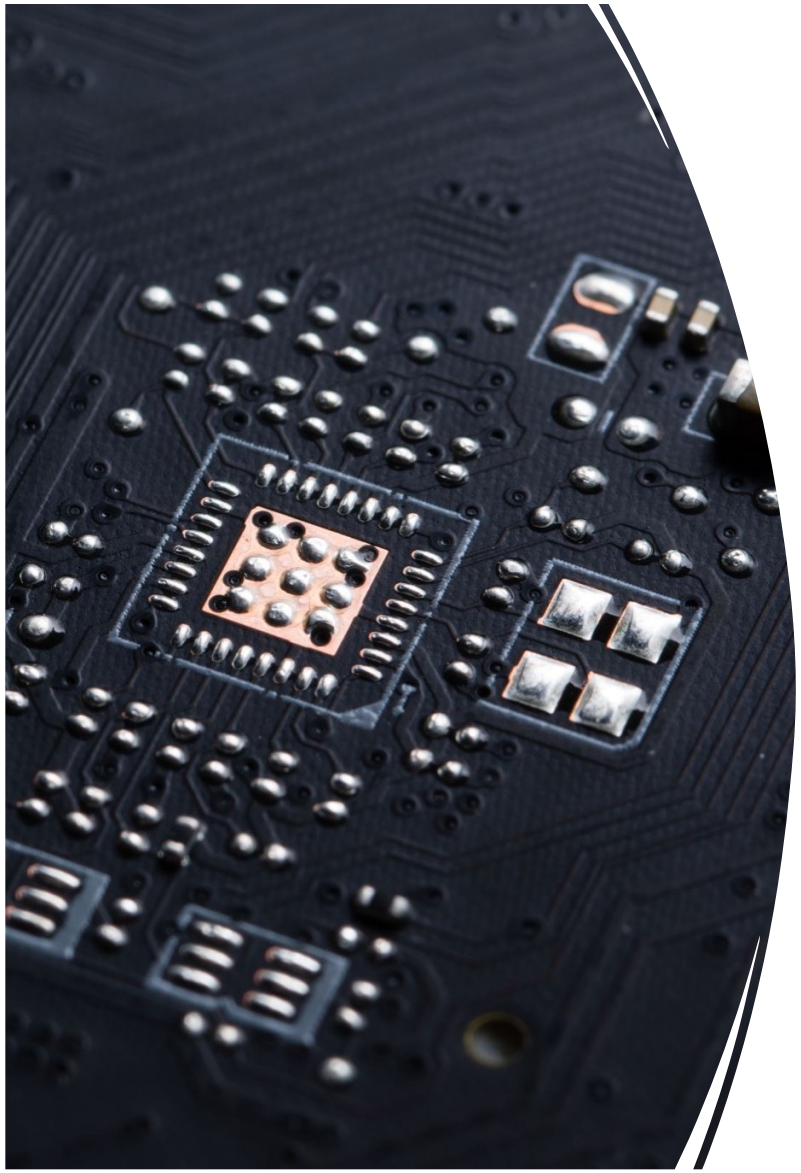


Memory

The Hippocampus and Medial Temporal Lobe/System

Amnesia = memory loss
H.M. due to Hippocampus and near by tissue damage

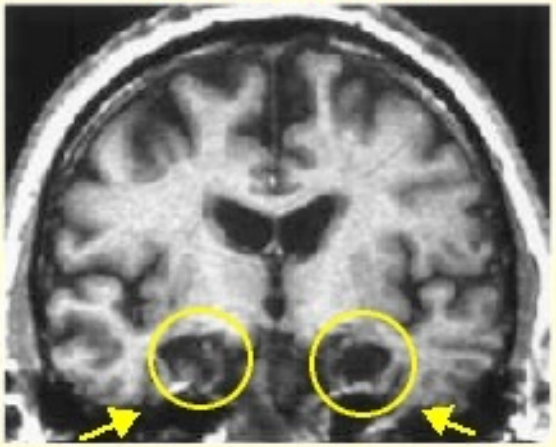
- Patient H.M. (1929-2008) was born in 1929 in Connecticut. He was knocked down by a bike when he was 7 and was unconscious for several minutes. He soon began having minor seizures. When we was 16-years-old, he had his first major seizure. By the time he was 27, H.M. was suffering 10 minor seizures every day and a major seizure weekly. He could not hold a job or live any kind of a peaceful life.

- 1953 - a major brain operation by Dr. Scoville involving a bilateral medial temporal lobe resection (= removal of the hippocampus and nearby tissue structures including **the perirhinal, entorhinal, and parahippocampal cortices as well as the amygdala)**.

- The surgery was "successful" in significantly reducing H.M.'s seizures. However, by age 28 it became clear that H.M. had a pervasive problem with his memory. He was referred to **Dr. Brenda Milner**, a Canadian neuropsychologist, in Montreal.

- Beginning in 1955, H.M. has been the subject of many studies for the rest of his life.

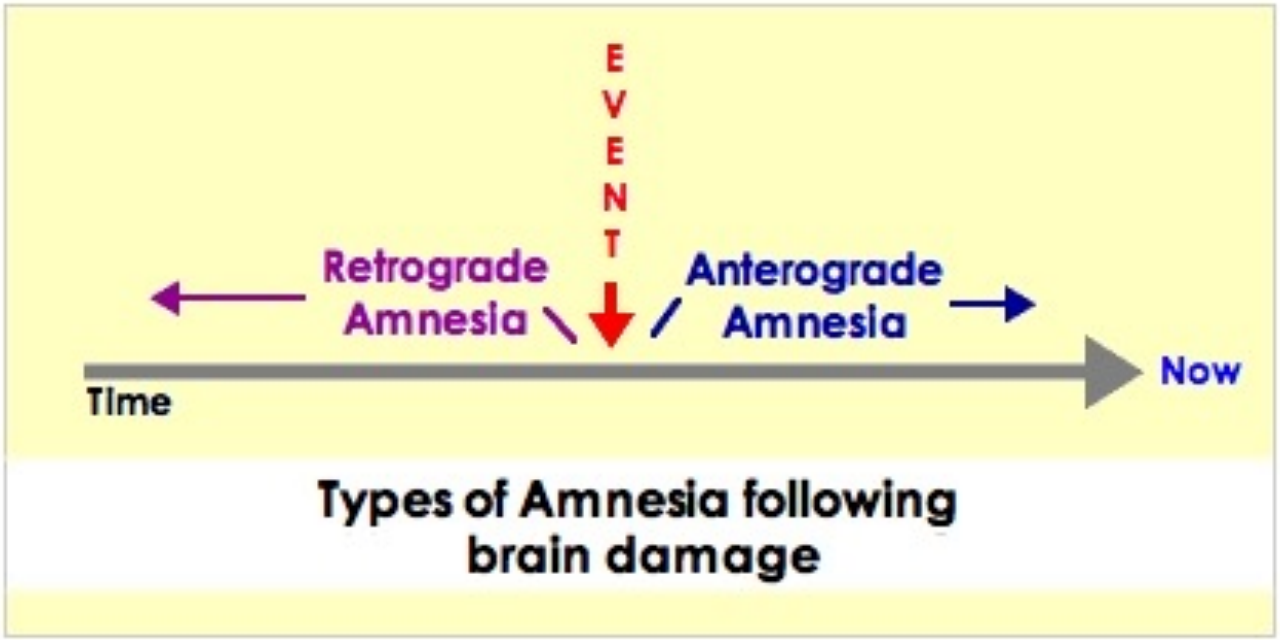
MRI scan of "H.M."



NOTE THE RESULTS OF HIS BILATERAL MEDIAL TEMPORAL LOBE RESECTION AND THE REMOVAL OF THE HIPPOCAMPUS

What kind of brain functioning did H.M. show after his operation?

- No effect on intellect & language functions. I.Q. slightly higher in the years immediately after operation.
- Personality was relatively the same except for "emotional placidity" (= no complaints; no requests even for food)
- Good short-term memory, i.e., for new items up to about 5-10 minutes after the experience.
- Massive **anterograde amnesia** (loss of memories of new events ***since*** brain damage)
- and moderate **retrograde amnesia** (loss of memories of events ***before*** brain damage).



Types of Amnesia following brain damage

Declarative memories - i.e., facts, and no new memories of events,

- e.g., what happened in the world since 1955.
- He did not learn new words which came into English since his operation.
- However, he did respond with some new learning

- Prompt: "Elvis" • HM's response: "Presley"
- Prompt: "Fidel" • HM's response: "Castro"
- Prompt: "Martin Luther" • HM's response: "King"

H.M.’s Outcome post surgery

when he examined pictures of past events including those of his family, he recognized names & some places, but could not recall the **events** pictures showed,

Intact **procedural memory**, i.e., learning how to do something new.

severe impairment in **episodic (personal) memories.**

Severely diminished **episodic memory**

he had very little memory of any specific events of his earlier life

(exception: he remembered that he once flew in a two-seater airplane as a child which was true).

H.M. showed poor new explicit memory, but nearly normal implicit memory.

- **Explicit memory**: recall of information which one knows is in memory

- **Implicit memory**: influence of recent experience on behavior even though one doesn't recognize memory is being used.

What does the Hippocampus Do? Theories of Hippocampal Functioning (= Medial Temporal Lobe/System)

1. Declarative Explicit Memory: Bilateral damage in humans leads to impairment in storing any new memories for facts (declarative memories) and events (episodic memories).

The basal ganglia seem to be more important for new procedural memories.

2. Spatial Memory

London taxi cab drivers have "the Knowledge" = a detailed memory for every single street in London and how to go from one place to another by the quickest route.

The drivers have larger posterior hippocampi (plural of hippocampus) than normal.

- Humans with damage to the hippocampus do poorly on tests of spatial memory

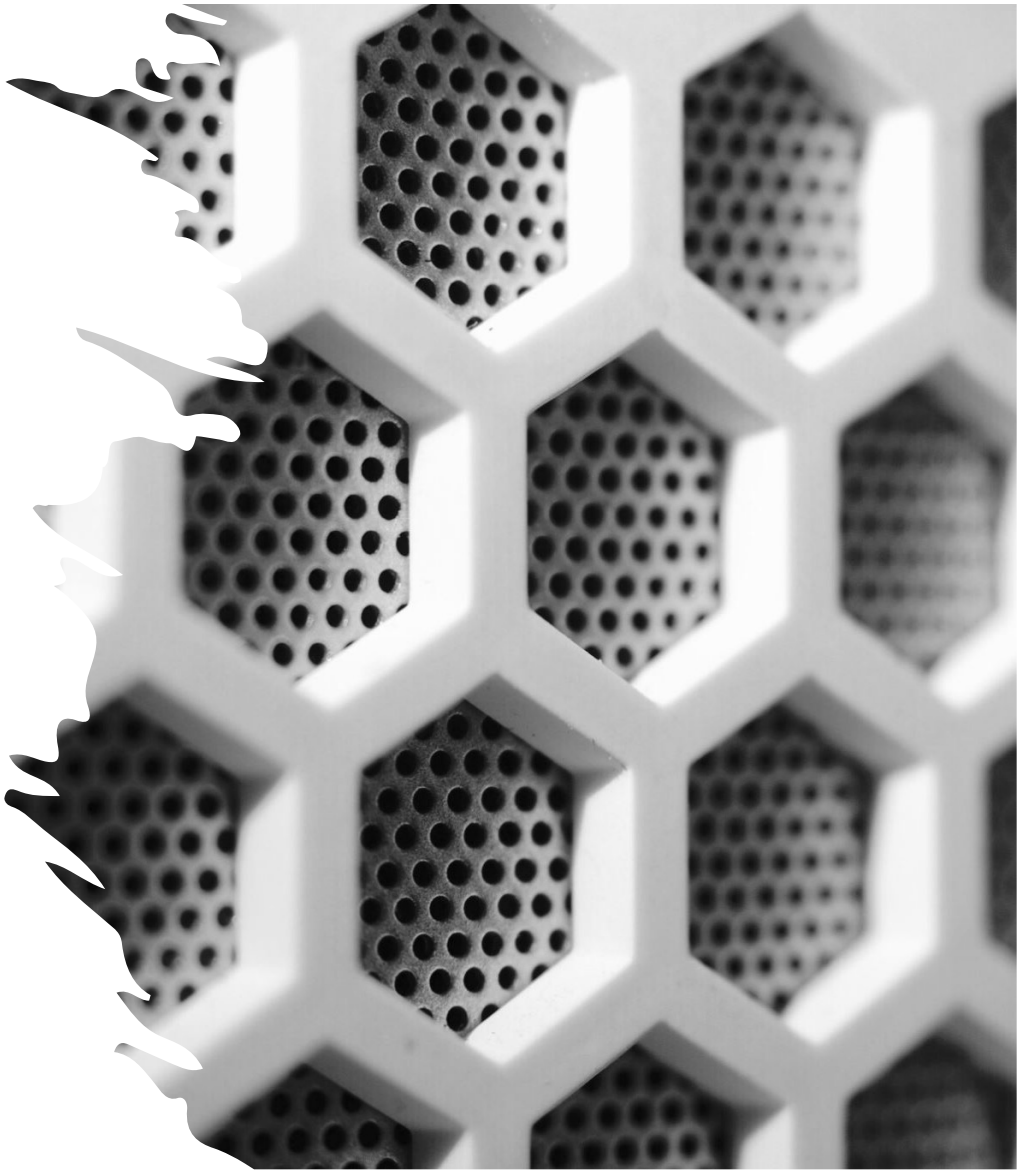
- Bird species with good spatial memory (e.g., Clark's nutcracker which finds hidden seeds during winter) have larger hippocampi relative to rest of brain than birds who have poor spatial memory.

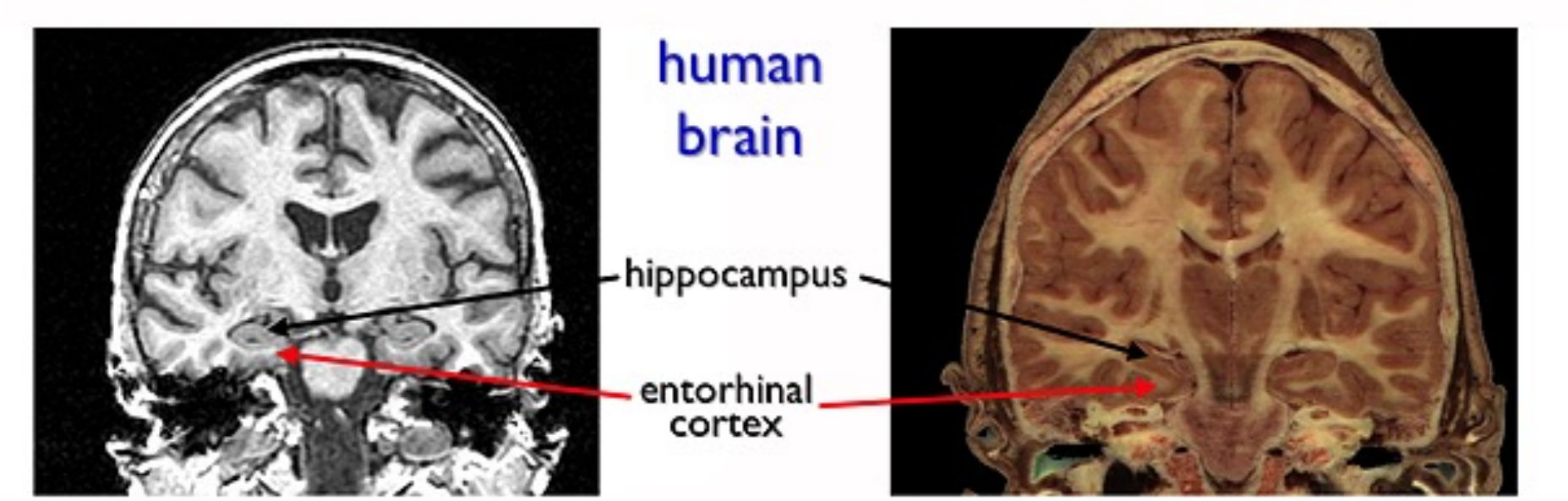
The Brain's "***navigational grid*** "

- "**Place Cells**" •
- in the brain of rats a spatial map reference system associated with the hippocampus.
- When rats in an enclosed space moved to different places in that space, specific cells in the hippocampus fired.
- These creates a ***mental map*** of the space. These cells appear to have a memory function as well and allow an animal to navigate environments later on in which they had previously found themselves.

The Brain's Grid Cells

- "**Grid Cells**" • the entorhinal cortex a special type of cell called a "grid cell" which
- (1) fires as rat moves around a spacial environment and
- (2) are arranged in a hexagonal patterns.
- These cells not only provide a ***knowledge of place*** but also of the ***direction of the animal's head*** as well.
- This brain area appears to allow an animal to ***calculate distance*** between itself and different places within the environment.




human
brain
hippocampus
entorhinal
cortex

3. Context: Configural Learning & Binding

- Recent work suggests a major role for the hippocampus in binding together all the elements of declarative memory, complex spatial memories, and single-event configurational memories.

- Memory is a collection of different pieces of experience: sights, sounds, smells, tastes, etc.
- These are probably stored in diverse parts of the brain and require some sort of map to bring them back together again.
- The hippocampus may provide that map via connections to the rest of the forebrain

V. Striatum: Implicit or Habit Learning (Where Skills and Habits Meet)

is involved in **modulating the movement of our muscles**.

But, we have now come to understand that this area of the brain is also involved in a major way in **learning**.

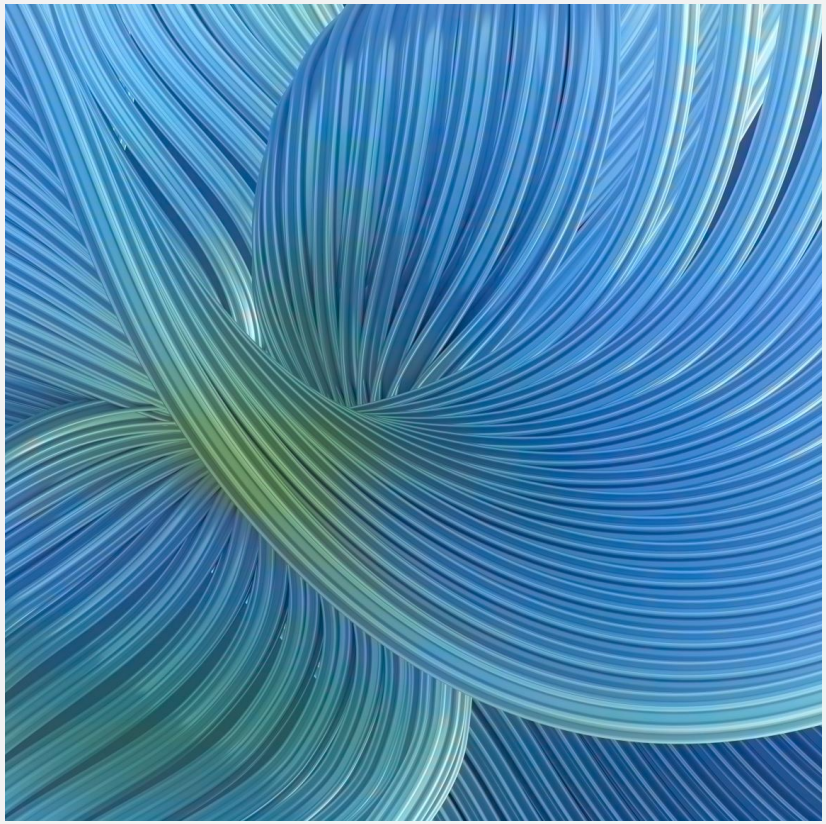
- We learn many memories of experiences after only a single event.
- But, consider how you tend to learn gradually what to expect of another person's behavioral tendencies, for example:
  - how other members of your basketball team will move offensively
  - how your mother will unpack the weekend's shopping from Wegman's, or
  - the various cues your teacher might give about what he or she expects in class.

implicit or **habit learning**.

Gradual implicit or habit learning appears to depend upon a diverse set of nuclei in the subsurface of the brain called the **basal ganglia**.

These include
the **striatum** (i.e., **putamen** and **caudate nucleus**) as well as the **globus pallidus**, **substantia nigra**, and **subthalamic nuclei**.

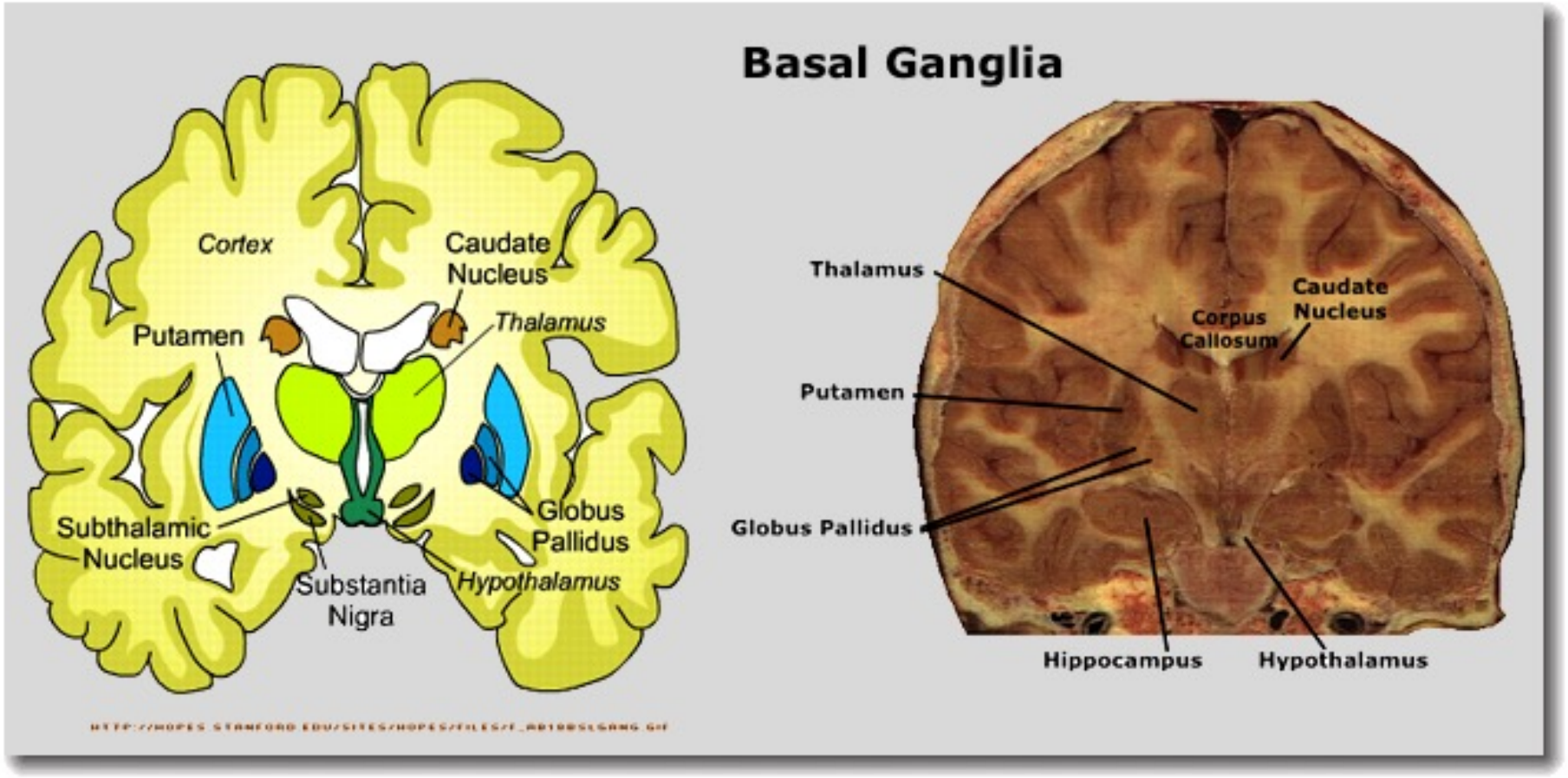
These bodies use dopamine as a neurotransmitter and have previously been shown to be centrally involved in movement.



"reinforcement-level learning"

- The Striatum

- **Gradual learning over multiple trials**
- Learning **habits and skills**
- Learning requires **prompt feedback (= reward or punishment is clear)**
- Learning is **implicit**, that is, what is learned is **not put into words, but into actions**
- If the striatum is **damaged**, the ability to learn new skills or habits is **impaired** and **previously learned skills/habits are often impaired as well**


Cortex
Caudate Nucleus
Thalamus
Putamen
Subthalamic Nucleus
Substantia Nigra
Hypothalamus
Globus Pallidus
Basal Ganglia
Thalamus
Caudate Nucleus
Corpus Callosum
Putamen
Globus Pallidus
Hippocampus
Hypothalamus