attention
  ▫ Low level = ADHD

Dopamine Pathways
### SOME NEUROTRANSMITTERS AND THEIR FUNCTIONS

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<td>Glutamate</td>
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<td>Oversupply can overstimulate brain, producing migraines or seizures (which is why some people avoid MSG, monosodium glutamate, in food).</td>
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Endorphins

- Neurotransmitter chemically similar to opiates
- Released during times of stress
- Block pain by blocking "Substance P"
- Produces euphoria
  - "Runner’s High"
- Natural anti-depressant?
Hormones

Rumors persisted that Sage was using spiritual growth hormones.
Hormones

- Chemicals made by the endocrine glands and secreted in bloodstream
- Affect the brain and other tissues of the body
- Examples
  - Epinephrine
  - Estrogen/Androgen
Epinephrine

- Adrenaline
- Increases heart rate, blood pressure, blood sugar
- Feelings of excitement during emergency situations
Sex Hormones

- Sex hormones have two effects:
  - Direct physical development of female/male sex characteristics
  - Activate sexual behavior in animals

- **Estrogen**: secreted in greater amounts in females

- **Testosterone**: secreted in greater amounts in males
Testosterone and Aggression

• Aggression: Intention to do harm
  ▫ Physical or verbal
  ▫ Direct or indirect

• Gender differences
  ▫ Cross-cultural research
  ▫ Varies by situation
  ▫ Purpose varies
Testosterone and Aggression

Testosterone **does not cause aggression**

- Complex relationship
  - Higher levels of T after aggressive behaviors
  - Many hormones associated with increased stress (e.g., Cortisol)
  - Higher levels of E also correlated with aggression

- Women: Pro-social behavior, positive affect, and friendliness

- Generally: Strength, impulsiveness, and adventurousness
Nervous System

- **Nervous System**
  - All nerve cells in the body
  - Speedy, electrochemical communication system

- **Two parts:**
  - Central Nervous System
  - Peripheral Nervous System
Nervous System

Central Nervous System (CNS)

Brain and spinal cord

Peripheral Nervous System (PNS)

Sensory and motor neurons that connect the CNS to the rest of the body
The Nervous System

Nervous System (NS)

Central NS

Peripheral NS

Somatic NS (Voluntary)

Autonomic NS (Self-Regulation)

Sympathetic NS (Arousing)

Parasympathetic NS (Calming)

Brain

Spinal Cord
Peripheral Nervous System (PNS)

- **Somatic Nervous System**: The division of the PNS that controls voluntary movements of skeletal muscles.

- **Autonomic Nervous System**: Part of the PNS that controls the self-regulated action of internal organs and glands.
The Nervous System

Nervous System (NS)

Peripheral NS

Somatic NS
(Voluntary)

Autonomic NS
(Self-Regulation)

Sympathetic NS
(Arousing)

Parasympathetic NS
(Calming)

Central NS
(Brain & Spinal Cord)
Autonomic Nervous System (ANS)

- **Sympathetic Nervous System**: Division of the ANS that arouses the body, mobilizing its energy in stressful situations.

- **Parasympathetic Nervous System**: Division of the ANS that calms the body, conserving its energy.
Autonomic Nervous System (ANS)

- Sympathetic NS
  - “Arouses”
  - (fight-or-flight)

- Parasympathetic NS
  - “Calms”
  - (rest and digest)
Summary so far...

• Introduction to neuropsychology
• Studying the brain: methodology
• Brain communication: Nervous system
  ▫ Peripheral NS
    • Somatic NS
    • Autonomic NS
      • Sympathetic NS
      • Parasympathetic NS
  ▫ Central NS
• Brain organization: Structures