Learning

- **HM's Tests:**
    1. Digital span +1 test: *declarative* memory (explicit)
        - Short-term memory: retain phone number long enough for one use
            - HM could barely do this
        - Tests long-term memory: retain phone number for a whole day
            - HM could *not* do this
    2. Block Tapping Memory Span Test: *spatial* memory (explicit)
        - HM was required to remember a tapping sequence to see if his lesion affected non-declarative memory as well.
            - He could only remember the tapping sequence up to 5 blocks and could not remember how to get to his house
    3. Mirror drawing test: *long-term sensorimotor* skill (implicit)
        - Sensorimotor tasks could be recalled from day to day
            - He remembered how to preform the task, but could not remember actually taking the test.
    4. Incomplete pictures test: *visual perceptual skill* (implicit memory)
        - Implicit visual memory also called *priming memory*
            - He preformed very well with these tasks, indicating that MTL is independent of priming memory
    5. Classical conditioning: associative learning (implicit memory)
        - CS = tone; UCS=air puff; Response = eye blink
            - HM was slow to learn, but retained it for years
                - MTL is independent of associative learning
- **Conclusions from HM**
    1. Medial Temporal lobes play an important role in memory
        - Memory functions are not equally distributed throughout the brain
    2. Different structures are involved in forming working and long term memories
        - HM could retain long term memories and suffered almost no retrograde amnesia and could also retain several forms of short term memory
    3. Memories of different nature (implicit and explicit)
        - HM maintained implicit memory, but lost long-term explicit memory
- **Generalization of MTL Amnesia:**
    - *Loss of long-term explicit memory formation and retention of long-term implicit memory formation*

- Other types of amnesia
    1. Korsakoff's syndrome
        - Caused by: Alcoholism/vitamin B1 deficiency/diffuse damage to neocortex, hippocampus, and cerebellum

- Early stage: anterograde amnesia for episodic memory
- Later stages: severe retrograde amnesia, personality changes, and extreme confusion

2. Alzheimer's disease:
    - Initially mild deterioration of memory and intellect leads to confusion, anxiety, irritability, major anterograde and retrograde amnesia resulting in widespread neural death
    - Reduced ACh level due to deterioration of basal forebrain and other diffuse damage
    - Narrowed gyri, wider sulci, enlarged ventricles
    - *Amyloid plaques*: large extracellular sheers of peptides arranged in sheets block cell-to-cell signaling
    - *Neurofibrillary tangles:* paired helical threads of proteins in neurons that disrupt vital cell transport systems
        i. Both are prevalent in rhinal cortex, hippocampus, and neocortex and are probable cause of memory deficits
3. Post-traumatic amnesia:
    - A blow to the head produces coma, followed by a period of confusion after the victim regains consciousness
        i. Victim has period of retrograde amnesia for events hat occurred during the period right before the blow and anterograde amnesia for events that occurred during the period of confusion

Memory

- Hippocampus and consolidation:
    - **Standard consolidation theory**: affected memories transferred to a more stable storage during a set time period (STM to LTM)
    - **Continuous Consolidation theory**: Initial memory encoded in hippocampus and/or neocortex and with each recall, a physical change in the brain occurs that stores memory (*engram*) that makes disruption more difficult
        - Consolidation continues indefinitely and some memories will be consolidated preferentially over time
    - **Reconsolidation:** each time a memory is recalled from LTM, it is in an easily-altered state in STM and must be reconsolidated

- **Reference memory**: the general principle required to perform a task (ex: go to the baited arms)
- **Working (short-term) memory**: the memory necessary for successful performance of the task
    - Both are affected by hippocampal lesions in rats (short-term memory not dependent on hippocampus in humans)
- **Hippocampal place cells and entorhinal grid cells**

    - Grid cells establish a grid representation of a location so that during movement place cells can fire according to their new location while orienting according to the reference grid of their external environment.
        - Grid cells allows species to understand their position in space
        - A place cell becomes active when an animal enters a particular space in the environment (place field)
- **Hippocampal role in learning/memory**:
    - **Hippocampal cognitive map theory:** Hippocampus is specialized for spatial location memory and constructs/maintains maps of the external world
    - Also involved in the organization and flexible expression of **non-spatial memory**
        - Ex: hippocampal neurons fire in a place field, but only when a non-spatial stimulus is there also
- **Rhinal cortex role**:
    - *Object recognition*
        - Mumby box – rat learns that food is next to a specific object/visual cue and remembers that visual stimulus even when placed in a different setting with other arbitrary visual cues
- **Inferotemporal cortex**:
    - *Memories of visual input*
- **Prefrontal cortex**:
    - *Temporal (timely) order of events and working memory* (attention and task management)
        - Phineas Gage
- **Cerebellum:**
    - Pavlovian conditioning and sensorimotor skills
- **Amygdala**:
    - *Role* in memory for emotional significances of experiences (it itself does not store memories, rather strengthens emotionally significant memories stored in other areas)
    - Fear conditioning.
- **Striatum** (caudate and putamen): *habit formation*
- **Long-term Potentiation**
    - Long-lasting enhancement in signal transmission between two neurons that results from stimulating them synchronously; modification of synaptic strength.
    - Synaptic plasticity demonstrated in a number of areas implemented in learning and memory
        - Protein synthesis required for maintenance
        - Increased number and thickness of dendritic spines
        - Changes in dendritic branching