INFORMATION PROCESSING IN LEARNING AND MEMORY

Key Concepts

- **Learning**: The process of acquiring new information
- **Memory**: The persistence of learning in a state that can be revealed at a later time
- **Memory Stages**: Encoding (acquisition and consolidation), storage, and retrieval

Brain Structures and Memory

Medial Temporal Lobe

- **Hippocampus**: Critical for forming new long-term memories (not for storage)
- **Case Study - H.M.**: Had bilateral medial temporal lobe removal
  - Intelligence remained intact
  - Short-term memory preserved
  - Severe anterograde amnesia (inability to form new long-term memories)
  - Moderate retrograde amnesia (loss of memories 1-2 years before surgery)

Memory Consolidation

- **Consolidation**: Biological changes underlying long-term retention of information
- Hippocampus coordinates consolidation but effects take place in neocortex
- Once consolidation is complete, hippocampus no longer required

Other Brain Regions Involved in Memory

- **Diencephalon**: Damage to dorsomedial nucleus of thalamus and mammillary bodies causes amnesia
  - Example: **Alcoholic Korsakoff's Syndrome**
- **Anterior and Lateral Temporal Lobes**: Damage leads to severe retrograde amnesia
- **Prefrontal Cortex**: Involved in encoding and retrieval processes
  - **HERA Model** (Hemispheric Encoding-Retrieval Asymmetry):
    - Left hemisphere dominant for encoding
    - Right hemisphere dominant for retrieval

Animal Models of Memory

- Research with monkeys confirms importance of hippocampus in memory
- The parahippocampal and perirhinal cortices also crucial for memory function
- **Amygdala**: Not crucial for episodic memory but important for emotional memory

- Medial temporal lobe not essential for short-term/working memory

Brain Imaging and Memory

Episodic Memory

- Right hippocampus active during encoding but not recognition
- Left prefrontal cortex active during encoding
- Right prefrontal cortex active during retrieval

Semantic Memory

- Left prefrontal cortex (including Broca's area) active during semantic retrieval

Procedural Memory

- Motor cortex, supplementary motor area, and putamen (basal ganglia) active during implicit learning
- Right dorsolateral prefrontal cortex active during explicit learning

Perceptual Priming

- Decreased blood flow in bilateral occipital cortex during priming
- Hippocampus not activated during implicit perceptual priming

Cellular Basis of Learning and Memory

- **Hebb's Law**: "Neurons that fire together, wire together"
- **Long-Term Potentiation (LTP)**: Enhanced response of neural circuits after repeated stimulation
  - Requires **NMDA receptors** for induction but not maintenance
  - Blocking LTP impairs spatial learning and memory

Memory Systems

- **Sensory Registration**: Initial brief storage of sensory input
- **Working Memory**: Temporary storage and manipulation of information
- **Procedural Memory**: Skills and habits (implicit)
- **Semantic Memory**: General knowledge and facts
- **Episodic Memory**: Personal experiences with temporal-spatial context

Amnesia Types

- **Anterograde Amnesia**: Inability to form new memories after brain damage
- **Retrograde Amnesia**: Loss of memories formed before brain damage

- **Isolated Retrograde Amnesia**: Dense retrograde amnesia with preserved ability to form new memories