Memory

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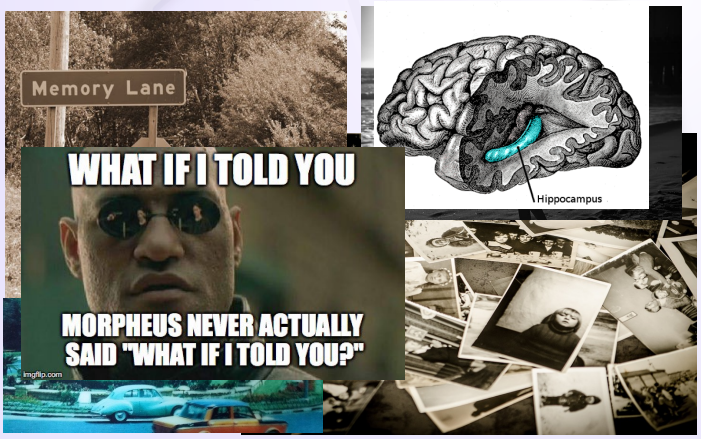
Memory: Its Personal

Your Own Personal Synapses…

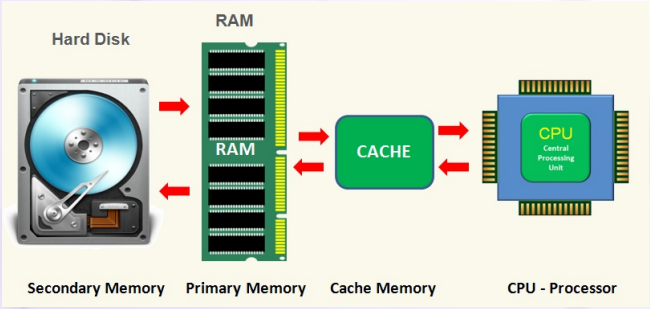
Hippocampal Compression!



Memory Questions

- What *is* memory?
- How can I improve my memory?
- Is Memory Accurate?

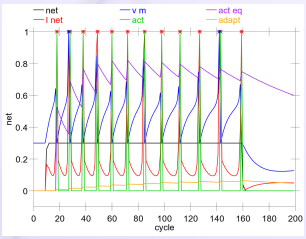
Computer Memory



RAM = Fast, Temporary
Hard Disk = Slower, Long Term

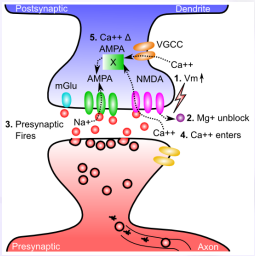
But… no RAM, Hard Disk equivalent in the Brain!

Two Neural Forms of Memory: Activation vs. Synaptic Changes



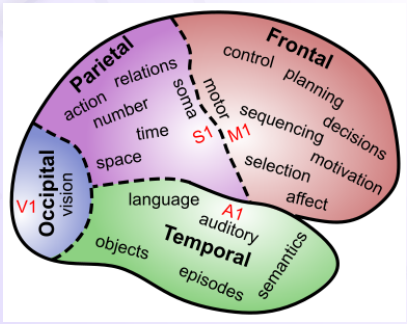
Activation = Neurons continue to fire action potentials, "remembering" what you were just seeing, thinking

But when firing stops.. You forget..



Synapses change strength ("weight") as a result of LTP / LTD (learning): this encodes long-term memories that last even after your activation switches to something new..

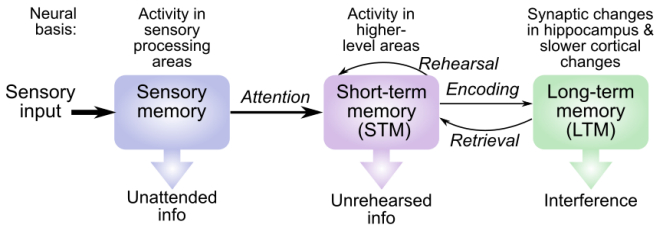
The Brain IS Memory



Memory is located in every single synapse in the brain

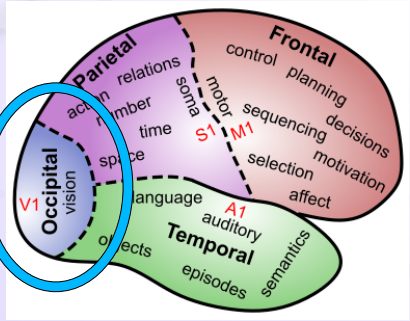
There are as many different kinds of memory as there are neurons and synapses and brain areas…

"Modal" Model



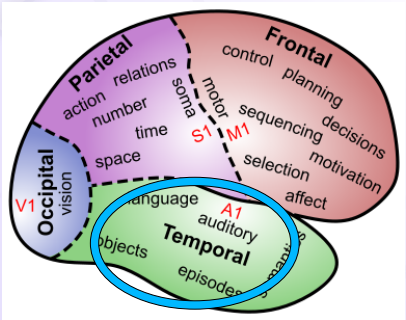
Sensory: **iconic** (visual, < 1 sec), **echoic** (auditory, < 4 sec)
STM: ~20 seconds max, limited capacity (3-4 really, 5-7 for verbal)
LTM: essentially unlimited capacity

Where is Sensory Memory?



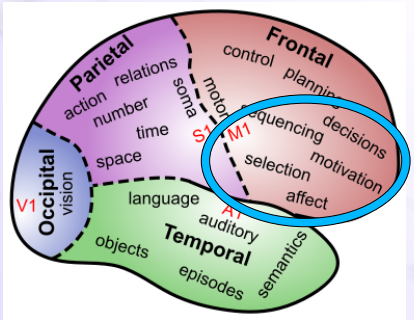
Surprise! It is just neural firing in **sensory** brain areas – those neurons just keep on firing away (briefly..)

Where is Short-Term Memory?



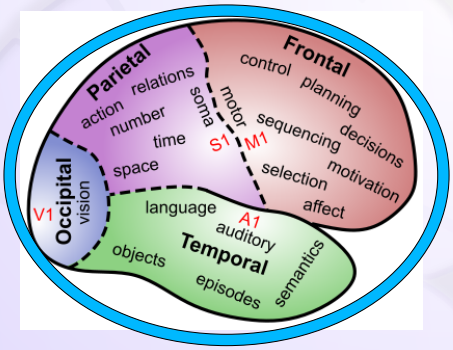
Surprise! It is neural firing in higher level brain areas that represent specific thing you're remembering – those neurons just keep on firing away (briefly..)

Where is Short-Term Memory?



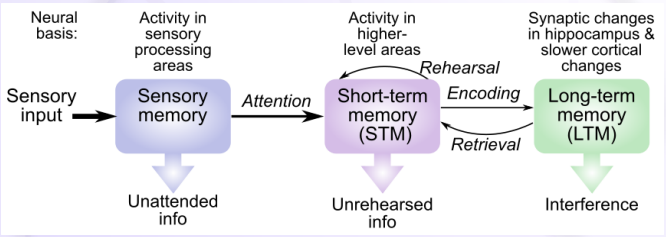
Extra surprise! And it usually requires contribution from prefrontal cortex – has extra holding power to keep those neurons firing longer!

Where is Long-Term Memory?



Surprise! It is in the relevant brain area(s) that encode the specific information! LTM is the sum total of all those synaptic weight changes!

"Modal" Model Dynamics



Sensory & STM do not need to be encoded or retrieved: **Active**..
LTM *does* need to be **encoded** and **retrieved**: **Offline**
Sensory -> STM requires **attention**
STM = transient, needs **rehearsal** to maintain

Sperling Task

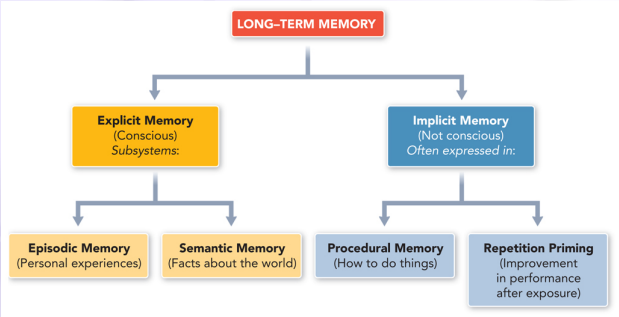
L	Z	R
Q	P	B
N	K	S

Full report: remember everything
Partial report: remember middle row

Attentional focus on iconic -> STM

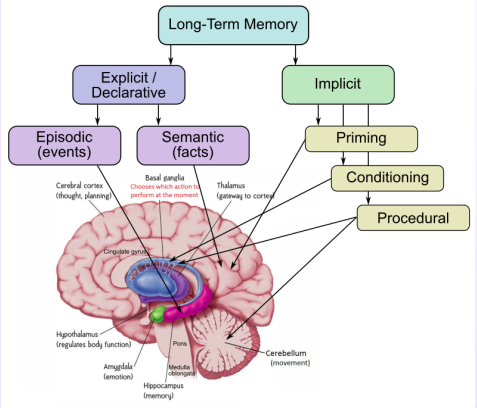
How memories transfer

Organization of LTM



Is this the best way to organize LTM?
Can you think of any other ways?

Where is Long-Term Memory?



"Explicit" vs. "Implicit" is unreliable distinction

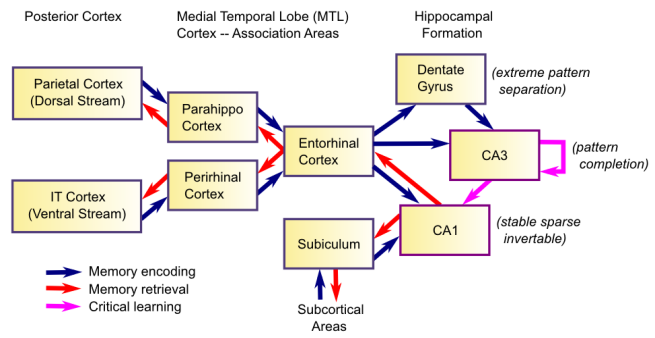
Episodic = hippocampus

Semantic = rest of brain (mostly)

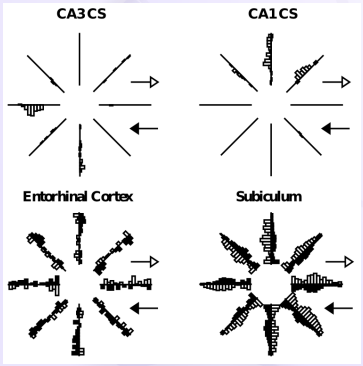
Procedural = Parietal

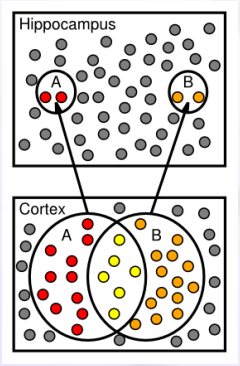
Priming happens everywhere..

Hippocampal Episodic Memory



Sparse Activity: Context Specific

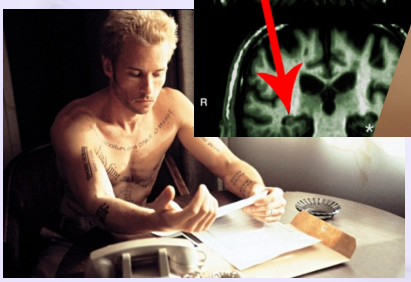




Amnesia

H.M.: epilepsy resection of hippocampus

Still could learn skills: mirror tracing..



Memento (C. Nolan movie)

Learning Rules Across the Brain

Area	Learning Signal: Reward	Error	Self Org
Primitive Basal Ganglia	+++	- - -	- - -
Cerebellum	- - -	+++	- - -
Advanced Hippocampus	+	+	+++
Neocortex	++	+++	++

\+ = has to some extent … +++ = defining characteristic – definitely has
\- = not likely to have … - - - = definitely does not have

Procedural = Cerebellum, Basal Ganglia
Episodic = Hippocampus
Semantic = Neocortex

How to Improve your Memory

- Organize into existing **chunks** (mnemonics)
- Put it in **place** (method of loci: space is special)
- Make connections, and big: **elaborate, levels**
- Generate output: synthesize it
- Error signals: Testing effect (quizzes!)

Chunks!

- OWA… TAJER… KIAM…
- SBCVTMCBNOBH vs. HBONBCMTVCBS

Organizing information into chunks = bigger **Memory Span**

SF was able to remember 110 random digits by chunking into running times, etc.

Encoding and Remembering

Deeper encoding = better memory

- **elaborative encoding** (e.g., method of loci – put each thing in its own special place)
- **Levels of processing**: deeper is better!

LTM can be very **context dependent** (why?)

- state-dependent = a kind of context..

Spaced learning = learning across more contexts – makes memory stronger, more robust!

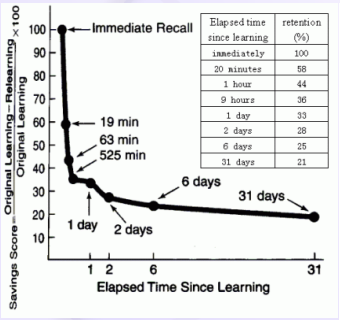
Episodic -> Semantic

LTM memory typically starts in the hippocampus: encode disjointed "facts" = "events"

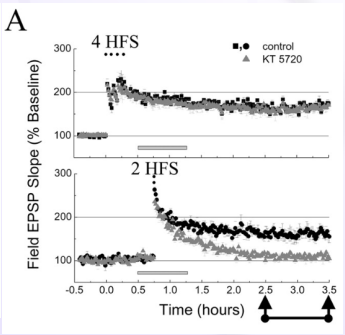
Then slowly, rest of brain soaks up these disjointed facts and organizes them systematically into semantic memory in cortex

This is why it takes 10 years to *really* learn..

Memory Retention: Decay / Interference



Elapsed time since learning	retention (%)
immediately	100
20 minutes	58
1 hour	44
9 hours	36
1 day	33
2 days	28
6 days	25
31 days	21



Retro / Pro Interference

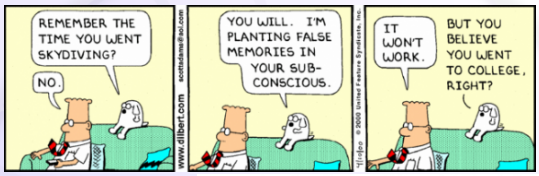
Retroactive Interference:

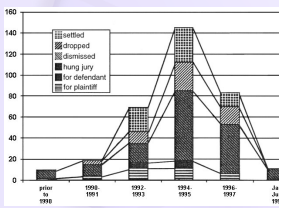
* New learning ruins old (retro) memories
* This is most common form (synapses changing)

Proactive Interference:

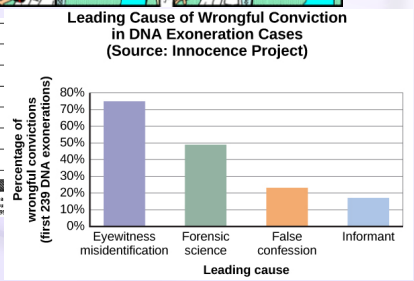
* New (pro) learning is worse because of existing
* Rarer: e.g., sure that person is "Robin" but is not..

False Memories: Real world issue!





Repressed memory cases



Deese Roediger McDermott

Working Memory vs. STM

Working memory = activity in PFC reflecting stuff you are actively working on

Working memory is a special kind of STM: because PFC is special in not being so easily distractible