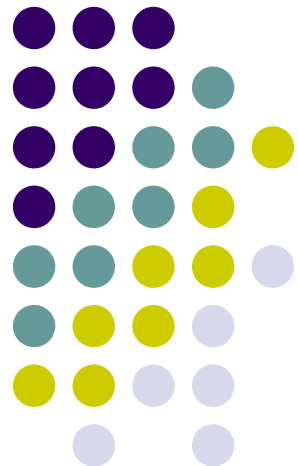
9.01 Introduction to Neuroscience
Fall 2007

Learning and Memory

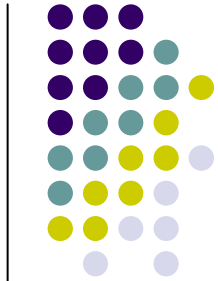
David Purger

9.01 Review

12/15/07

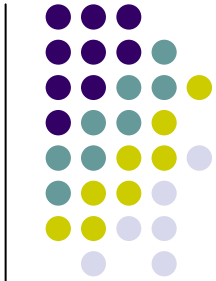


Types of Memory



- Declarative
  - Facts and figures
  - Easy to form, easy to forget
- Procedural
  - Skills, habits, behaviors
  - Hard to form, hard to forget

Length of memory

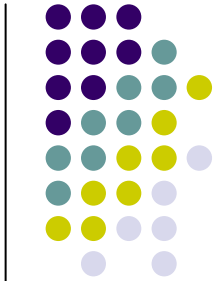


- Short-term memory
  - Persist for seconds to hours
  - Vulnerable to disruption
- Long-term memory
  - Persist up to a lifetime
  - Consolidation: converting STM→LTM, or sensory information→LTM
- Working memory
  - Temporary storage for information undergoing active manipulation by the brain
  - Digit span: 7+/-2

Amnesia

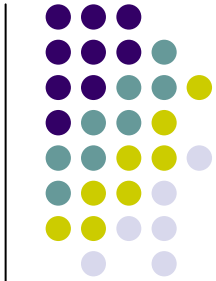
- Can be caused by ischemia, trauma, stress, drugs…
- Retrograde
  - Recent past memory is diminished
- Anterograde
  - No new memories are consolidated

Engrams



- Engrams: how memories are stored
- Hebb's cell assemblies
  - Network of simultaneously active neurons
  - STM as long as connections were active
  - Consolidation by synaptic strengthening ("neurons that fire together, wire together")
  - Pattern completion can later activate entire assembly by activating part of it
  - Destruction of part of network does not destroy memory

Memory storage: temporal lobe



- Inferotemporal (IT) cortex
  - Faces encoded by firing patterns of many cells: population coding
- Medial temporal lobe (hippocampus, rhinal cortex)
  - Hippocampus: consolidation
  - Most severe memory deficit from perirhinal cortex damage
  - Lesions: decreased performance on DNMS, psychic blindness, anterograde amnesia for declarative memories

Patient H.M.

- Medial temporal lobectomy in 1953 to relieve epileptic seizures
- Result: decreased seizures, but partial retrograde amnesia (3 years before surgery) and severe anterograde amnesia
  - Procedural memory intact

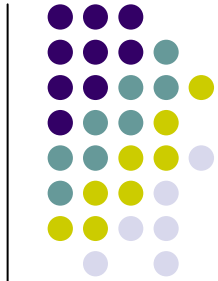
Diencephalon

- Thalamus, hypothalamus
- Also involved in memory formation
- Lesions lead to anterograde, some retrograde amnesia
  - Korsakoff's Syndrome: Alcoholism→Thiamin deficiency→Diencephalon damage→Memory impairment

Place cells

- Cells that only respond when animal is in a specific location (relational memory)
  - Human hippocampal cells activated during imagined or virtual navigation through environment

Other memory types



- Procedural memory
  - Striatum (caudate nucleus and putamen) critical for procedural memory
  - Lesions from Huntington's/Parkinson's impair procedural memory
- Working memory
  - Lateral intraparietal cortex (LIP), prefrontal cortex

Experiments

- Lesions
- Behavioral studies
- Stimulation