Learning and Memory
Multiple memory systems

- Memory is organized according to its **content**. Although learning mechanisms may be largely overlapping, different types of memories are stored by and in **different** parts of the brain.

- **Example**: Claparède’s amnesic patient (1951) Hid a pin in his hand and shook the amnesic patient’s hand who quickly withdrew her hand in pain. The next day, she did not remember his face but hesitated when he went to shake her hand.

- **Emotional** content was stored separately from declarative memories.
Multiple memory systems

Long-Term Memory

- Declarative (Explicit)
  - Facts (Semantic)
  - Events (Episodic)
  - Medial Temporal Lobe (Hippocampus and surrounding cortices) and Diencephalon

- Nondeclarative (Implicit)
  - Skills & Habits
  - Priming
  - Classical Conditioning
  - Nonassociative Learning
    - Emotional
    - Skeletal
    - Cerebellum
    - Reflex Pathways

After Squire et al. 1991
Medial temporal lobe anatomy

- Hippocampal region
- Diencephalic areas
- Neocortical sensory and association areas (frontal, temporal, parietal lobes)
- Perirhinal cortex
- Parahippocampal cortex
- Hippocampus
- Thalamus
- Lateral ventricle
- Entorhinal cortex
- Rhinal sulcus
The case of H.M.

- Suffered epileptic seizures
- William Scoville performed a bilateral MTL surgical resection (hippocampus, amygdala and surrounding cortex).
- Tested by Brenda Milner (1957)
- Impaired ability to learn new facts and events (declarative memory)
- Intact language, IQ, working memory, and nondeclarative memory (skills, habits, priming, conditioning, etc...)

Henry Molaison
1926-2008
The case of H.M.

H.M.’s *retrograde amnesia* (memory for events that occurred before surgery) extended back to childhood. His *anterograde amnesia* (memory for events that occurred after surgery) was permanent.

H.M. lost all contact with the past. He could not recognize people he saw every day and he could not recognize himself.
Rey-Osterrieth Complex Figure Test

Milner, personal communication
Mirror drawing task
H.M. – Intact working memory

H.M. was able to remember 584 for several minutes. How?

“It’s easy. You just remember 8. You see 5, 8, and 4 add to 17. You remember 8, subtract it from 17 and it leaves 9. Divide 9 in half and you get 5 and 4 and there you are: 584. Easy.”

Yet, after a brief distraction, all this was lost.
Henry’s lesion and amnesia
Milner’s conclusions

- The ability to **acquire new declarative memories** is a distinct function located in the MTL.
- The MTL is **not required** for immediate (working) memory.
- The MTL is **not required** for habit and skill memory.
- The MTL **cannot be** the ultimate storage site for long-term memory (remote memories were intact).
- The notion of memory systems was defined somewhat based on what H.M. could and could not do.
- **Larry Squire** (UCSD) did extensive work with human amnesia cases as well as animal models of amnesia.

- E.P. was one of his patients.

- E.P. was amnesic since 1992 (Herpes simplex encephalitis)

- Severe damage to medial temporal lobe but little non-MTL damage.
Nondeclarative tests - priming

ABSENT
INCOME
WINDOW
DISCUSS
CHEESE
ELEMENT

ABS_____
INC_____
WIN_____
DIS_____
CHE_____
ELE_____

E.P.’s performance

WIN____
Complete this word with the first word that comes to mind

Window... Winter
Which one of these did you see 10 minutes ago?

Stefanacci et al., J Neurosci 2000
False Memories: Eyewitness

- View a scene of a traffic accident. Asked either:
  - “How fast was the white car going when it smashed into the black car?”
  - “How fast was the white car going when it hit the black car?”

- Question affected the response:
  - smashed: 40.8 MPH
  - hit: 34.0 MPH

- Eyewitness testimony altered by how the question is asked.
The misinformation paradigm

Initial

Misinformation

“The car came to a yield sign”

Test or?

Loftus et al. 1978
The misinformation paradigm

Despite never seen a Yield sign, endorsement at ~60%
Implanting false memories

- Recalling memories from going to Disneyland during childhood and interacting with the Bugs Bunny character.
- Able to generate impossible false memories in ~30% of participants.
- Implanted false memories of interacting with an inappropriate Pluto based on misleading story.

Loftus et al. 2003
More False Memories

- Using fake photographs

“I’m still pretty certain it occurred when I was in sixth grade, at the local school there... I’m pretty certain that mum is down on the ground taking a photo.”
Why do we forget?

- **Encoding failure**: Information was never encoded & never made it from working memory into long-term memory.

- **Decay**: Memories simply weaken with time, regardless of what other material is learned.

- **Interference**: Memories can interfere with each other to cause forgetting of existing information, or to hamper acquisition of new information.

- **Loss of retrieval cues**: We forget because we lose access to the information, but the information itself is not lost.
Highly Superior Autobiographical Memory (HSAM)

“I remember every day, everything said to me, every place I went, every book I've read, every face I've seen, everything that I have done since I was 13 years old. My memory before 13 is fragmented, at best. However, everything afterward seems to be burned into my brain, whether I like it or not, with shockingly true to life clarity.”

- Jill Price (A.J.)
  excerpt from e-mail to Jim McGaugh
Only autobiographical memories
Structural changes in HSAM brains

Increased gray matter density

- Insula
- Parahippocampal gyrus
- Lentiform nucleus

Increased white matter integrity

- Uncinate fasciculus

LePort et al. *Neurobio Learn Mem* (2012)