

A classical landscape painting. In the foreground, a large, weathered column stands prominently, its base and lower shaft covered in thick ivy. The column is positioned on the left side of the frame. In the background, a body of water stretches across the middle ground, reflecting the sky. On the left bank, there are ruins of ancient buildings, including a long colonnade. On the right bank, there are more ruins, including a large archway. The sky is filled with soft, wispy clouds, and a small, bright light source, possibly the sun or moon, is visible in the distance. The overall color palette is muted, with earthy tones and soft blues.

Memory

10/22/24

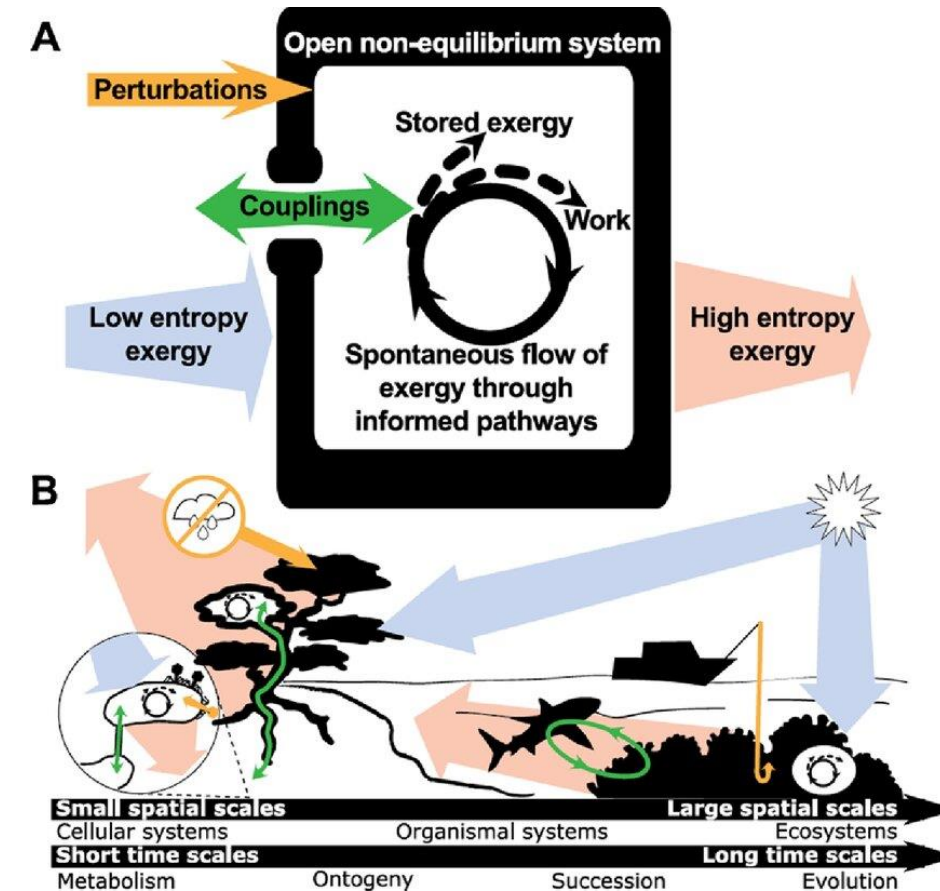
Philosophical Considerations

- Memory can anchor you to a sense of identity and self, but also burden you with the weight of the past
- Forgetting can be a tool of liberation, allowing you to move beyond the past and engage with more lightness and vitality, but it can also be a tool of oppression, a way to erase your memory of who and what you are
- Memory is ambiguous – both liberating and destructive, both fragile and powerful, both healing and devastating, both a source of truth and a source of deceit
- Memory can guide future action, what we remember and forget influences our posture towards the future
- We reconstruct our memory of the past based on what is important to us in the present



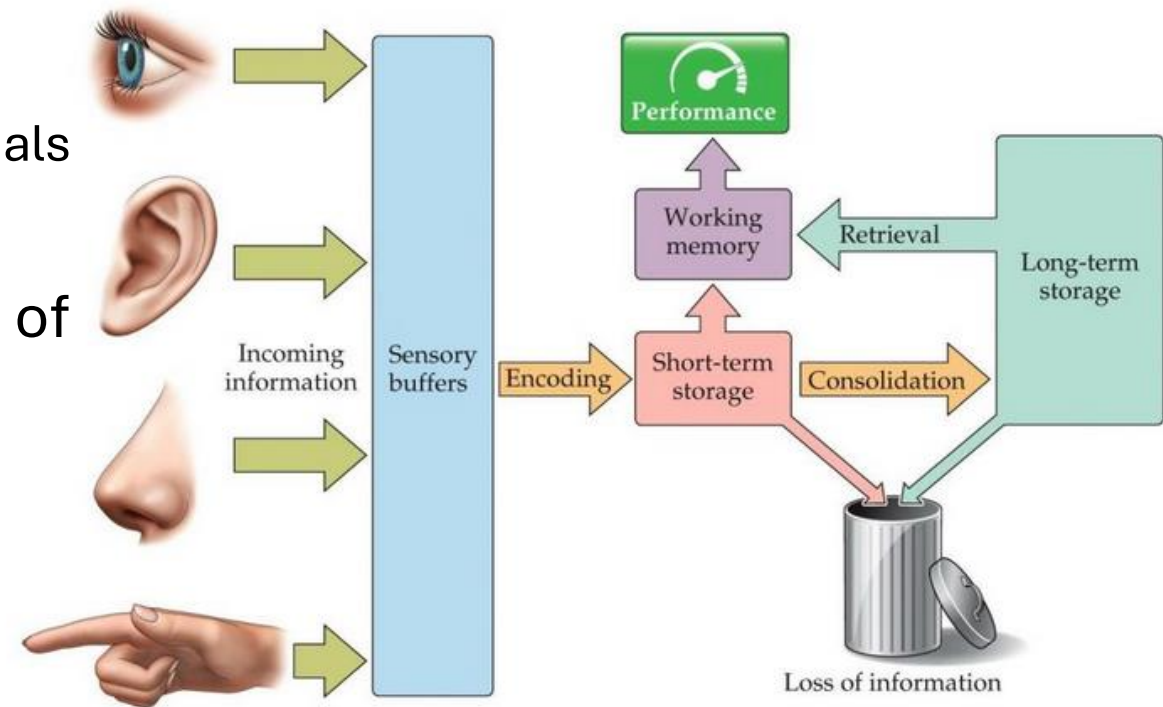
What is memory?

- In biology: the process of encoding, storing, and retrieving information
- More fundamentally: **information preservation** that allows the past states of a system to influence its future states
 - The persistence of **causal relationship**
- **Dissipative structures** – thermodynamically-open systems (exchanging energy and information with their environment) that can maintain consistent patterning/structure while staying far from equilibrium
 - Hurricanes, ecosystems, cells, solar coronal loops
 - Structure as memory



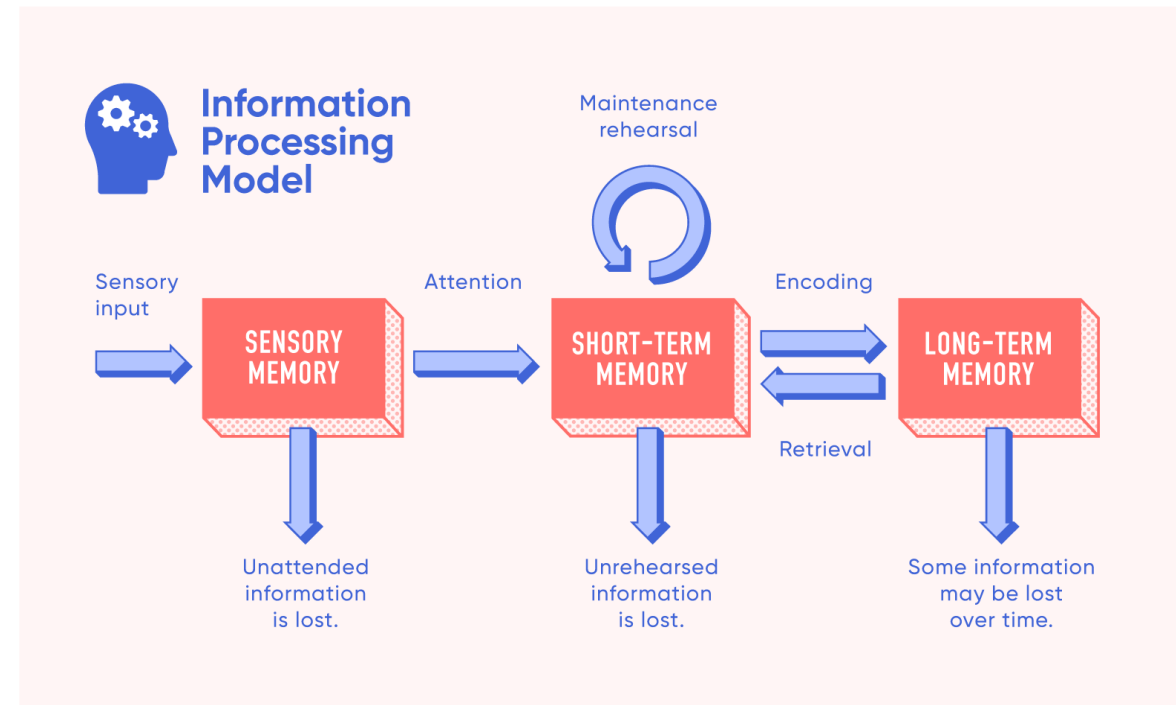
Fundamental Processes of Memory

- **Encoding:** sensory information is transformed by neural processing into signals that the system understands
 - Perceptual processing encodes sensory signals into meaningful percepts
- **Storage:** neural signals are consolidated and retained for anywhere from fractions of a second (sensory memory) to a lifetime (long-term memory)
 - Longer term memory processes leverage synaptic plasticity to store information in the system
- **Retrieval:** reconstructing stored information as needed
 - Can be influenced by context, cues



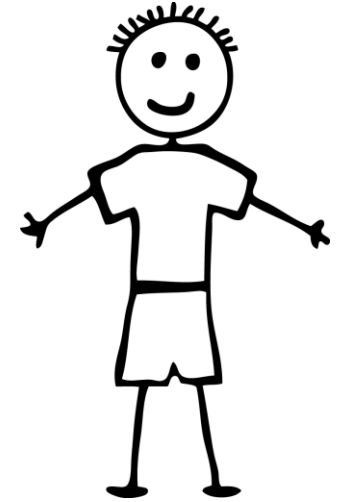
What to store?

- You are already filtering sensory information that you perceive, based on your motivations, attention, expectations, and emotions
- These same principles apply to what memories are stored and how they are remembered
- What is remembered:
 - More emotionally intense experiences
 - More novel and surprising experiences
 - Relevant to goals/motivations
 - Repetition and rehearsal
 - Richer context, more associations, sensory details



Depth of encoding

- **Shallow encoding:** processing information at the superficial level, focusing on surface features, like physical attributes, without engaging in meaning and context
 - Color, shape, person's clothing, the goal of a motor action, the tempo of a song, rote rehearsal of information
- **Deep encoding:** processing information at the meaning-making level, making connections to prior knowledge
 - Significance of a feature, a person's emotions, underlying mechanics of a motor action
- Processing the deeper significance, meaning, context, relational understanding of information results in stronger, more enduring memories



The present moment

- **Specious present:** the timespan that you perceive as “now” – a brief duration which can hold multiple events (milliseconds to seconds) – in which sensory and cognitive information is integrated in a unified perception
 - “the short duration of which we are immediately and incessantly sensible” – William James
 - Allows you to experience the world in a more continuous way, rather than as discrete moments and events
- **Sensory memory:** sensory information is briefly held as a buffer in order to integrate information into a coherent perceptual experience
 - Iconic (visual) – 250-500 ms
 - Echoic (auditory) – 2-4 s
 - Haptic (touch) – 2-4 s
 - Olfactory (smell) – seconds to minutes
- Very large capacity to these processes – what gets attended to or deemed relevant gets retained in short-term memory



Short-term and working memory

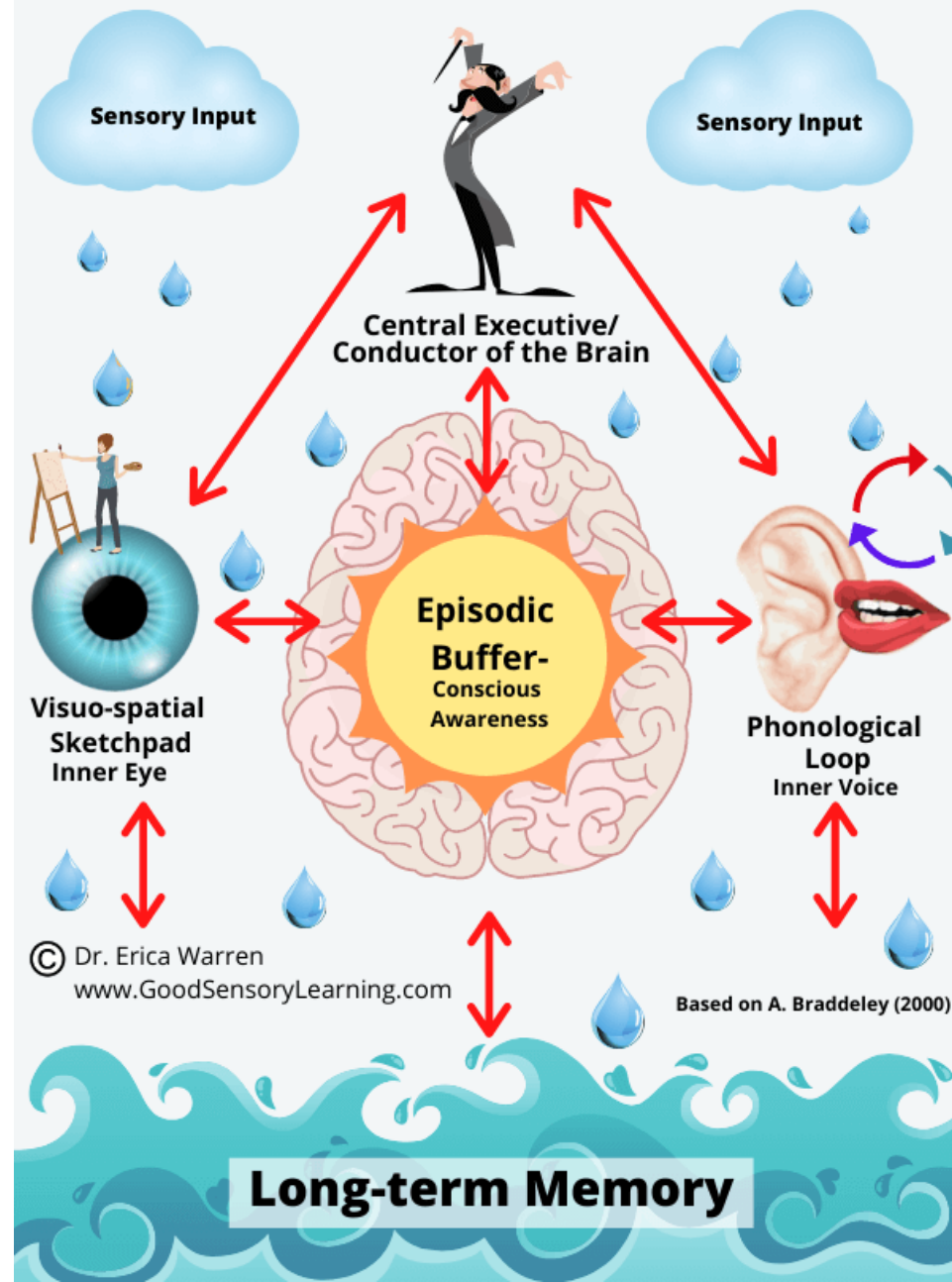
- **Short-term memory (STM):** temporary storage process that can hold a limited amount of information for a brief period (15-30 s)
 - Miller's law: can hold about 7 ± 2 items
 - Holds information **passively**
- **Working memory (WM):** broader system that both holds and actively manipulates information to perform cognitive tasks
 - Capacity is more dynamic, depends on cognitive load
 - Manipulates information **actively**
- Remember, these concepts are models that we use to help us make sense of how our minds work...



Baddeley and Hitch's working memory model

- Central executive: manager/conductor of system, directing attention and cognitive resources
 - PFC
- Phonological loop: processing auditory and speech information – storage and rehearsal
 - Broca's area, left inferior parietal cortex
- Visuospatial sketchpad: processing visual and spatial information – manipulation, navigation, orientation
 - Occipital lobe, parietal cortex, right superior parietal cortex
- Episodic buffer: integrates information from phonological loop, visuospatial sketchpad, and long-term memory to create a coherent episode or memory trace
 - Mainly the hippocampus and parahippocampal regions, along with frontal and temporal cortex

Working Memory Model



























Which words were on the list?

- Juice
- Cushion
- Floor
- Chair
- Needle
- Table
- Couch



Remembrance of things past is
not necessarily the remembrance
of things as they were.

Marcel Proust

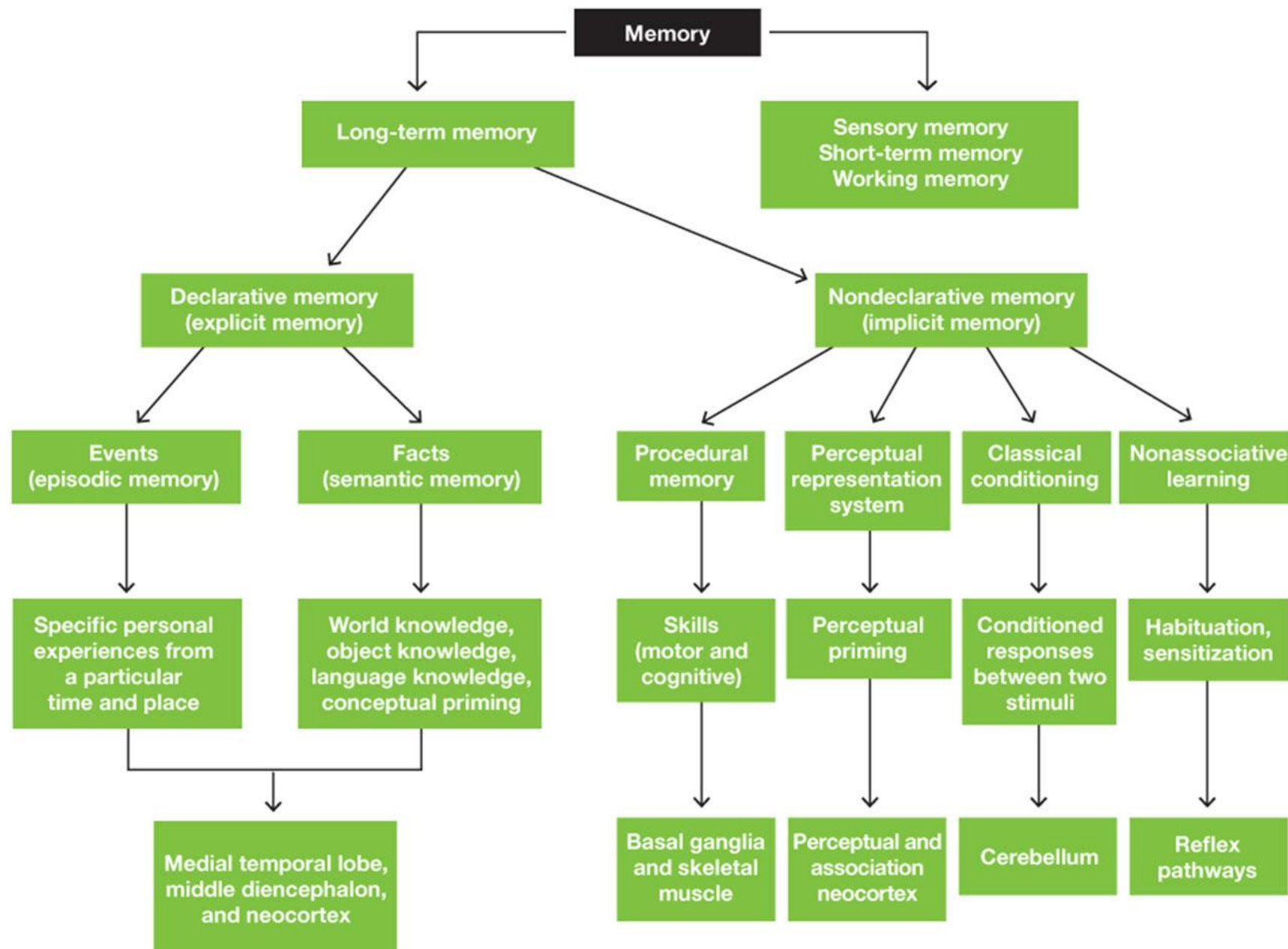
Memory is constructive

- You were noticing and encoding patterns and relationships in the words – they were not discrete, isolated experiences that you ‘store’ and ‘retrieve’ – you were forming a bigger picture about what is being presented and what is meaningful
- Memories are constructed out of these larger narratives that we create in order to make sense of the world
- Similarly, we forget what is not relevant or what does not fit into our story. Forgetting is just as important to being able to know what is important, what matters
- Both remembering and forgetting have complex consequences!



Long-term memory

- **Long-term memory (LTM):** storage of information over extended periods of time, minutes to lifetime
- **Explicit (declarative)**
 - **Episodic:** personal experiences and events
 - **Semantic:** general knowledge and facts
- **Implicit (non-declarative)**
 - **Procedural:** skills and habits
 - **Priming:** enhanced ability to recall information from prior exposure
 - **Conditioning:** learned associations between stimuli
 - **Habituation:** reduced responsiveness from repeat exposure

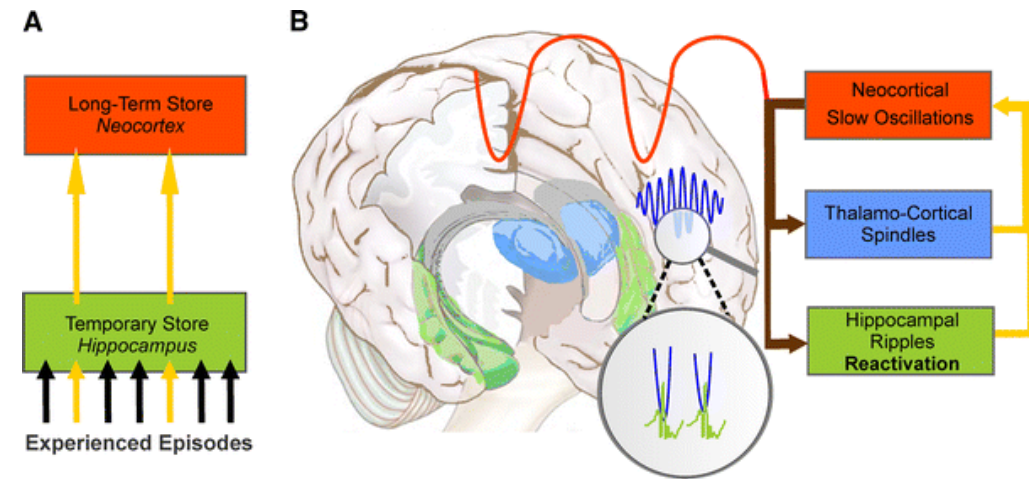


Limitations of memory models

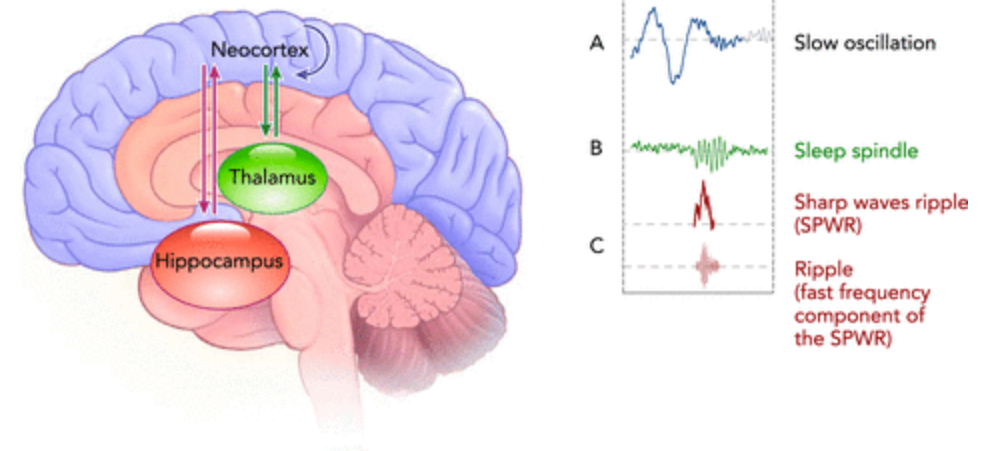
- Categorical distinctions (explicit vs implicit, short-term vs long-term) oversimplify – we can conceptualize different components abstractly, but the reality of these processes is that they are very interactive and overlapping
 - Learning a skill involves both procedural and explicit memory
- Encoding, consolidating, storing, retrieval, learning, forgetting are all very dynamic and multi-dimensional processes
- These models help us think about these processes – which is useful for deep encoding! – but we should remember to use them pragmatically, not think they are ground-truth

Sleep consolidation

- **Slow-wave sleep (SWS):** deepest stage of sleep, declarative memories are consolidated
- **REM sleep:** procedural (implicit) memories and emotional memories are consolidated
- Mechanisms-
 - **Sharp waves and ripples:** highly synchronized high-frequency bursts in which memory traces are encoded between hippocampus and neocortex
 - **Sleep spindles:** 12-16 Hz bursts in the thalamus that regulate communication between hippocampus and thalamus
 - **Synaptic consolidation:** pruning of unimportant connections and enhancement of important ones to improve overall efficiency
- There is a dialogue between **sleep spindles, sharp waves and ripples**, to facilitate **replay** and **consolidation** in **hippocampus** into **long-term storage** in **neocortex**



Neural interplay



Tip-of-the-tongue phenomenon

- When you are temporarily unable to retrieve a full memory trace, despite having the “feeling of knowing”
 - Ex. Can remember the feeling of the word – it starts with a ‘puh’ sound...
 - Disconnect between semantic (meaning) and phonological (sound) memories
- **Interference:** a similar but incorrect memory/word may be “blocking” access to retrieval of the correct word
- **Activation thresholds:** memories may be stored across a network, so attempts to retrieve may activate related nodes of the network (similar words, familiar sounds) without finding the central node
 - A sufficient amount of activity (threshold) must be reached to activate the memory
- The **memory trace** may have faded, due to a lack of use (TOT is more common for less used words)
- The **retrieval cues** may not be strong enough to activate the full memory
- Thinking too hard about it can overburden **working memory**, and may be creating **interference**, so shifting attention and relaxing effort allows the process to work more efficiently
- **Incubation effect:** consciously stepping away from a problem can allow the mind to subconsciously reach solutions

