

BIO-311 - Neuroscience

Memory & Cognitive Maps of space

Diseases of memory

Alzheimer's disease

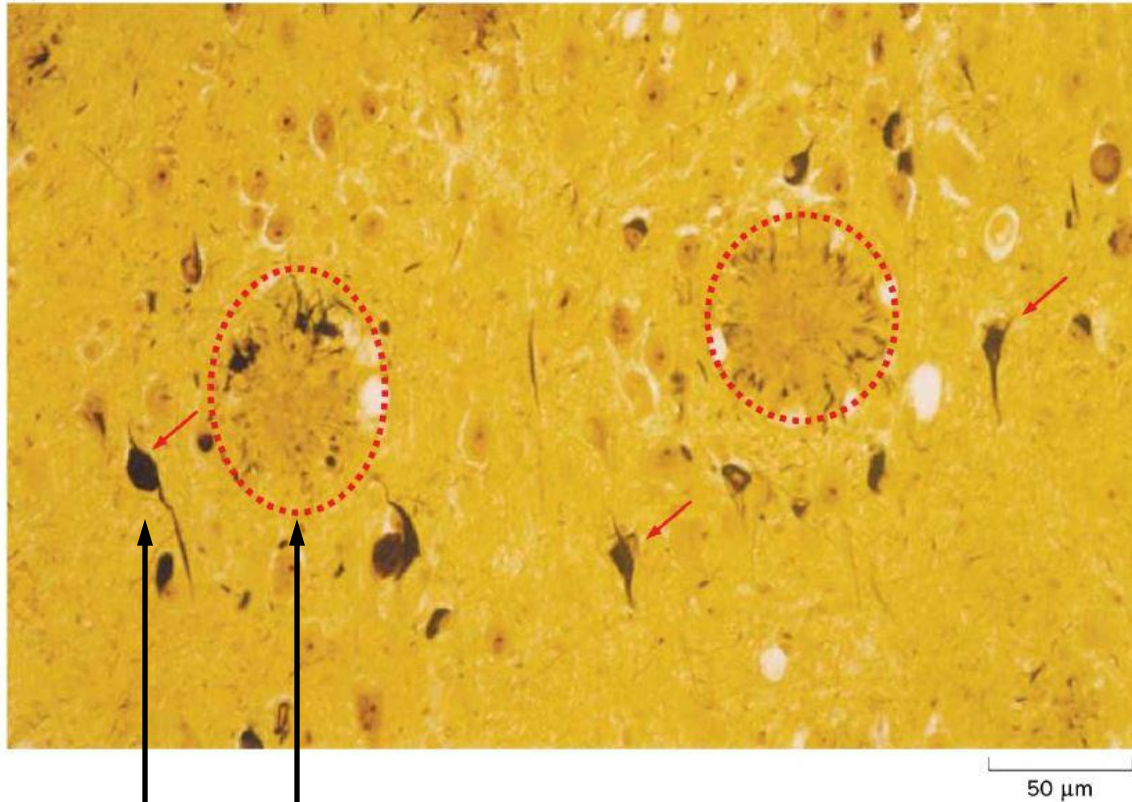
- A **neurodegenerative disorder** described in 1907 by Alois Alzheimer (who also noted the histological changes)
- Age of onset >60 years for "late onset", most forms are "sporadic"
- Incidence, **5-10%** at 65 years and higher thereafter
- Familial forms: earlier (40 - 60 years old), inherited autosomally-dominant

Clinical signs:

- impairment of recent memories and attention
 - failure of language skills
 - failure of visual and spatial orientation
 - alterations of personality
 - gradually patients lose their ability to cope with daily life
-
- Morphological signs (in post-mortem brains)...

Morphological signs of Alzheimer's disease (AD):

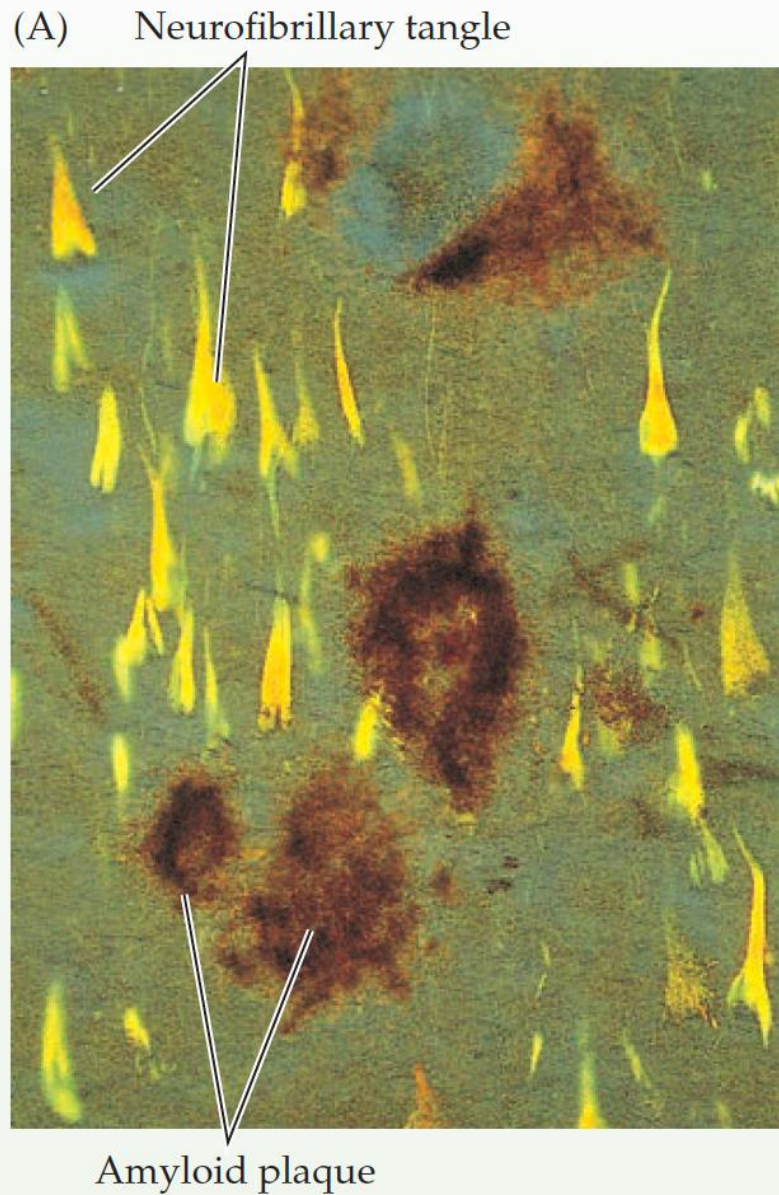
(A)



Neurofibrillary tangles (abnormal cytoskeletal filaments inside neurons)

Amyloid plaques (extracellular deposits, ~50 μm wide) contain "**Aβ**" peptides

Histological alterations occur in the neocortex, hippocampus, temporal lobe and some brainstem nuclei

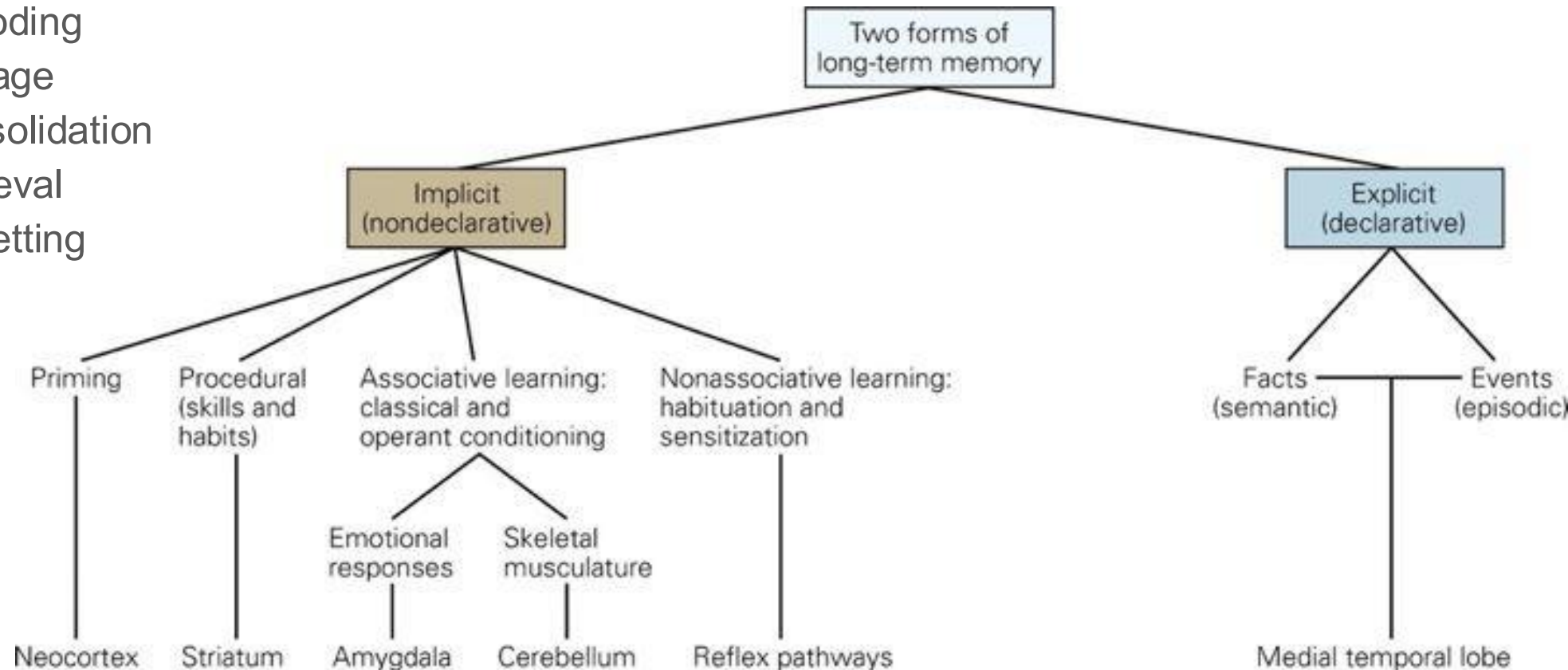
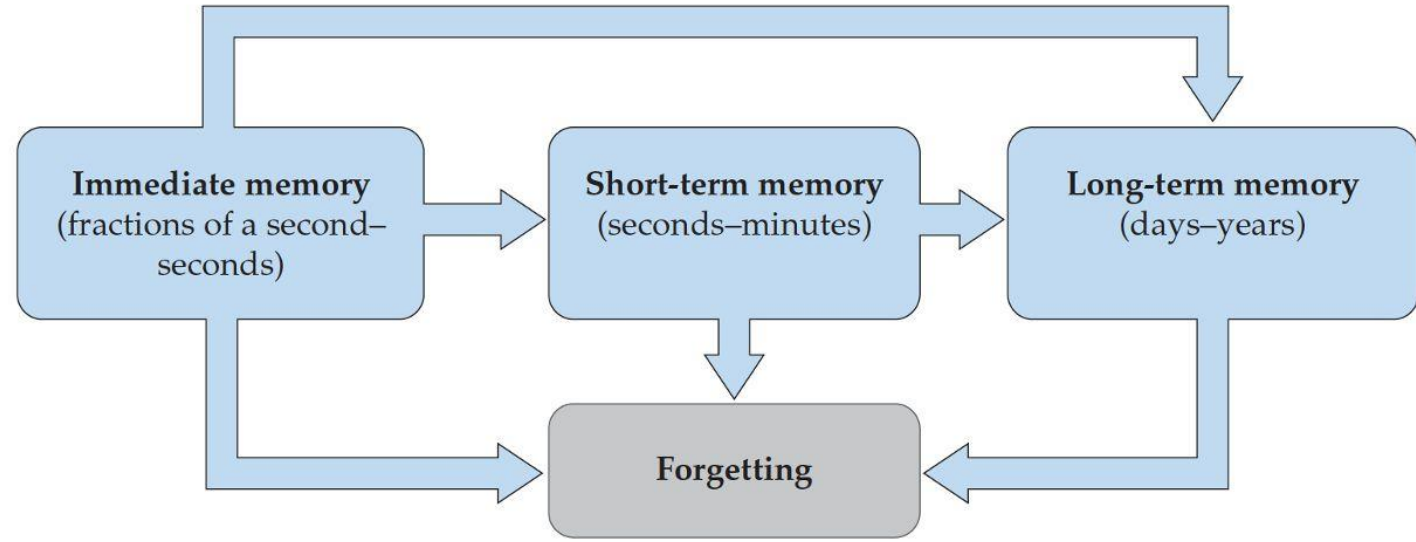


Summary

- Memory: definitions in terms of time-scale and kinds (implicit, explicit, procedural, declarative)
- Role in and relationship between Prefrontal Cortex and short-term memory
- Explicit, episodic memories: role of hippocampus and temporal lobe
- What patient H.M. tells us about the locus and kinds of memory
- ‘Concept cells’ in temporal lobe and hippocampus in humans
- Long-term plasticity at excitatory synapses studied in hippocampus (which synapse; which fundamental mechanism)
- Role of the hippocampus for spatial navigation & spatial memory as studied in rodents
- Classical conditioning as a form of ‘implicit’ long-term memory
- Alzheimer’s Disease and its putative underlying mechanisms

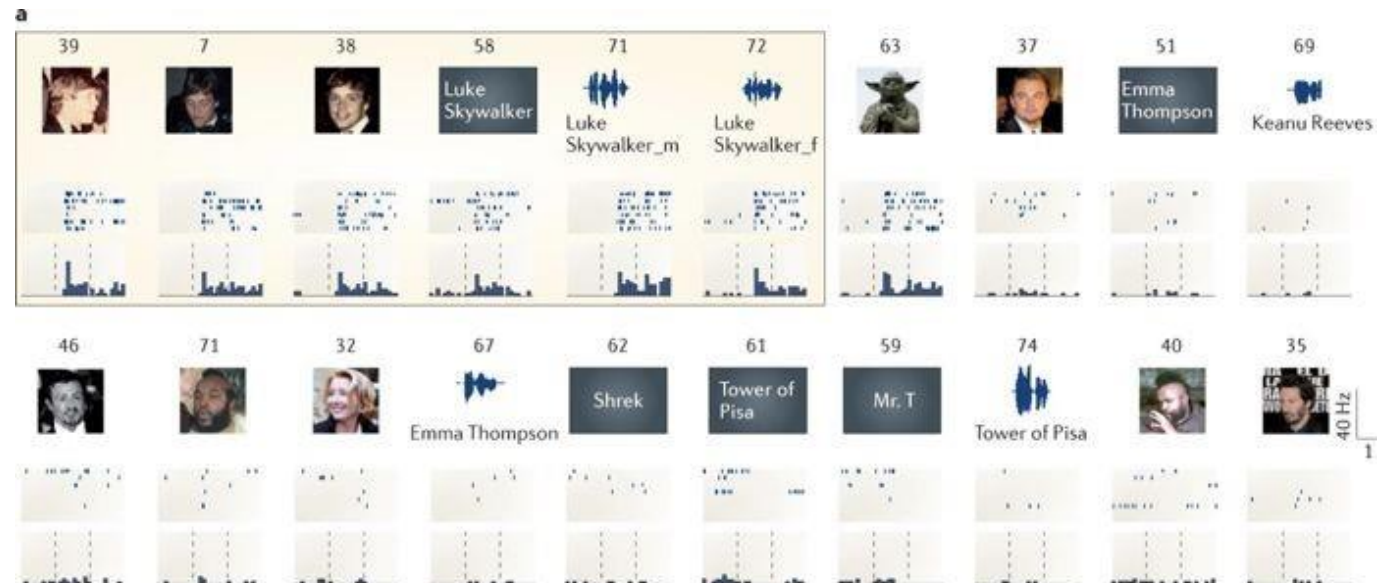
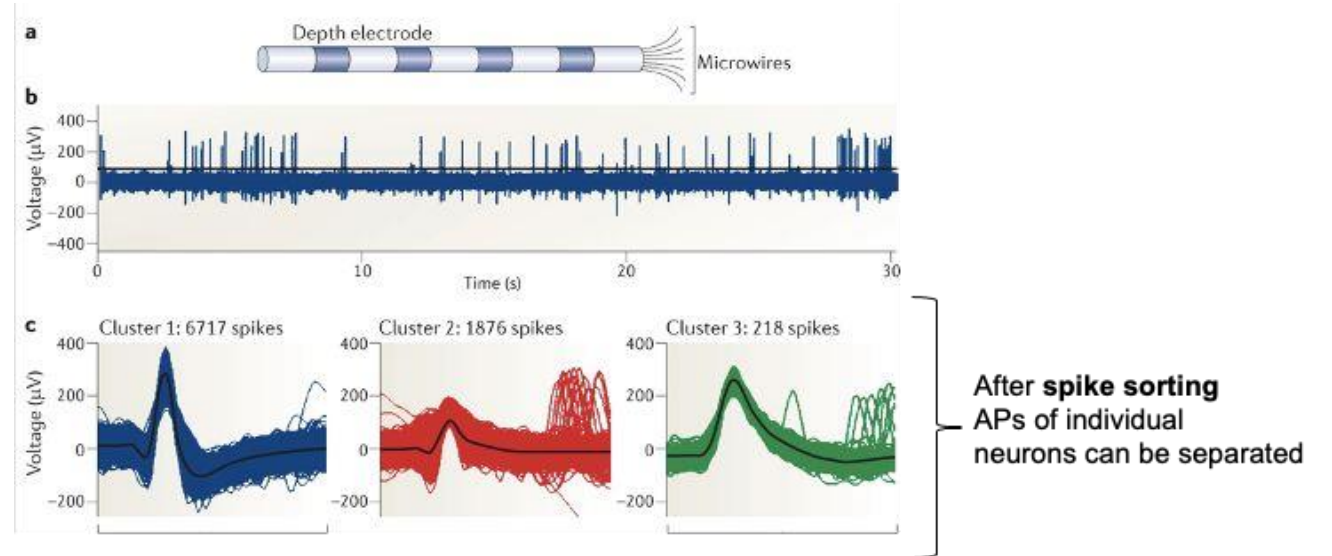
Memory

- long-term
 - implicit
 - encoding
 - storage
 - consolidation
 - retrieval
 - forgetting
 - explicit
- short-term
- immediate



Concept cells

- Multi-sensory cues of the same “concept” trigger a response



Conditioning: associative learning (implicit)

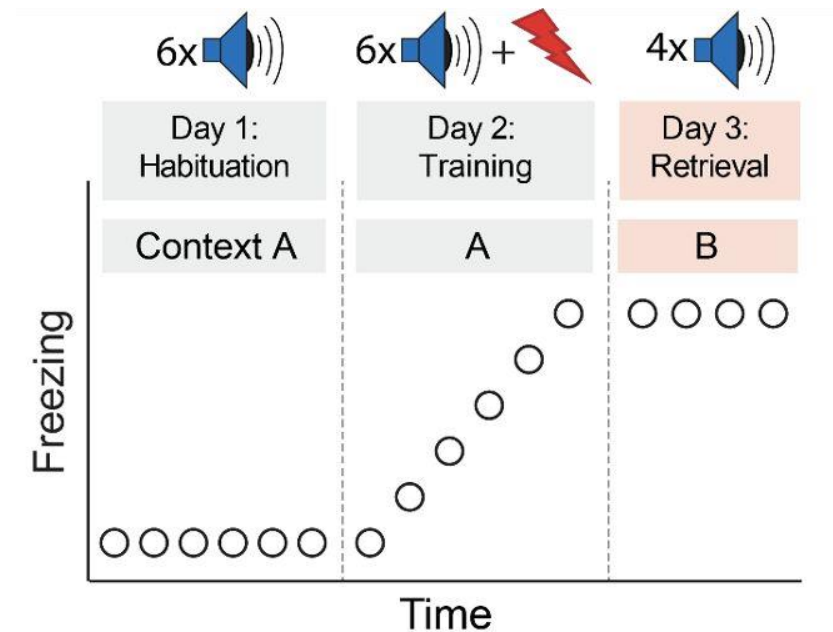
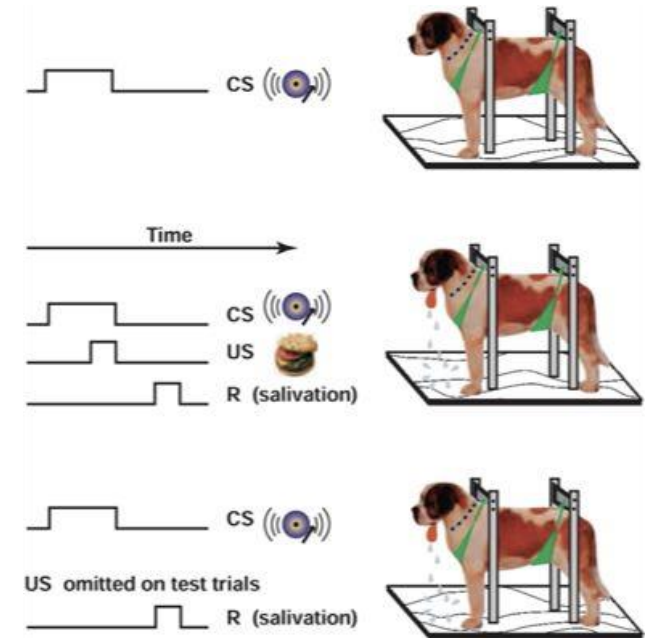
- classical conditioning vs operant conditioning
 - classical: produce a novel response to a previously neutral stimulus
 - operant: reward a specific behaviour

CS: conditioned stimulus

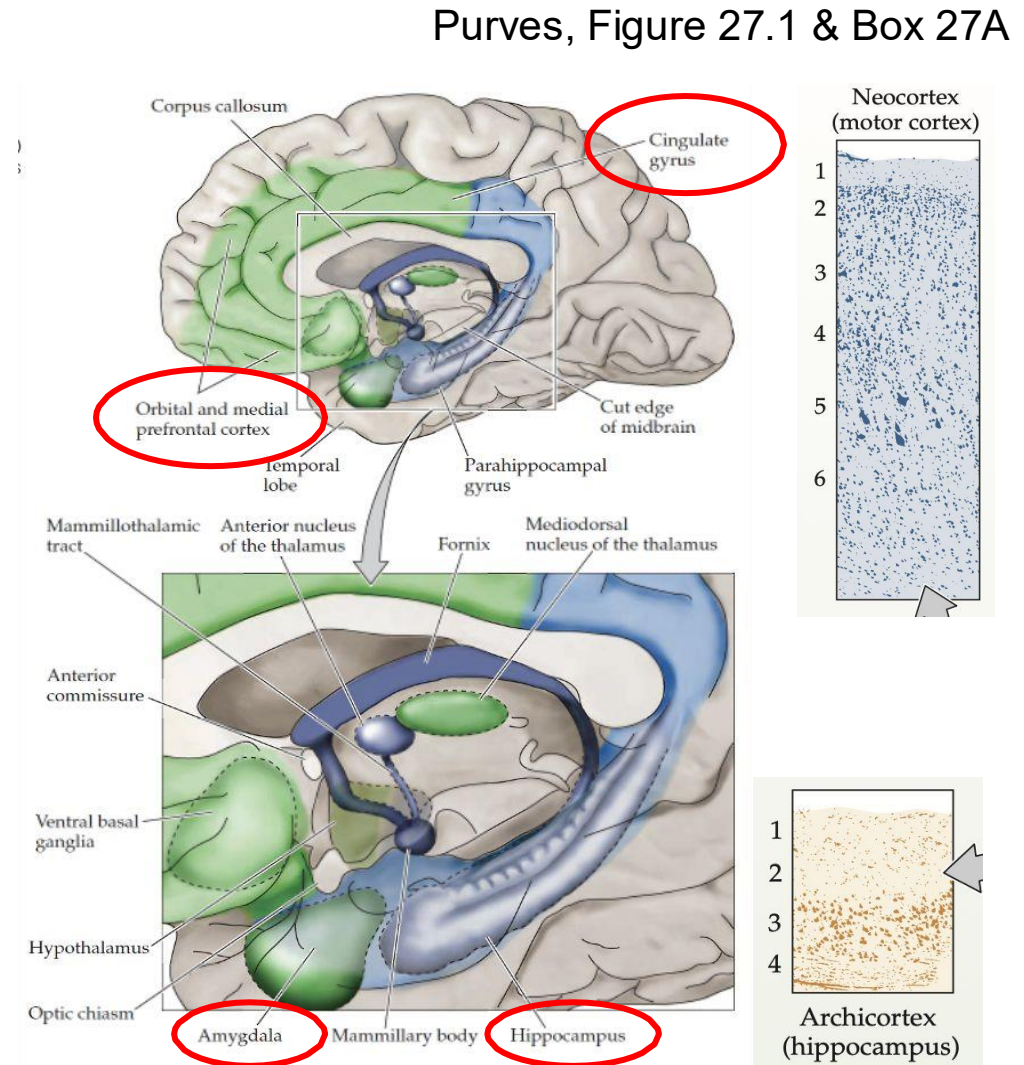
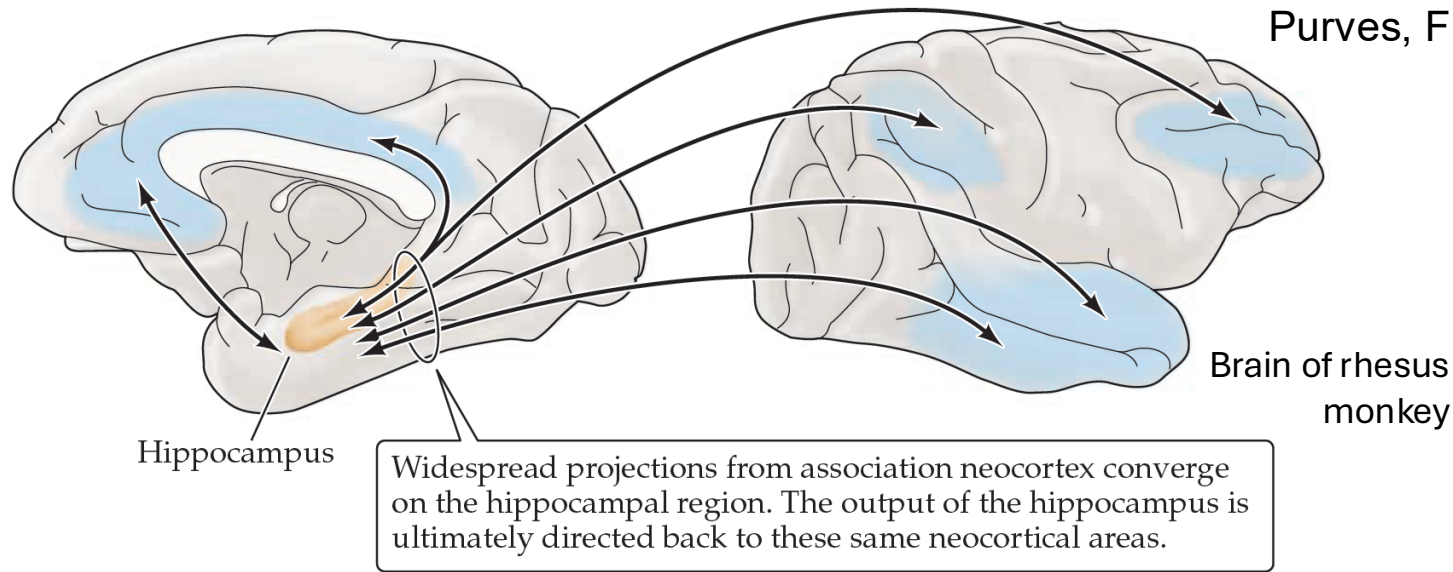
US: unconditioned stimulus

CR: conditioned response

Skinner box. This apparatus is the most widely used method for studying operant conditioning. Purves FIGURE 30.7



Communication between hippocampus and cortex in memory formation



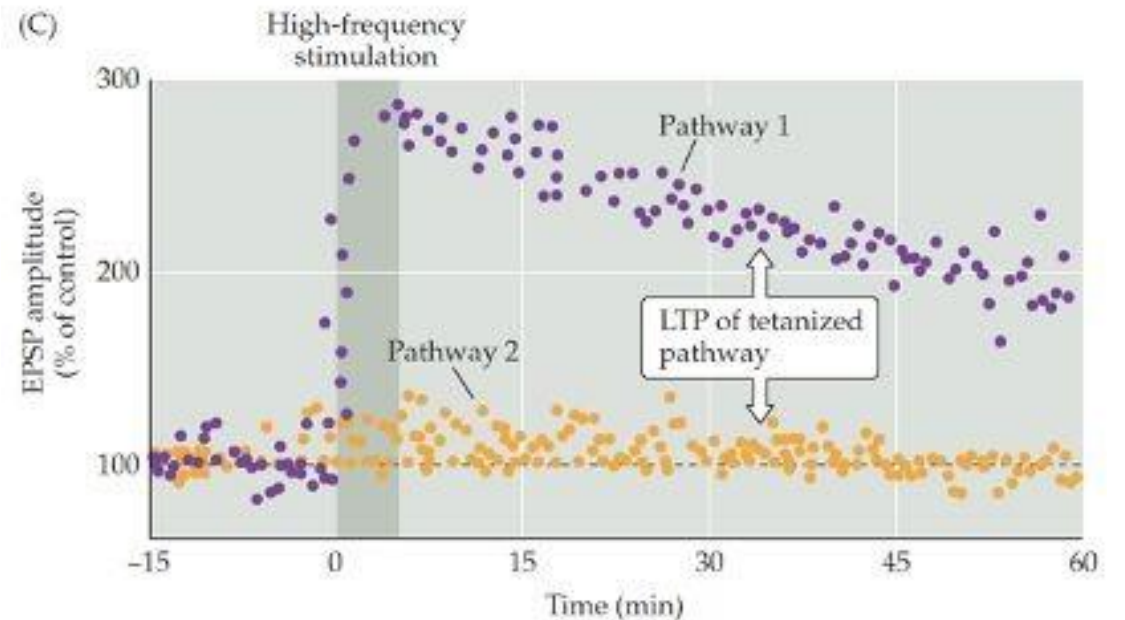
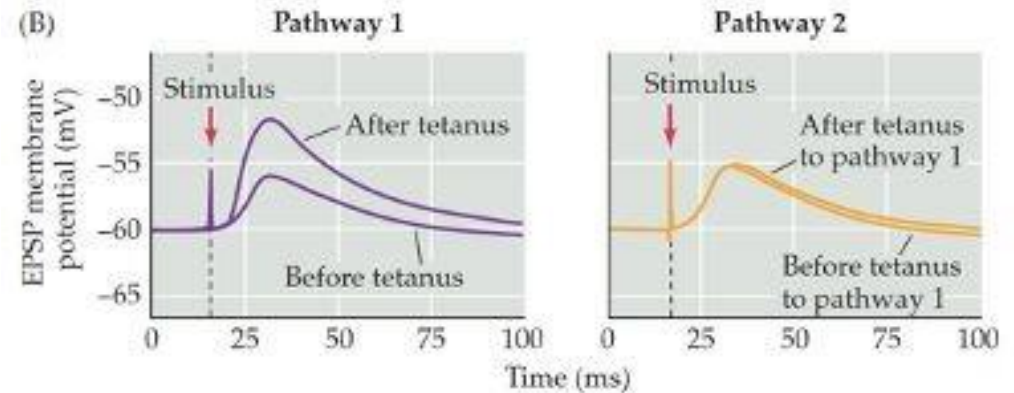
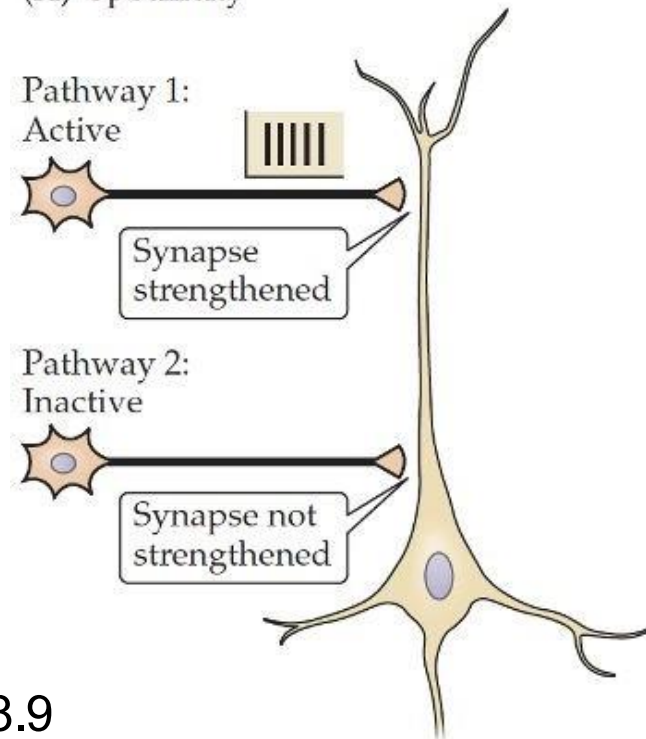
Association cortices

- Limbic association cortex
- parietal association cortex
 - objects, self, spatial awareness
- temporal association cortex
 - declarative memory
 - identifying, naming objects
- frontal association cortex
 - planning of purposeful behaviours
 - short-term ('working') memory

Long-term plasticity mechanisms

- Reinforcement by tetanic stimulation
- Coordinated firing is crucial
- «Fire together, wire together»

(A) Specificity

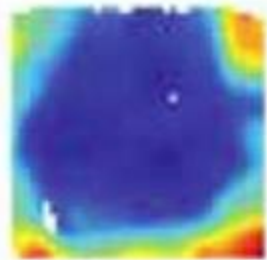
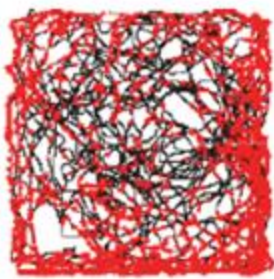


The basic elements of the cognitive map

Medial entorhinal cortex

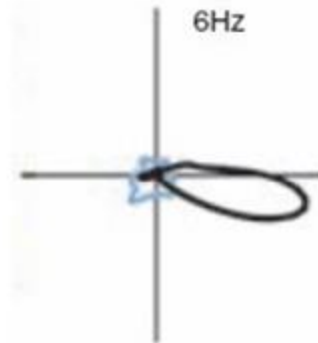
Hippocampus

Border cells



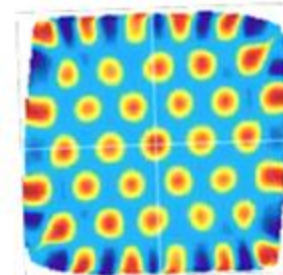
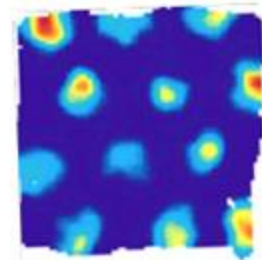
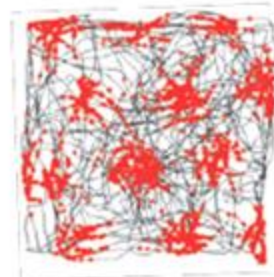
Moser, O'Keefe, Knierim 2008

Head-direction cells



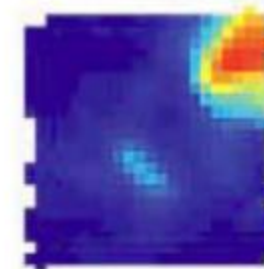
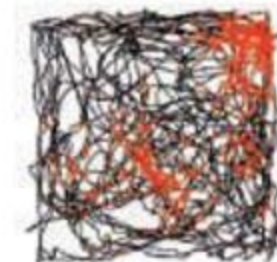
Ranck, Taube 1980s

Grid cells



Moser 2005

Place cells



O'Keefe 1971