Introduction
- Significance of Emotions
  - Emotional experience; Emotional expression
  - Human brain imaging techniques
    - Renaissance in the study of emotion
  - Affective neuroscience
    - Neural basis of emotion and mood
  - Mood
    - Emotion extended in time

What Is Emotion?
- Theories of Emotion
  - The James-Lange Theory
    - Experience emotion
      - Response to physiological changes in the body
  - The Cannon-Bard Theory
    - Thalamus—Key role in emotional sensations

What Is Emotion?
- Unconscious Emotions
  - Sensory input: Emotional impact
  - Without conscious awareness of stimuli
  - Rules out theories of emotion
  - Many ways to process emotional information

The Limbic System Concept
- Broca’s Limbic Lobe
  - Group of cortical areas
    - Forms a ring around brain stem
The Limbic System Concept

- The Papez Circuit
  - Emotional system on the medial wall of the brain
  - Links cortex with hypothalamus

The Papez Circuit

- Hippocampus: Emotion
- Rabies infection:
  - Evidence of infection; Hyperemotional responses
- Role of anterior thalamus in emotion
- Lesions led to emotional disorder
- Limbic system: interconnected structures around the brain stem
- Together, thought to govern sensation and emotional expression

The Limbic System Concept

- Difficulties with the Single Emotion System Concept
  - Diverse emotions experienced
  - Structures involved in emotion
  - No one-to-one relationship between structure and function
  - Limbic system: Utility of single, discrete emotion system questionable

The Klüver-Bucy Syndrome

- Klüver and Bucy
  - Temporal lobectomy in rhesus monkeys
    - Decreased fear and aggression
    - Decreased vocalizations and facial expressions
  - Temporal lobectomy in humans
    - Exhibit symptoms of Klüver-Bucy syndrome
    - Flattened emotions

The Amygdala and Associated Brain Circuits

- Anatomy of the Amygdala

- The Amygdala and Fear
  - Bilateral amygdalectomy in animals—reduce fear and aggression
  - Range of effects of amygdalectomy lesions
    - Fear, anger, sadness, and disgust
    - S.M. case study
      - Inability to recognize fear in facial expressions
    - Electrical stimulation of amygdala
      - Increased vigilance or attention

The Amygdala and Associated Brain Circuits
The Amygdala and Associated Brain Circuits

The Amygdala and Fear (Cont’d)
- A Neural Circuit for Learned Fear
  - fMRI images and PET imaging: Confirm the role of amygdala in emotion

The Amygdala and Associated Brain Circuits

The Amygdala and Aggression
- Predatory Aggression—Attacks
  - Against different species for food
  - Few vocalizations; Attack head or neck
  - No activity in sympathetic division of ANS
- Affective aggression
  - Used for show, not kill for food
  - High levels of sympathetic activity
  - Makes vocalizations; Threatening posture

Neural Components of Aggression Beyond the Amygdala

The Hypothalamus and Aggression
- Removal of cerebral hemispheres
  - Sham rage
  - Behavior reversed by small lesions in hypothalamus
- Specific lesions, posterior hypothalamus in fear, aggression behaviors

Neural Components of Aggression Beyond the Amygdala

The Midbrain and Aggression
- Two pathways
  - Hypothalamus sends signals to brain stem
    - Medial forebrain bundle
    - Dorsal longitudinal fasciculus
Serotonin and Aggression

- Neurotransmitter Serotonin
  - Regulating aggression
  - Raphe nuclei of brain stem
- Experiments
  - Induced aggression in rodents
- Drug PCPA
  - Blocks serotonin synthesis

Serotonin and Aggression

- Serotonin Receptor Knockout Mice
  - 14 serotonin receptor subtypes
  - Knockout Mice (recombinant DNA techniques)
  - 5-HT₁₆ and 5-HT₁₈
  - High concentrations in raphe nuclei
  - 5-HT₁₆ and 5-HT₁₈ autoreceptors—global regulatory role
  - Agonists: Decrease anxiety, aggressiveness

Concluding Remarks

- Neural Pathways
  - Involved in the experience, expression of emotion
    - Involves widespread activity in the nervous system
- Emotional Reactions
  - Result of interactions between sensory stimuli
  - Brain circuitry; Past experiences; Neurotransmitter systems

End of Presentation