How We Learn: Memory & the Brain

or Where did I put those keys?

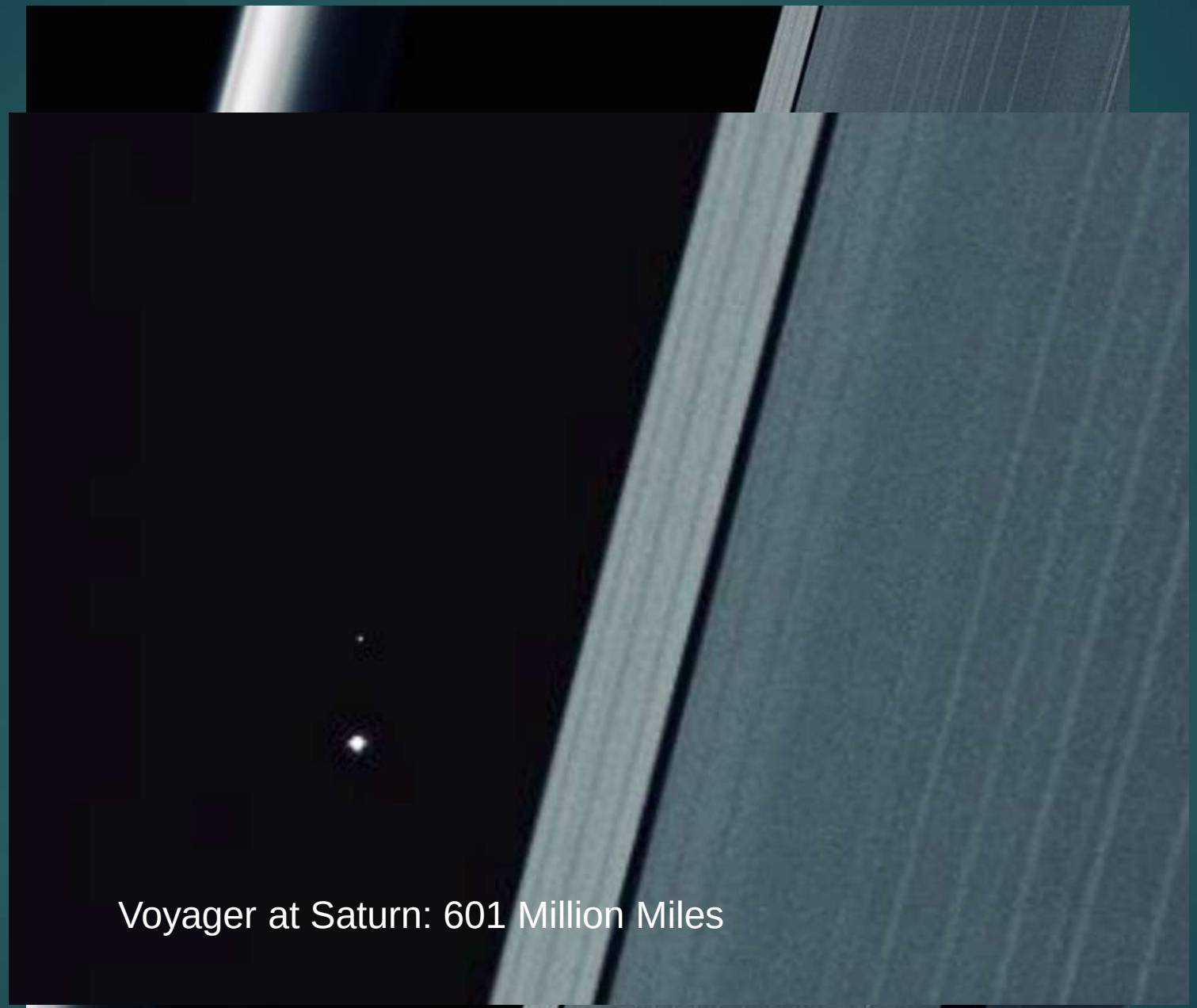
CHARLES J. VELLA, PHD

2019

Example of Learning over 18 years
No prior talent needed


THE
VELA
PUMPKINS

Passionate Pumpkin carving 10 year old daughters grow up to have good brains, high IQs, and graduate from UCSF School of Medicine in 2015 and is now a 3rd year radiology resident. Yeah Maya!!



Voyager at Saturn: 601 Million Miles

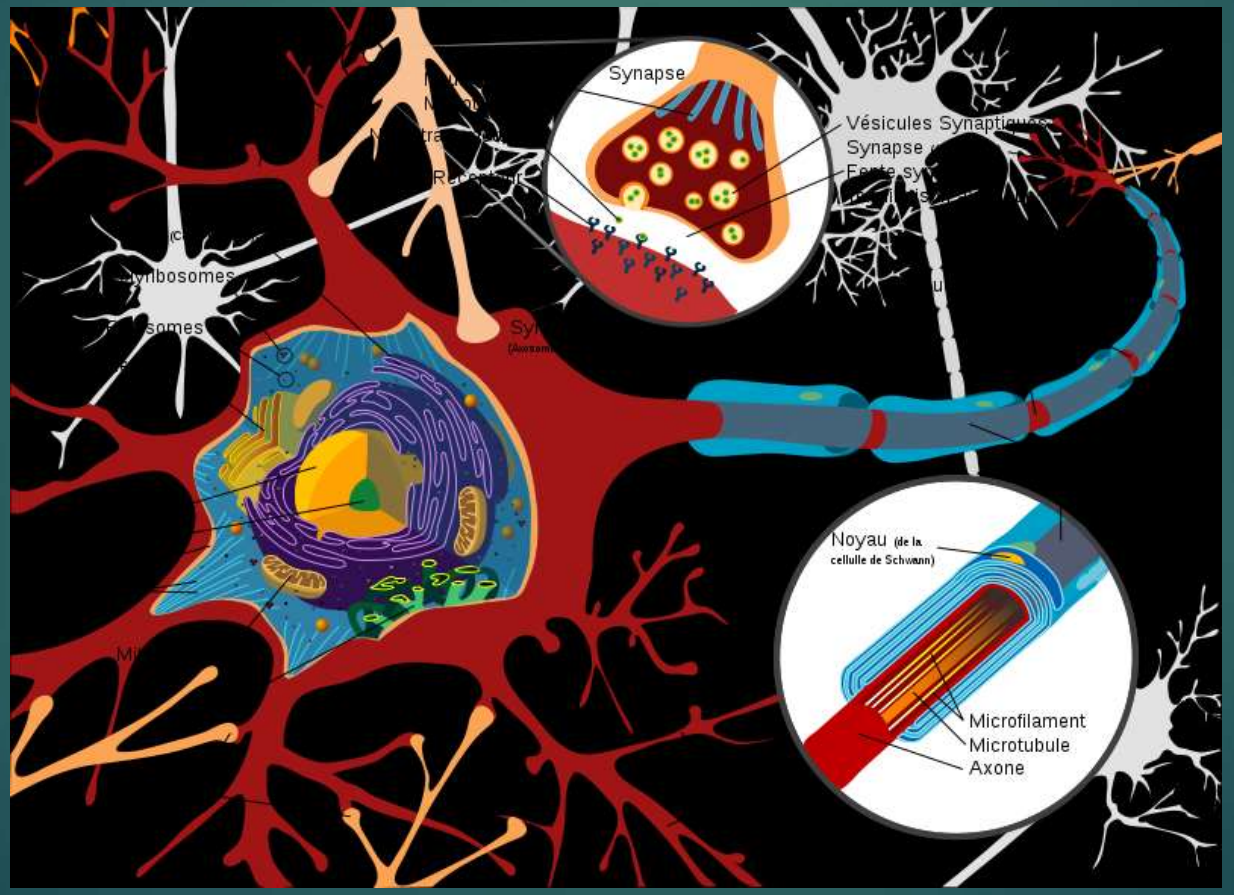
Nothing in biology makes sense except
in the light of evolution.

Theodosius Dobzhansky

….including human memory

Neurons: We have 170 billion brain cells with 10,000 synapses each (10 trillion connections)

Neuron

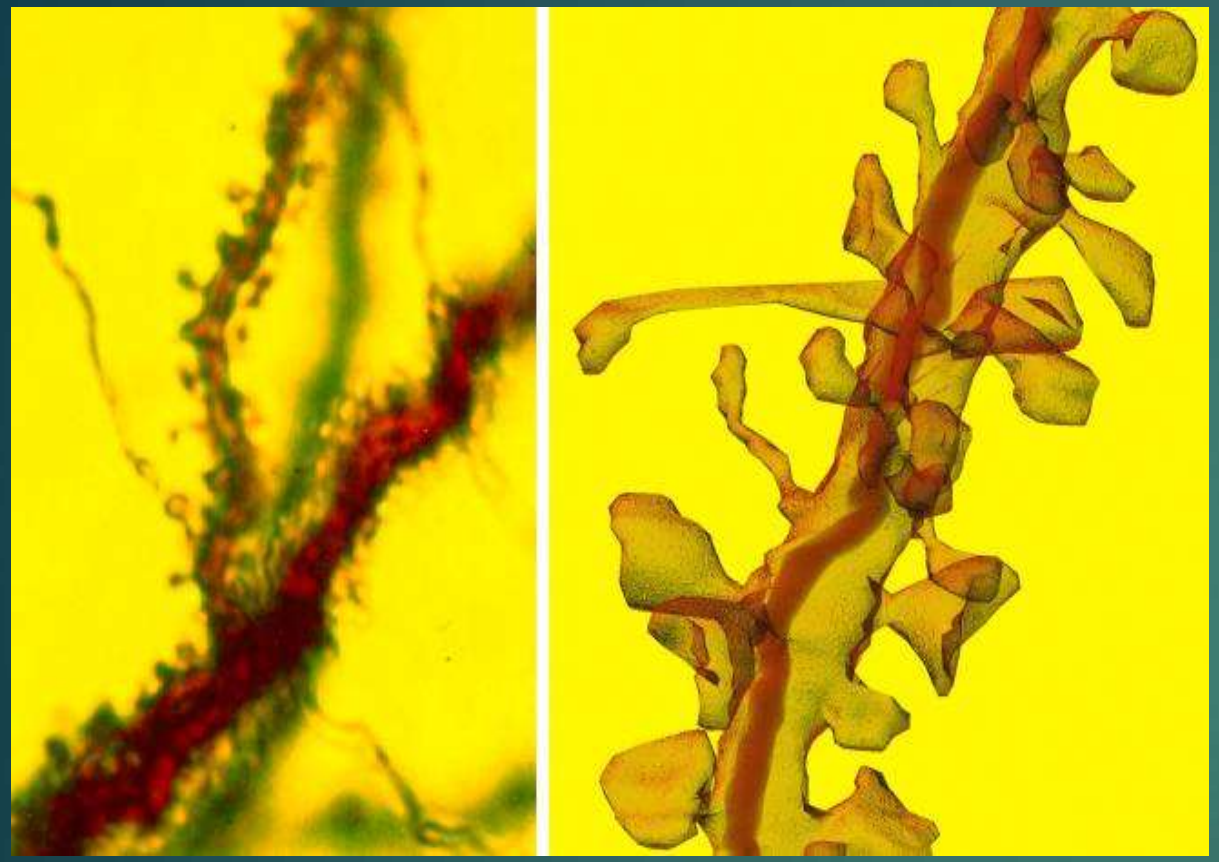


Axon

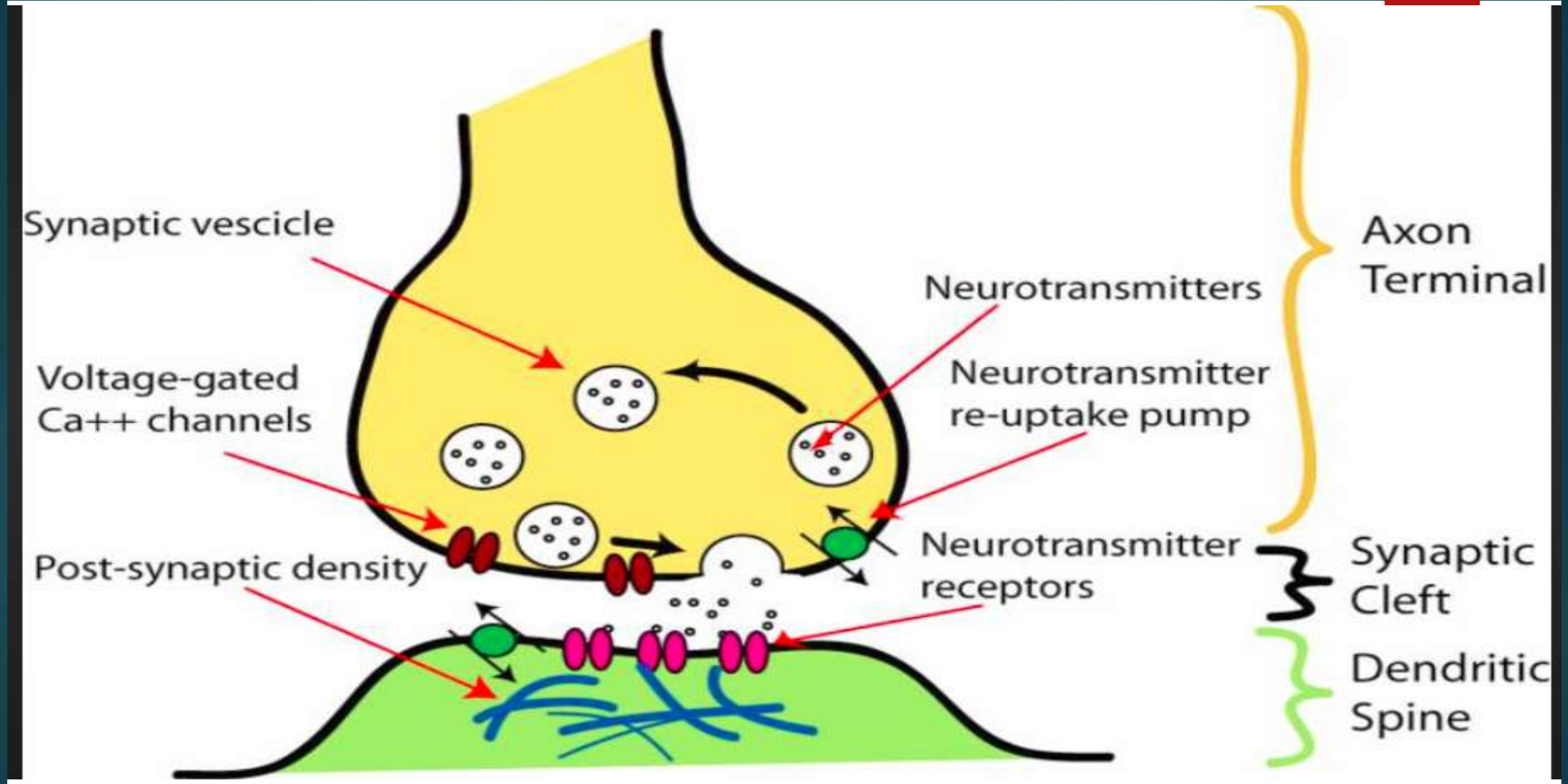
Dendrites

Suzana Herculano-Houzel et al., 2009

Dendrites under Electron Microscope

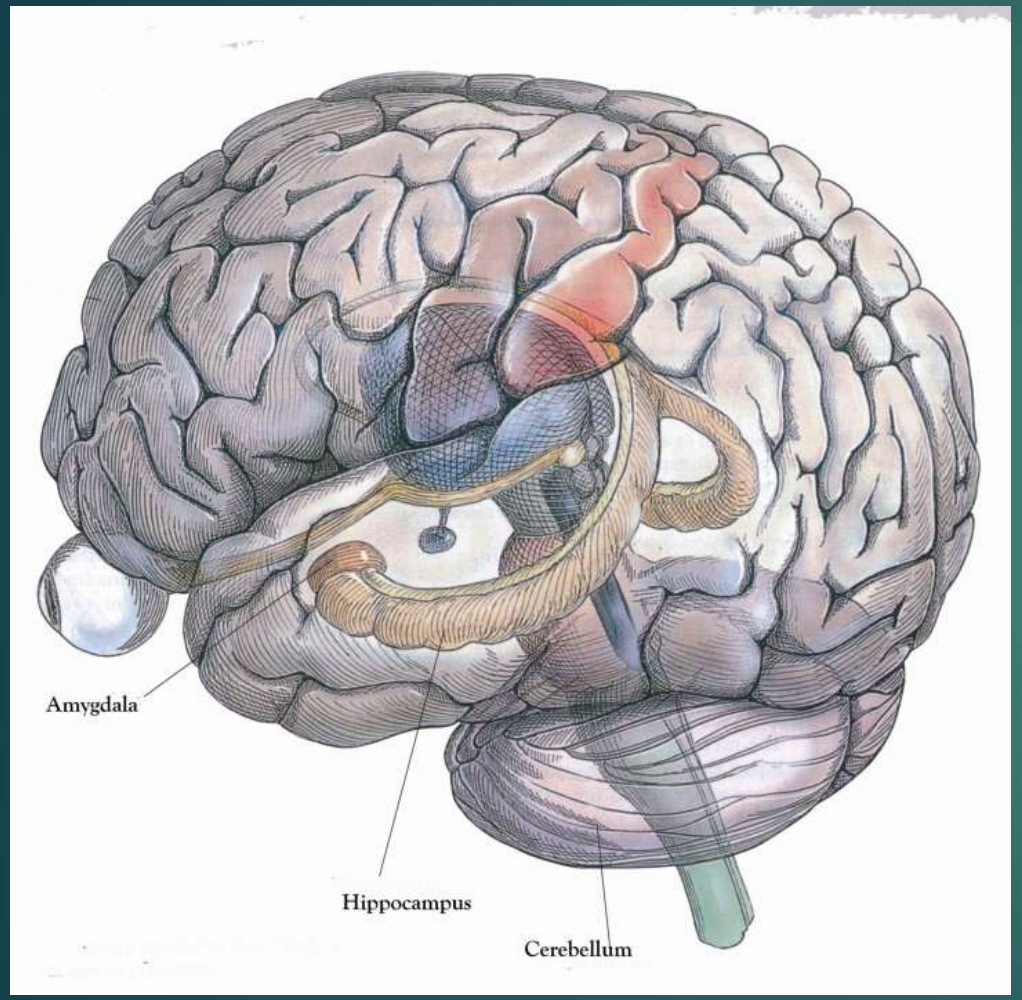


Highly dynamic: can appear in hours to days and also disappear.
60% of cortical spines are permanent; hippocampal spines recycle.


Synaptic vescicle
Voltage-gated
Ca++ channels
Post-synaptic density
Neurotransmitters
Neurotransmitter
re-uptake pump
Neurotransmitter
receptors
Axon
Terminal
Synaptic
Cleft
Dendritic
Spine

Synaptic connections
Are the basis of
memory

Hippocampus & Prefrontal Cortex



Hippocampus:

- Memory central
- Learning anything new
- Most sensitive to low Oxygen

Prefrontal Cortex

- what makes you a rational adults
- ability to inhibit inappropriate behavior
- Required for memory retrieval

Proust & his Madeleine: Olfaction and Memory

"I raised to my lips a spoonful of the tea in which I had soaked a morsel of the cake. No sooner had the warm liquid mixed with the crumbs touch my palate than a shudder ran trough me and I sopped, intent upon the extraordinary thing that was happening to me. An exquisite pleasure invaded my senses..... And suddenly the memory revealed itself. “

Function of the brain: buffer vs. environmental variability

- Main function of a brain is to protect against environmental variability through the use of memory and cognitive strategies that will enable individuals to find the resources necessary to survive during periods of scarcity.

- Lots of ideas why brain size increased; they can be boiled down to idea that the hominins placed a premium on:
  - memory storage capacity and behavioral flexibility
  - in response to quickly shifting environmental conditions.

Evolution of Memory

- Memory evolved, via natural selection, to enhance survival and reproductive fitness.
- Events that potentially effected our survival lead to superior long-term retention, i.e. visual and traumatic memory.
- Memory is constructive, especially sensitive to visual imagery and processing of meaning/future prediction.
- Memory is inherently associative; we link new info to what we know.

J. Nairne & J. Pandeirada, Cur. Dir. In Psy. Sc., 2008

Memory Evolved

- Natural selection advantages to organisms capable of using the past in the service of the present.
- At some point in our ancestral past, memory developed because it helped solve problems related to survival and ultimately, reproduction.
- An organism with the capacity to remember the location of food, types and location of potential predators, was more likely to survive.
- We remember animate (vs inanimate) better.

Cambrian: 500 MYA

- Need to know where I am and where is guy who wants to eat me

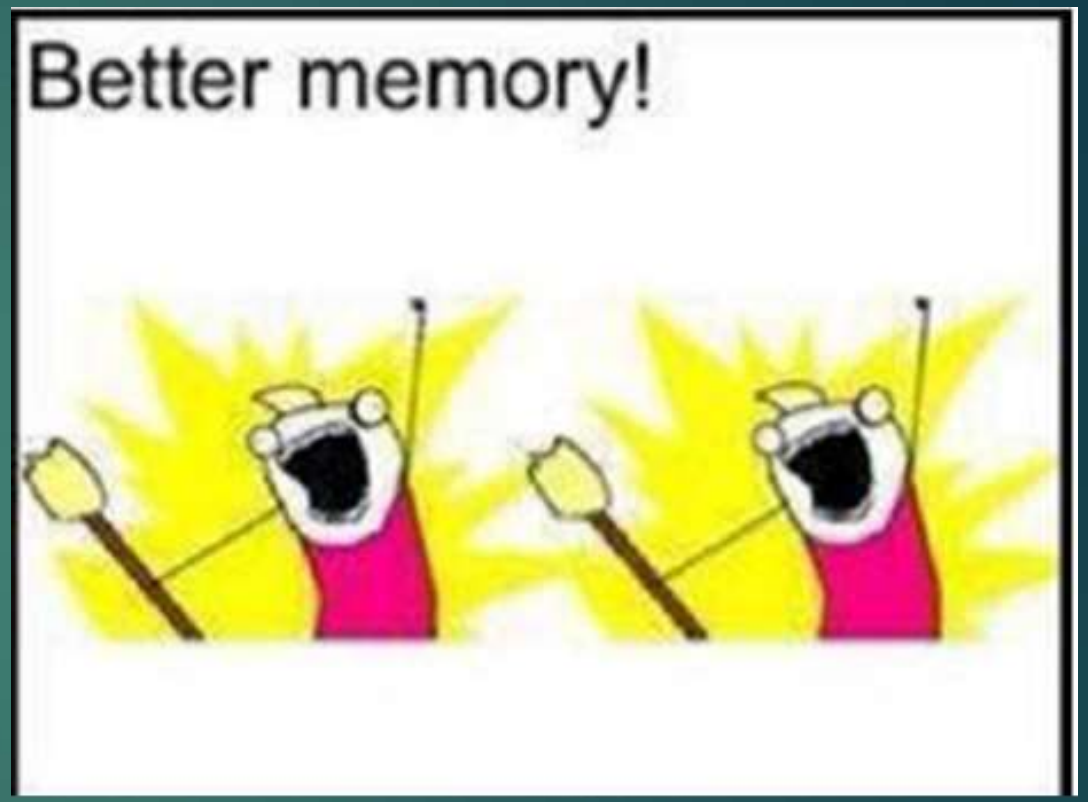
- Hippocampus (brain's memory central) is highly connected to smell

- Hippocampus has both memory and place (spatial) cells
- Olfaction (smell), locomotion & spatial position initially drove the development of memory in our original water environment; It specializes in connecting new to old information

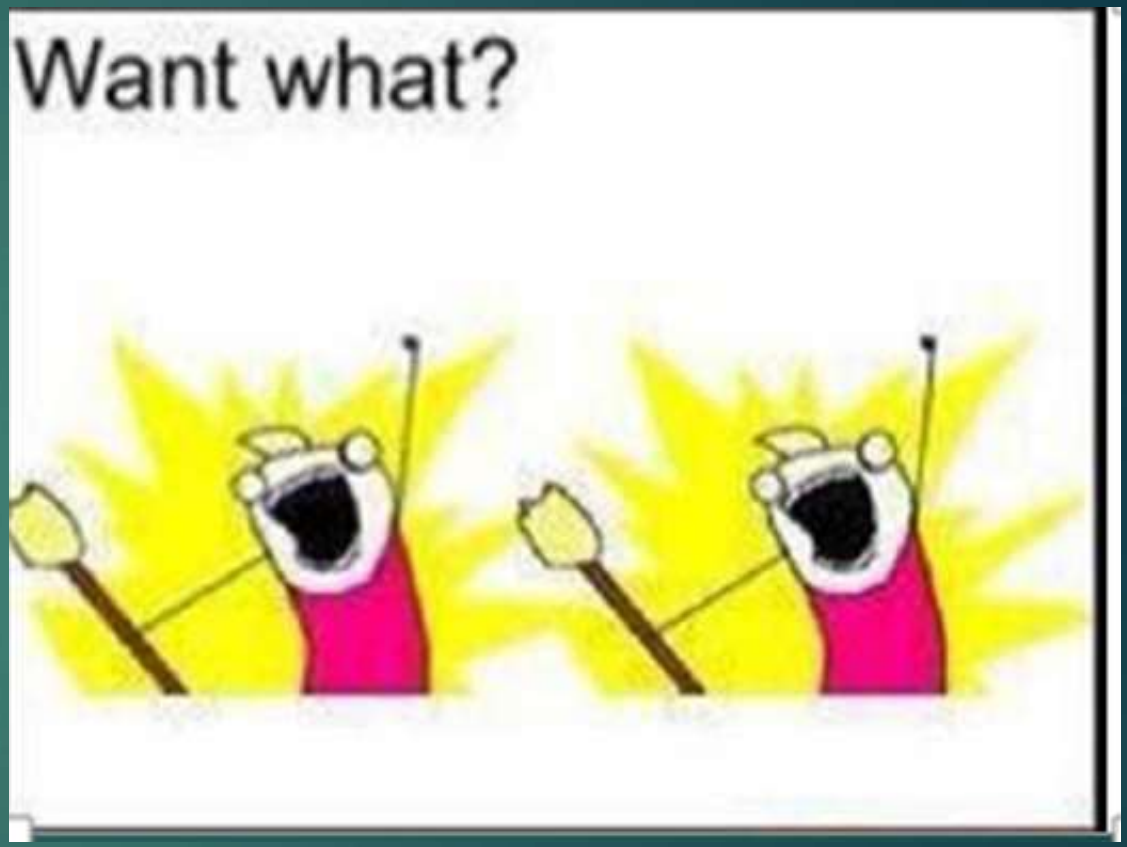
Jacob's Olfactory Spatial Hypothesis

- Brains evolved to map the world; to create a cognitive map of environment
- Development of the Hippocampus: evolution of associative learning
- Olfaction evolved for the primary purpose of navigating in a chemical world. Nervous systems developed specializations not just for the discrimination of odorants but for organizing the stimuli into functional associative memory structures
- The hippocampal map evolved from the olfactory environmental map


What do we want?


Better memory!


When do we want it?


Want what?

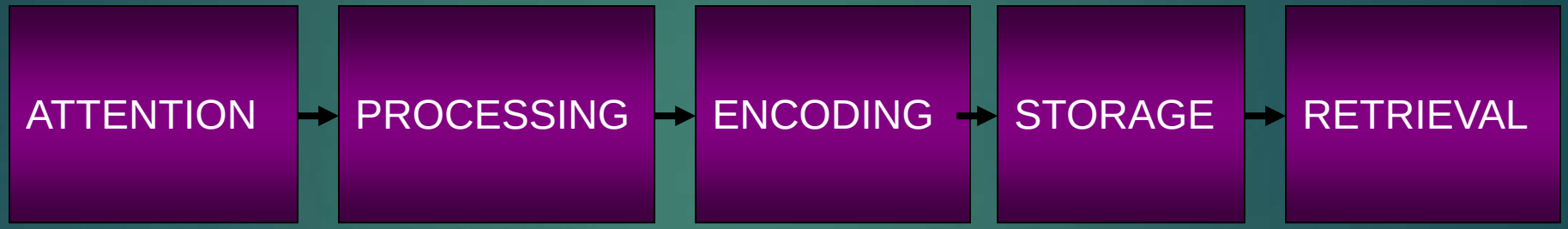
Functions of Memory

- Memory plays a huge part in how we make sense of the world — how we organize our past experiences and how we judge how we should act in the future
- Enables you to remember your past
- Determines your sense of self
- Determines your ability to plan for future

Learning: Ability to learn new things

Learning is a restless, piecemeal, subconscious, sneaky process that occurs all the time, when we are awake and when we are asleep.

Older Explanation of Memory



William James: *"My experience is what I agree to attend to."*

Tip #1: There is no memory without first paying attention.

Purpose of Memory: Future focus

- We think of memory as a record of our past experience.
- But the idea is not just to store information; it's to store relevant information.
- Memory is the use of our experience to guide future behavior.
- We process memory in order to solve problems and to do social interactions.
- Things we should learn from, things that are particularly important or that have strong emotions tied to them, may be things that are going to be important in the future.
- What's important for future behavior

Memory now:
Tasks not evolved for, but now need to remember

- Dates
- Names
- Social Security number
- Telephone numbers
- Addresses
- Facts for an exam
- Pin codes
- Shopping lists
- Facebook friends
- Parking lot floor number

Memory: A Current Review

Memory: The most common neurological complaint

Memory: The foundation of cognition and self identity

Memory: Not a unitary process

Multiple memory systems with different brain sites

Diverse Nomenclature

Memory: A reconstruction, not a replay, reproduction or perfect image

Tip #2:

Best way to remember things is to encode them into the format that your primate brain was good at processing:

Use visual & contextual images

Tip #3: Using categories increases memory

- Brain does this automatically: Memory tests assess semantic clustering ability

- Remember: chair, tiger, couch, elephant, bookcase, lion, table, zebra
  - Remind yourself of the category:
  - Furniture: chair, couch, bookcase, table
  - Animals: tiger, elephant, lion, zebra

Memory is not one thing or in one place in your brain; it is not a single process

We know this from patients who exhibit memory dissociations:

1 – No new factual learning, but normal behavioral learning

2 – Impaired short term Working Memory, but normal long term memory (LTM)

3 – Impaired LTM, but normal Working Memory

4 – No recognition memory of vegetables, but intact knowledge of how to cook them

5 – No knowledge of inanimate objects, but normal knowledge of animate objects

6 – New skill learning (i.e. riding a bicycle), but failure to remember where, when, and under what conditions skill was learned.

Memory in the Movies

Memento:
Best film on amnesia;
Error: Planning

Error: Engram
Location

Rashomon:
One of the Great films of all time:
Whose memory is correct?

Amnesia in the Movies

- **Rashoman**
- **Spellbound (Peck & Bergman)**
- **Anastasia**
- **Paycheck**
- **Memento**
- **50 First Dates**
- **Bourne Identity**
- **Long Kiss Goodnight**
- **Manchurian Candidate**
- **Eternal Sunshine of the Spotless Mind**
- **Finding Nemo**
- **The Majestic**
- **Mulholland Drive**
- **Paris, Texas**
- **The Lookout (accurate)**
- **Unknown White Male (Fugue)**

Memory on TV & in the Movies

- Although clinically rare, profound amnesia is a common cinematic device

- Most amnestic (inability to remember) conditions in films bear little relation to reality.

S. Baxendale, *BMJ*. 2004:
“Memories aren't made of this: amnesia at the movies”

Memory on TV & in the Movies 2

- In the movies, Traumatic Brain Injury results in a profound loss of memory for the past with intact new learning,
  - the exact opposite of neurologically based amnesia (no new learning and a small loss of past memories)

- At the cinema, two head injuries are better than one. One of the commonest "cures" for an amnesic syndrome sustained as a result of a severe head injury is another head injury.

- **In most films memories are not lost, just made temporarily inaccessible**. Recovery of memory is possible, via various unlikely means.

Long Term Memory: Human Brain's Memory Capacity

Number of Neurons: 86 billion

Number of Glial Cells: 86 billion

Number of neuronal synapses: 10^{13} (10 trillion)

Number of neuronal impulses transmitted in a lifetime: 10^{23} (100 sextillion)

For comparison: Library of Congress has only 32 trillion bytes of info in 530 miles of selves

Our brain could hold 3 million TV shows

LTM: storage of vast amounts of information, coded by perception and meaning; no upper limit; we never run out of memory space

Simonides of Ceos: Inventor of the Memory Palace or the method of loci

- Greek lyric poet (556-468 BC): Classic tale of his attending a banquet where he recited a poem and then was called out by 2 visitors; banquet hall roof collapsed killing everyone inside; all bodies crushed beyond recognition.
- Bereaved relatives could not identify any of the bodies until Simonides returned and correlated their identities to their positions (*loci* in Latin) at the main table before his departure.
- He later drew on this experience to develop the 'memory theater' or 'memory palace', a system for mnemonics.
- According to Cicero, Themistocles wasn't much impressed with the poet's invention: "I would rather a technique of forgetting, for I remember what I would rather not remember and cannot forget what I would rather forget."

Most powerful memory technique: Method of loci

- The oldest known mnemonic strategy is called the method of loci ("loci" is the plural of locus, which means location, or place).

- It's based on the assumption that you can best remember places that you are familiar with, so if you can link something you need to remember with a place that you know very well, the location will serve as a clue that will help you to remember.

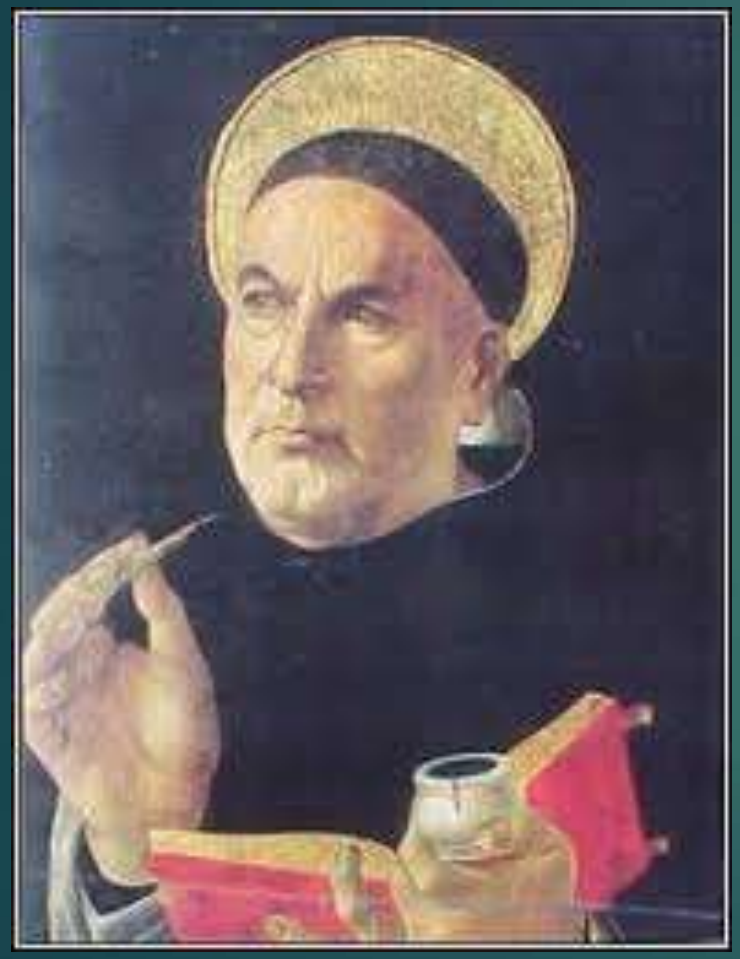
- It is possible to remember anything by associating it with a visual image of a location.

- Dating back to about 500 b.c., it was the most popular mnemonic system until about the mid-1600s, when the phonetic and peg systems were introduced.

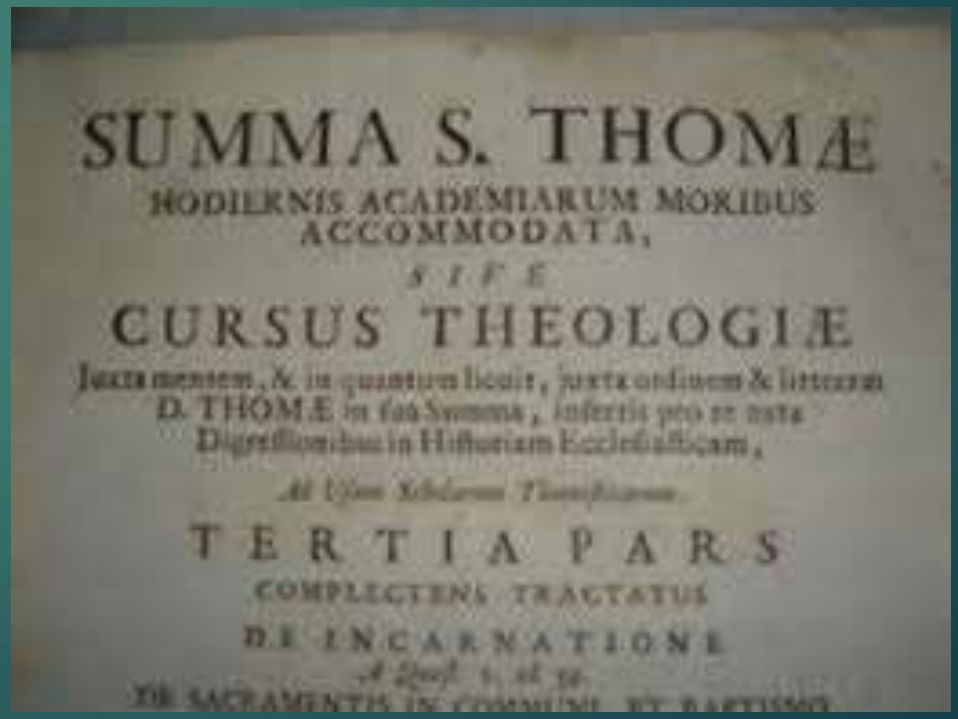
Tip #4: Method of loci

- Think of a place you know well, such as your own house.
- Visualize a series of locations in the place in logical order. Picture your path to get from the front door to the back door, noting each room as a separate memory location. Each piece of furniture could serve as an additional location.
- Place each item that you want to remember at one of the locations.
- When you want to remember the items, simply visualize your house and go through it room by room in your mind. Recall items in locations.
- Remember, the more creative and visually vivid your ideas, the better.

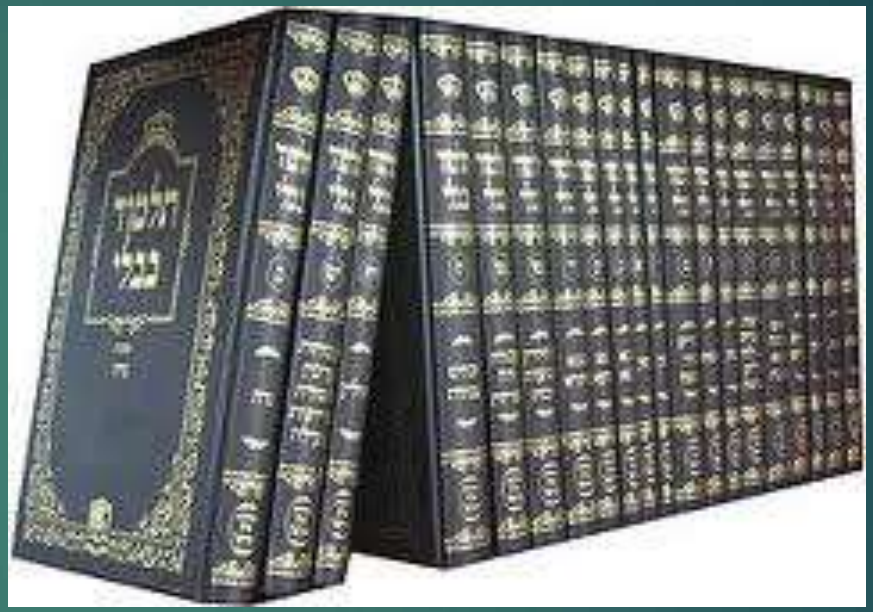
Thomas Aquinas: (1265–1274)
Middle ages was the age of mnemonics



Dictated the *Summa Theologica* (3100 pp) from memory



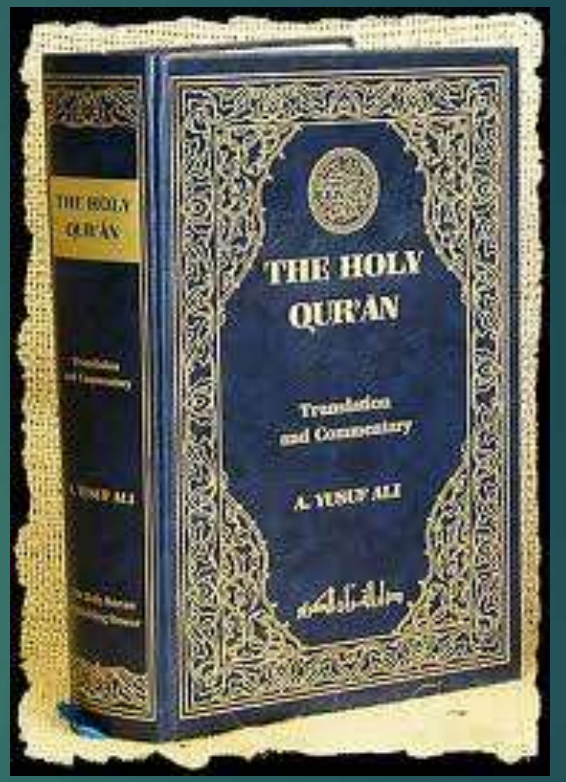
Jewish Talmudic Scholars:
Single minded perseverance in their studies



Stories of ultra-Orthodox Jews who memorized all 5,422 pages of the Babylonian Talmud so thoroughly that when a pin was stuck through any of the Talmud's 63 books, they could tell you which words it passed through on every page.

1917 *Psych Review*: group of Polish Talmudic scholars (Shass Pollak) who did this

Islamic Koran Scholars

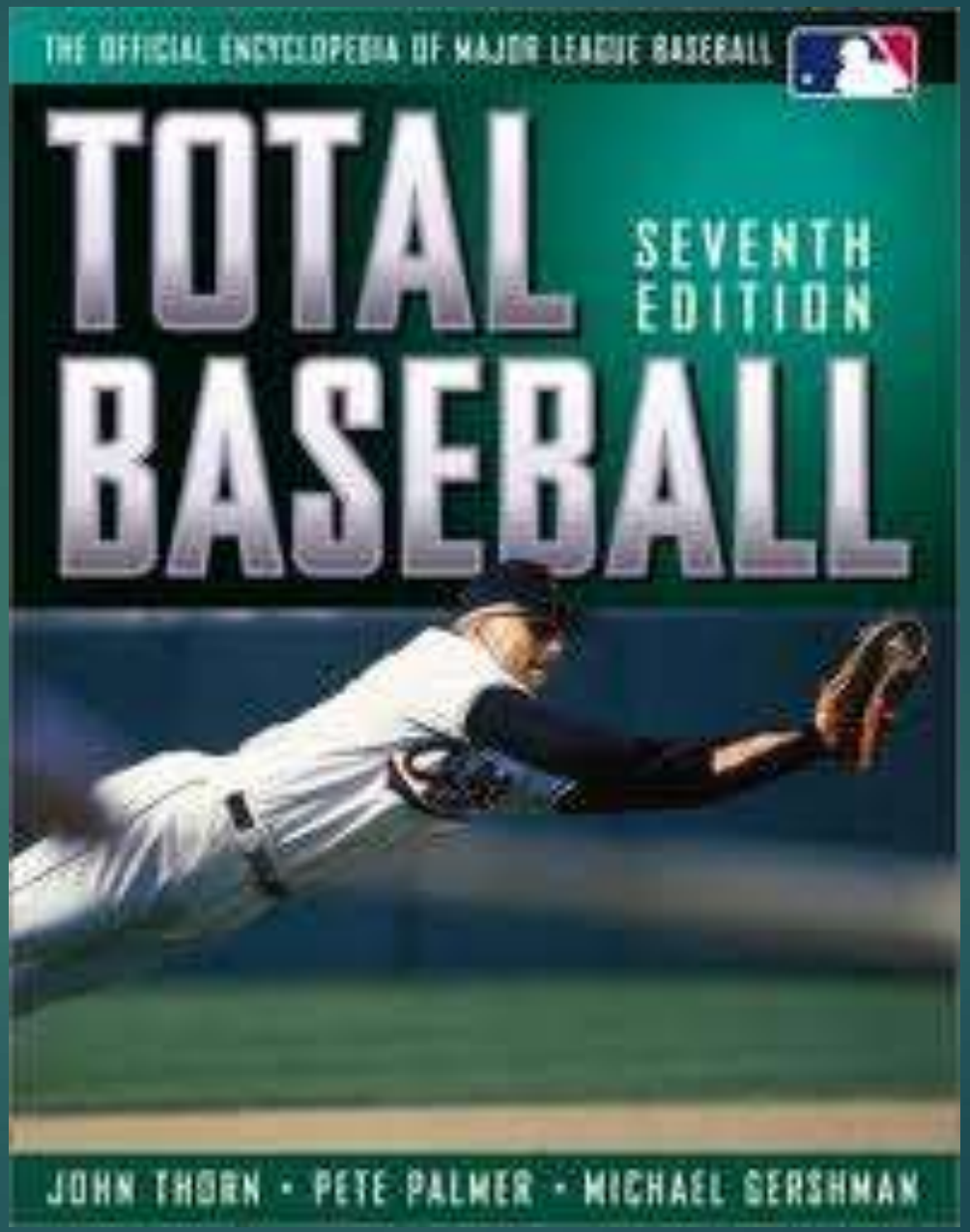


West African griots: Oral genealogists

Oral genealogists

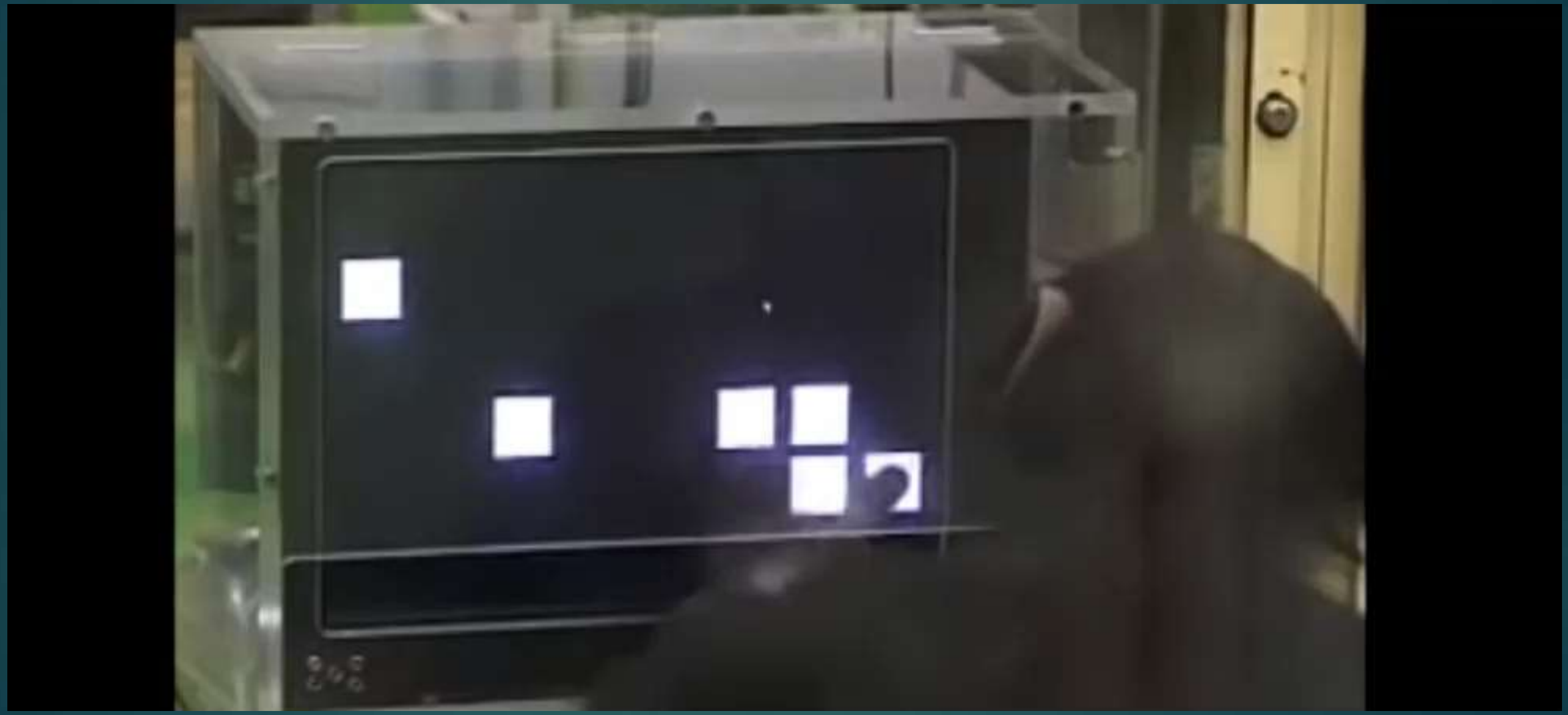
Walking history books, preserving their ancient stories and traditions through song

Baseball fanatics



Ayumu, the chimp: faster WM than human adults

- Chimps can memorize patterns of numbers at a glance
- Recalls 9 masked digits faster and more accurately than any adult human



Great human memorization ability

- Despite these prior examples of great memory ability,
  - there is continuing question of whether there is such a thing as photographic or eidetic memory,
  - without the use of mnemonics (learned memory techniques).

- Current opinion: photographic memory has never been scientifically demonstrated to exist.

That is what it takes to become a world memory champ.

Could you memorize the exact order of a deck of cards during the 53 seconds it takes elevator to get to the top of Empire State Building?

USA National Memory Championship

- March 13, 2007, New York: Joshua Foer memorized the order of a deck of cards in 1 minute 40 seconds
- World Champions: 1 deck in 30 seconds
- To attain the rank of grand master of memory, you must be able to perform three feats. You have to memorize:
  - 1,000 digits in under an hour,
  - Precise order of 10 shuffled decks of playing cards in 1 hour
  - 1 shuffled deck in less than two minutes.
  - 36 grand masters of memory in the world; but they have normal memory functioning otherwise
  - FMRI = R hippocampus activation

Moonwalking with Einstein - Joshua Foer

Mnemonic Training (Memory Palace) Reshapes Brain Networks to Support Superior Memory

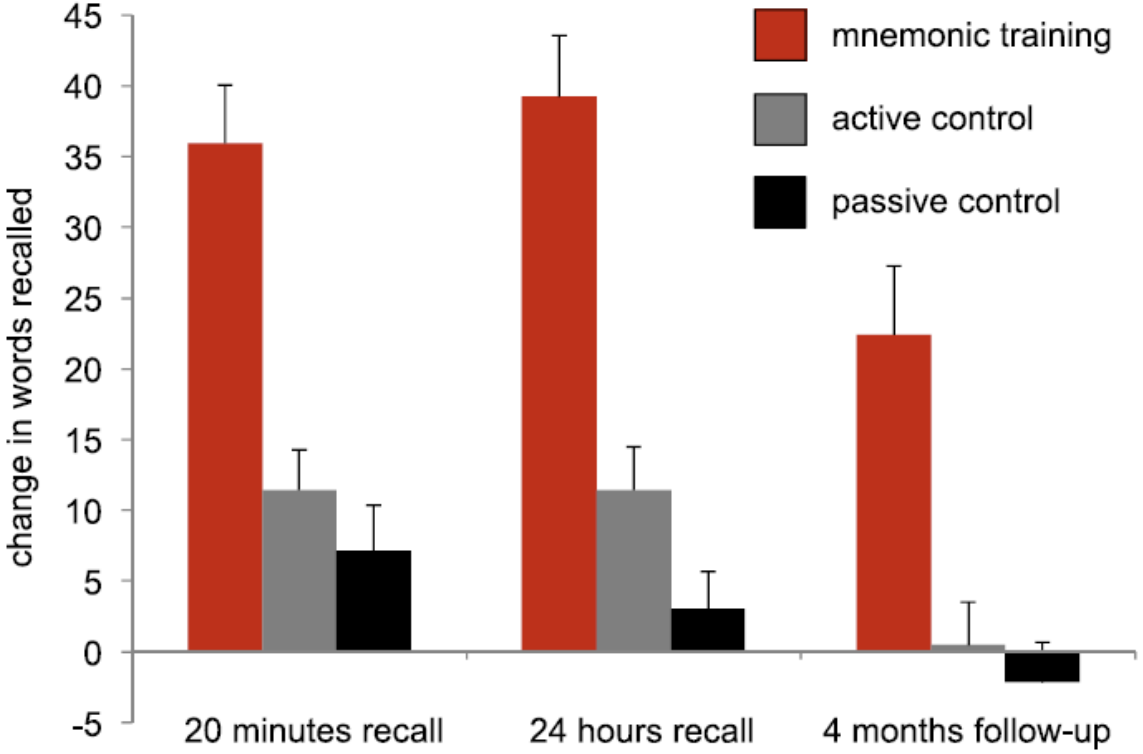


Figure 2. Mnemonic Training Has Potent and Enduring Effects on Memory Capacity

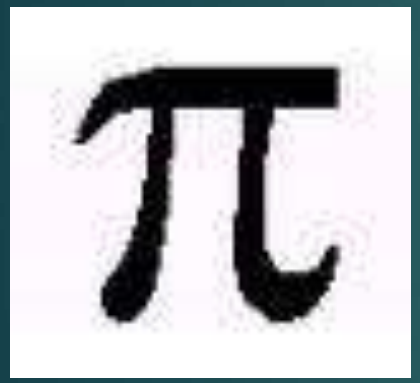
Experimental subjects improved significantly at memory tasks, yet did not exhibit any structural brain changes.

Most robustly increased Functional Connectivity among the right DLPFC, the MPFC, and structures of the MTL in expert users of mnemonics and in naive subjects after mnemonic training

(https://memocamp.com/)

Greatest Feats of Memory

- Oct 4, 2006: Akira Haraguchi, age 60,
  - Recited *Pi* to 100,000 decimal places from memory in 16 hours



3.1415926535 8979323846 2643383279 5028841971 6939937510 5820974944 5923078164 0628620899
8628034825 3421170679 8214808651 3282306647 0938446095 5058223172 5359408128 4811174502
8410270193 8521105559 6446229489 5493038196 4428810975 6659334461 2847564823 3786783165
2712019091 4564856692 3460348610 4543266482 1339360726 0249141273 7245870066 0631558817
4881520920 9628292540 9171536436 7892590360 0113305305 4882046652 1384146951 9415116094
3305727036 5759591953 0921861173 8193261179 3105118548 0744623799 6274956735 1885752724
8912279381 8301194912 9833673362 4406566430 8602139494 6395224737 1907021798 6094370277
0539217176 2931767523 8467481846 7669405132 0005681271 4526356082 7785771342 7577896091
7363717872 1468440901 2249534301 4654958537 1050792279 6892589235 4201995611 2129021960
8640344181 5981362977 4771309960 5187072113 4999999837 2978049951 0597317328 1609631859
5024459455 3469083026 4252230825 3344685035 2619311881 7101000313 7838752886 5875332083
8142061717 7669147303 5982534904 2875546873 1159562863 8823537875 9375195778 1857780532
1712268066 1300192787 6611195909 2164201989

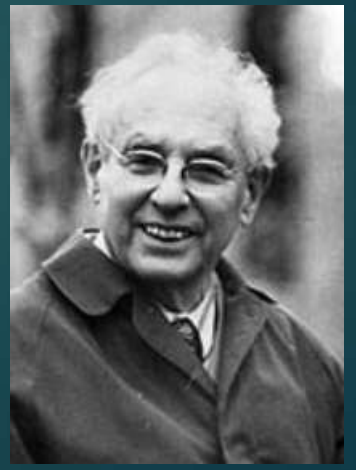
  - Later forgot most of it
  - He assigned kana sound symbols to numbers, allowing for the memorization of Pi as a collection of stories.

Alexander Luria, *Mind of a Mnemonist*: Study of Russian Journalist, Solomon Veniaminovich Shereshevskii

6	6	8	0
5	4	3	2
1	6	8	4
7	9	3	5
4	2	3	7
3	8	9	1
1	0	0	2
3	4	5	1
2	7	6	8
1	9	2	6
2	9	6	7
5	5	2	0
x	0	1	x

Note: With only 2 to 3 min study of such a table, S. was able to reproduce it in reverse order, horizontally, or vertically, or to reproduce the diagonals.

Shereshevskii



Luria

Hyperthymesia: Super memory

- Solomon V. Shereshevskii: A journalist who never took notes. Editor was disturbed and sent him to Luria for testing.

- S. used two “strategies” or abilities typical of mnemonists:

  - Rich synesthesia-like quality to his perception of stimuli - leads to stronger associative links: sounds had shapes, colors; letters had taste, fragrance
  - Vivid and elaborate visual imagery of things he should remember

- Lacked normal forgetting filter. Had poor EF (problem solving).

Highly Superior Autobiographical Memory: Hyperthymestic syndrome: excessive (hyper) and remembering (thymesis)

- Jill Price, Brad Williams,Rick Baron, Bob Petrella, Marilu Henner, a star of the hit TV show 'Taxi'; 56 known
- What day of month did the Loma Prieta earthquake occur?
- All together in James McGaugh lab: When he asked the group when a 7.1 earthquake hit the San Francisco-Oakland area, all replied, "October 17th, 1989."

- Perfect recollection of events of everyday of their lives

- A byproduct of compulsively making journal and diary entries.
- Often have depression stemming from the inability to forget unpleasant memories and experiences from the past
- Only 2 of 55 in the United States have successful marriages

Interest in topic is important

(Parker, McGaugh, 2006; Cahill,)

HSAM: highly superior autobiographical memory

- Larger left temporal-parietal junction & left posterior insula, as well as the lentiform nucleus (obsessive-compulsive disorder link).
- HSAM have far superior memory of distant past; are better at retaining memories; have habitual rehearsal of their past; but no better at acquiring memory (not superior learners)
- Often show obsessive behavior (tendency to hoard things or avoid germs), though none have been diagnosed with OCD. They habitually recall and reflect on their lives; a unique form of OCD.
- They do not exhibit better cognition in other realms, incl. other forms of memory.
- Genetic

Severely Deficient Autobiographical Memory (SDAM)

- 3 healthy, high functioning adults with the reverse pattern: lifelong severely deficient autobiographical memory (SDAM) with otherwise preserved cognitive function.

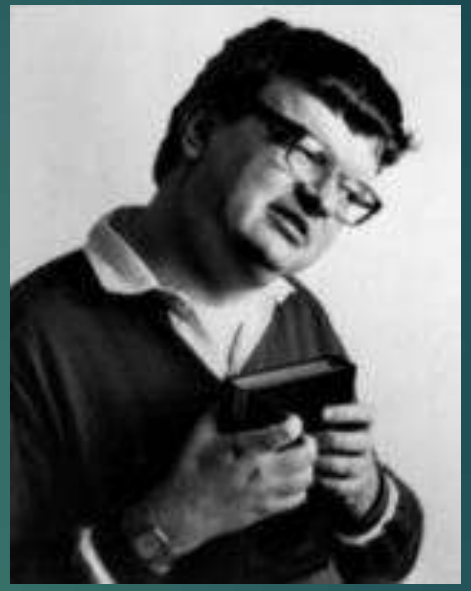
- Self-reported selective inability to vividly recollect personally experienced events from a first-person perspective; no fMRI activation of normal areas for episodic memory

- With the exception of complex figure recall, neuropsychological measures of recognition, cued recall, and free recall were normal

Daniela J. Palombo, et al., , 2015

Rain Man: Autistic Savant Kim Peek

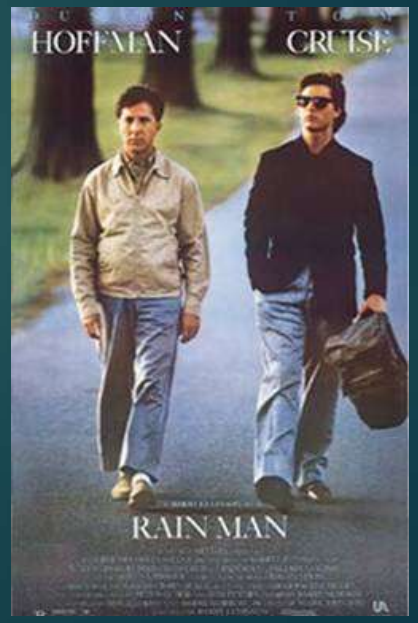
- Claim that he memorized every page of the 9,000-plus books he has read at 8 to 12 seconds per page (each eye reads its own page independently); never scientifically researched



- No corpus callosum

- Fewer than 25 prodigious savants living: Leslie Lemke (music), Alonzo Clemens (sculpting), Richard Wawro (painting), Stephen Wiltshire (drawing), Tony DeBlois (music)

- Non-normal brains: always profound memory ability in savants, with severe deficits in other cognitive domains



Artist Stephen Wiltshire can recreate exact view of London after just one helicopter flight over the city

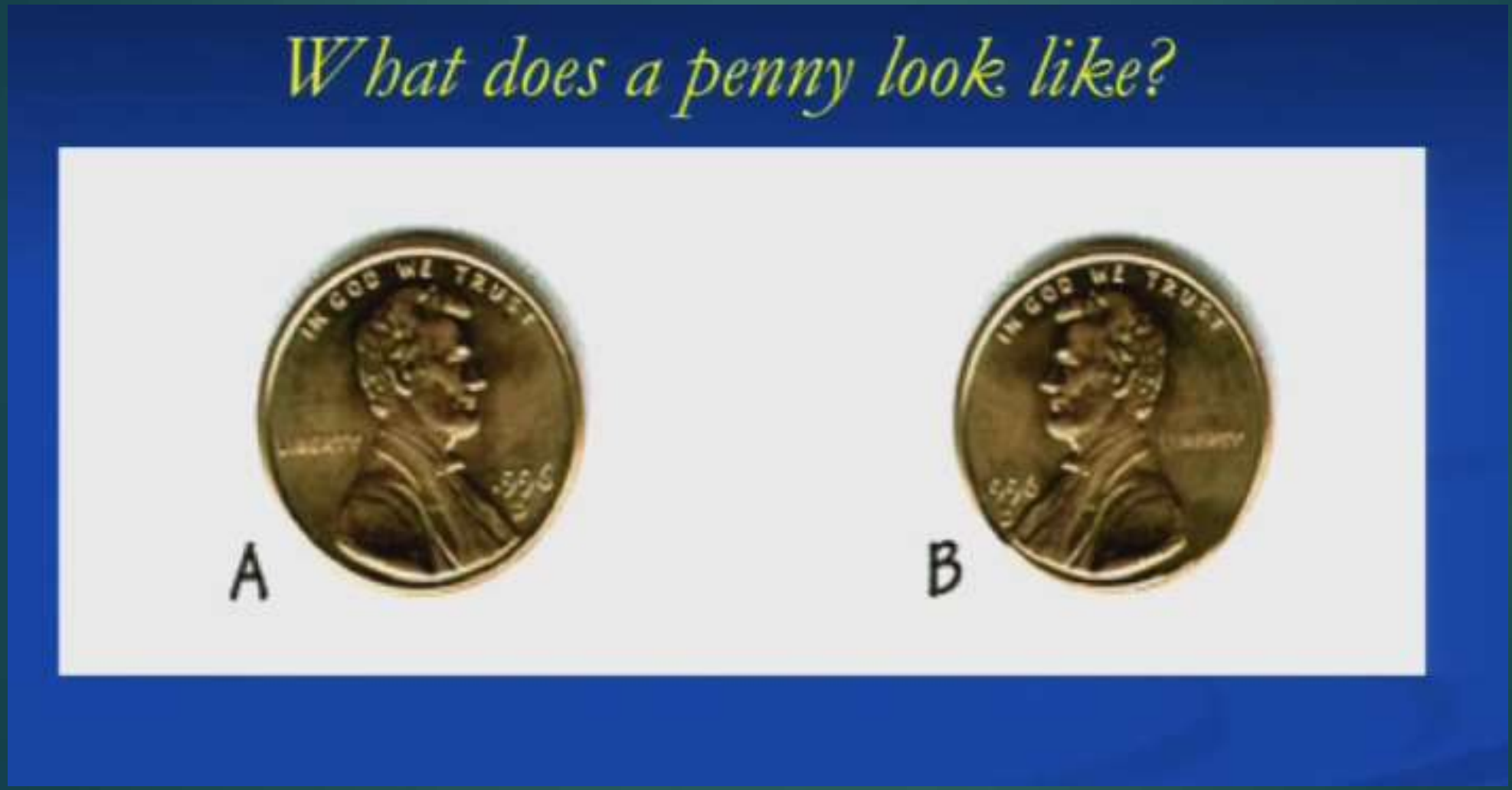
Memory in Birds

- The Nutcracker and Western Scrub Jay (birds) can remember:
  - thousands of food cache locations over a year:
  - when and where they hide food,
  - whether they are being watched at the time.

Crows really remember

- Crows will remember the face of someone who poses a threat to them for at least five years.
- Study: A team of scientists from the university exposed crows in Seattle to a ‘dangerous face’ by wearing a mask while trapping, banding and releasing birds at five sites.
- Over a five-year period after the trapping had stopped, they found that the mask received an increasingly hostile response from birds in the area – suggesting that the captured birds had been able to warn others.

Penny: Repeat encounters do not a memory make



And the correct answer…

All other US coins point to the left.

Answer: A

Memory Task

Read List 1

What was the main theme of the words?

40% of people include “sleep” for List 1 if asked to remember the list

List 1

Bed
Rest
Awake
Tired
Dream
Wake
Snooze
Blanket
Doze
Slumber
Snore
Nap
Peace
Yawn
Drowsy

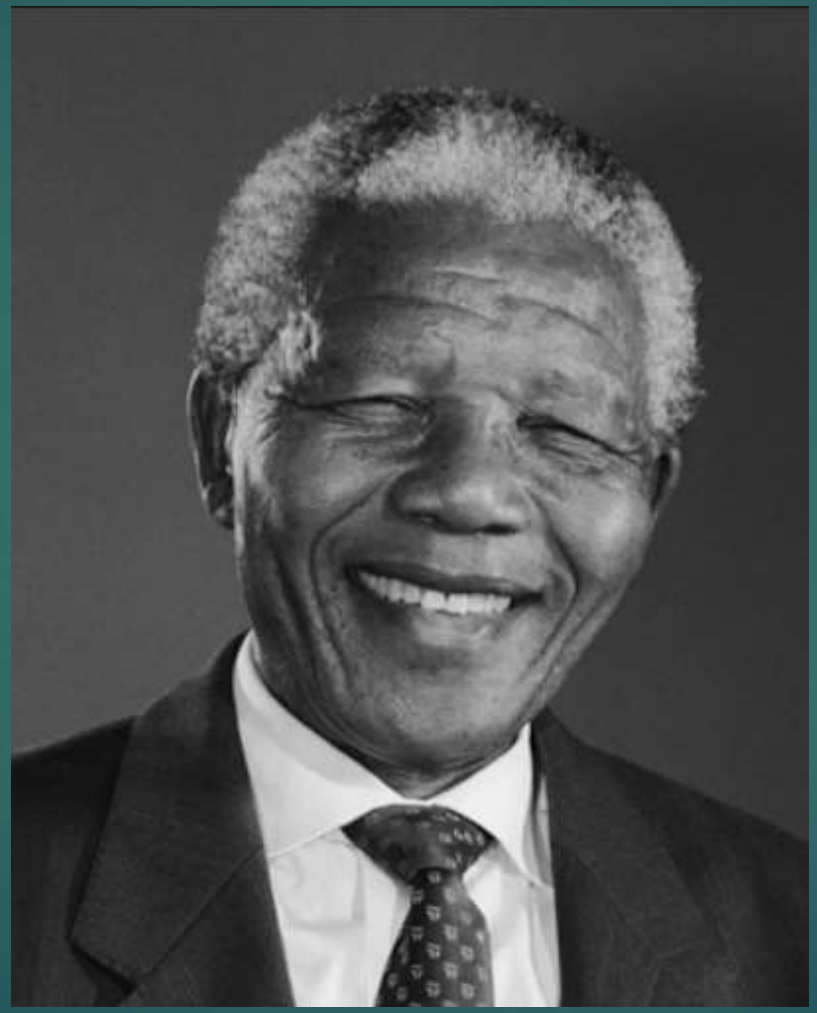
Example of creating false memory

Your memory is amazing

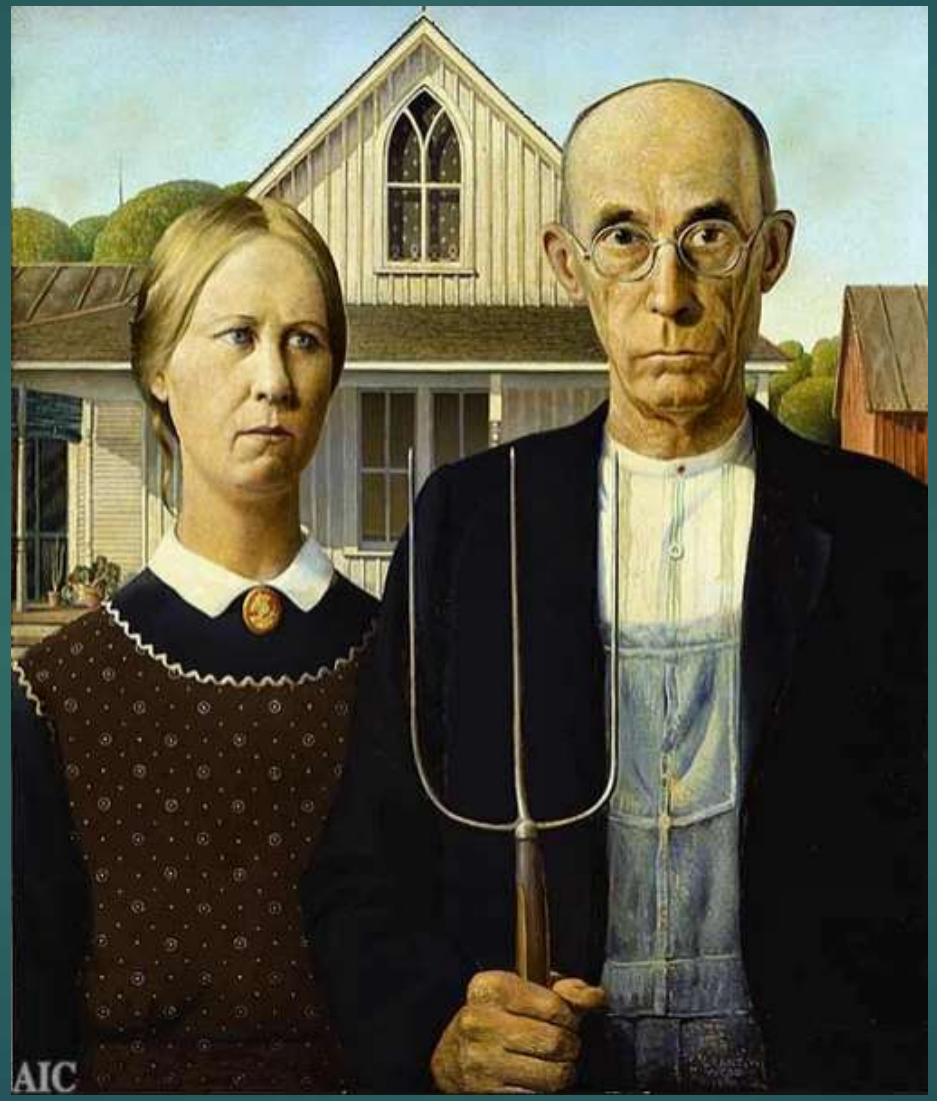
I want you to look at 15 pictures.

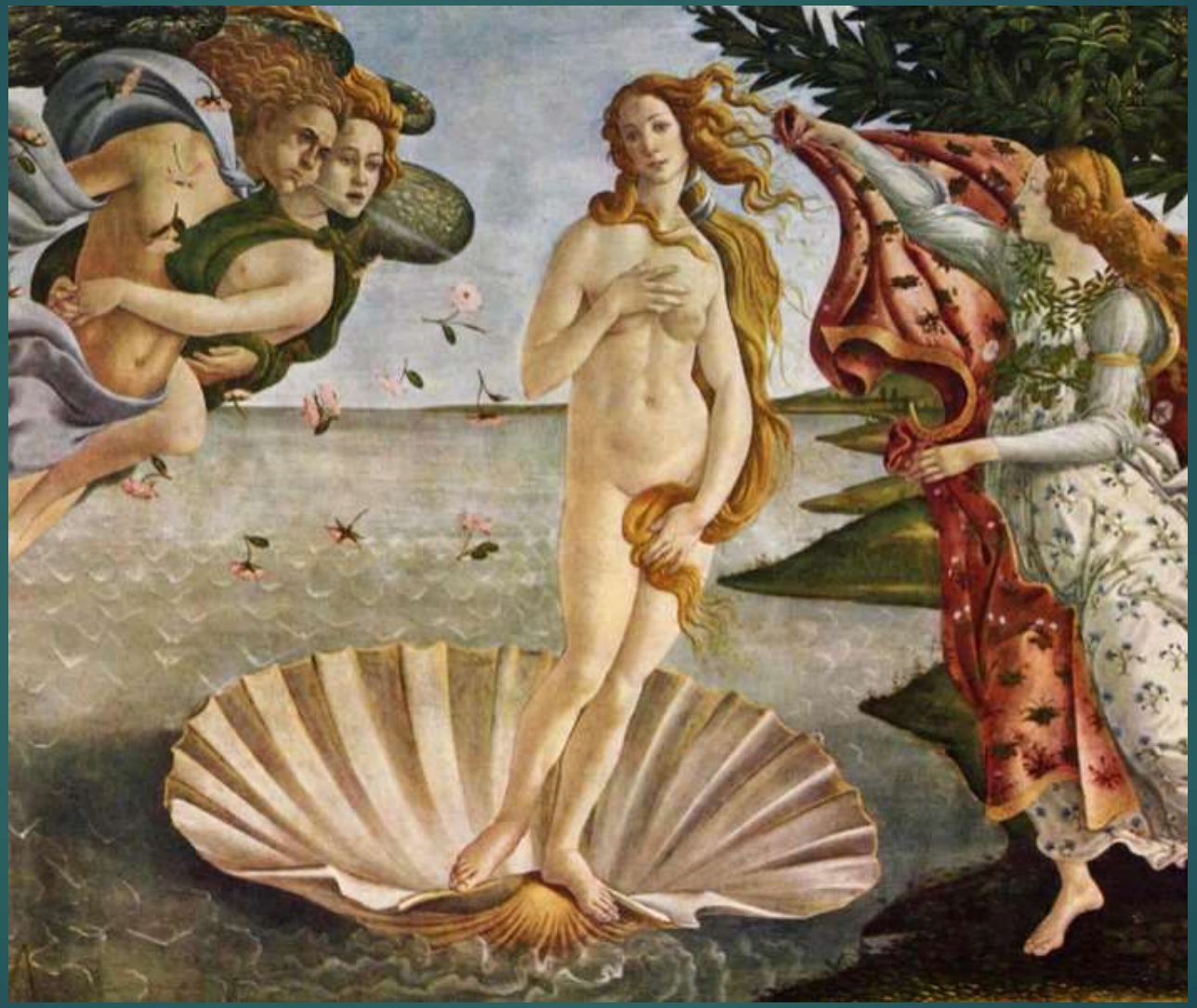
They will appear quickly.

Just keep looking at the screen.




Everett Collection / Rex Features


AIC



Modern Era of Memory in the Lab

Herman Ebbinghaus

In 1885, Ebbinghaus published first scientific paper on memory: *Über das Gedächtnis (Memory: A Contribution to Experimental Psychology)*

A Masochist: Created 2,300 new nonsense syllables (i.e. Rur, Hal, Mek, Bes, Sok, Dus) and memorized them

More practice sessions produced more retention, and slower rate of forgetting

Ebbinghaus's Discoveries and Contributions

- Learning curve: More you repeat information, the better the recall
- Distributed practice effect: Learn better if you spread it out over time, not cramming the night before.
- Forgetting Curve: Time is enemy of memory. Forget more as time passes;
- Sleep effect : forgetting is reduced when sleep occurs in the retention interval

The Location of the Memory Engram

- What is Long Term Memory: Perceptual/motor experience is stored as the outcome of the specific sensory/motor perceptual processing operations and in the same areas involved in the original perception and analysis of the event, i.e. red, round, on tree, tastes sweet = apple memory

- The increased probability of a network firing a similar pattern is how network of neurons "remembers."

- Locus of storage determined by sensory modality relevant to original learning and nature of the information, i.e. shape, color, function

The Location of the Engram: All memories are activations of neuronal networks

- Distributed Network of associations: Memory is located in multiple locations corresponding to specific sensory aspects located in different sensory areas via sensory network activation

- Synaptic pathway reinforcement as creator of our long term memories via long term potentiation.

- Location of LTM: All over the brain: Posterior Occipital, Parietal, Temporal lobes, Frontal (for motor programs); & BG and Cerebellum

Jennifer Anison neuron (or network)

- Invariant visual representation by single neurons in the human brain

- 2012 discovery of the "Jennifer Aniston neuron." In seizure pts, Quiroga discovered that one subject had a neuron that steadily fired whenever she was shown a photo of Jennifer Aniston. It didn't fire for other celebrities, but seemed linked to the *concept* of Jennifer Aniston. Another subject had a Halle Berry neuron, another had one for Bill Clinton.
- We don't all have Jennifer Aniston neurons, nor is there one neuron whose sole job is to recognize Jennifer Aniston
- Major discovery is of a neuron that is linked to a particular concept; these neurons easily form new associations; there are neural networks associated with particular concept, and that these networks overlap. JA neuron also fires for Friends cast-mate, Lisa Kudrow

R. Quian Quiroga, et al., 2012

Brain and Memory

- Multiple brain regions are involved in encoding a new memory
- Consolidation of memory involves the hippocampus and the prefrontal areas; eventually latter takes over memory retrieval
- LTM storage occurs in the cortex, where the memory was first processed and held in short-term memory.

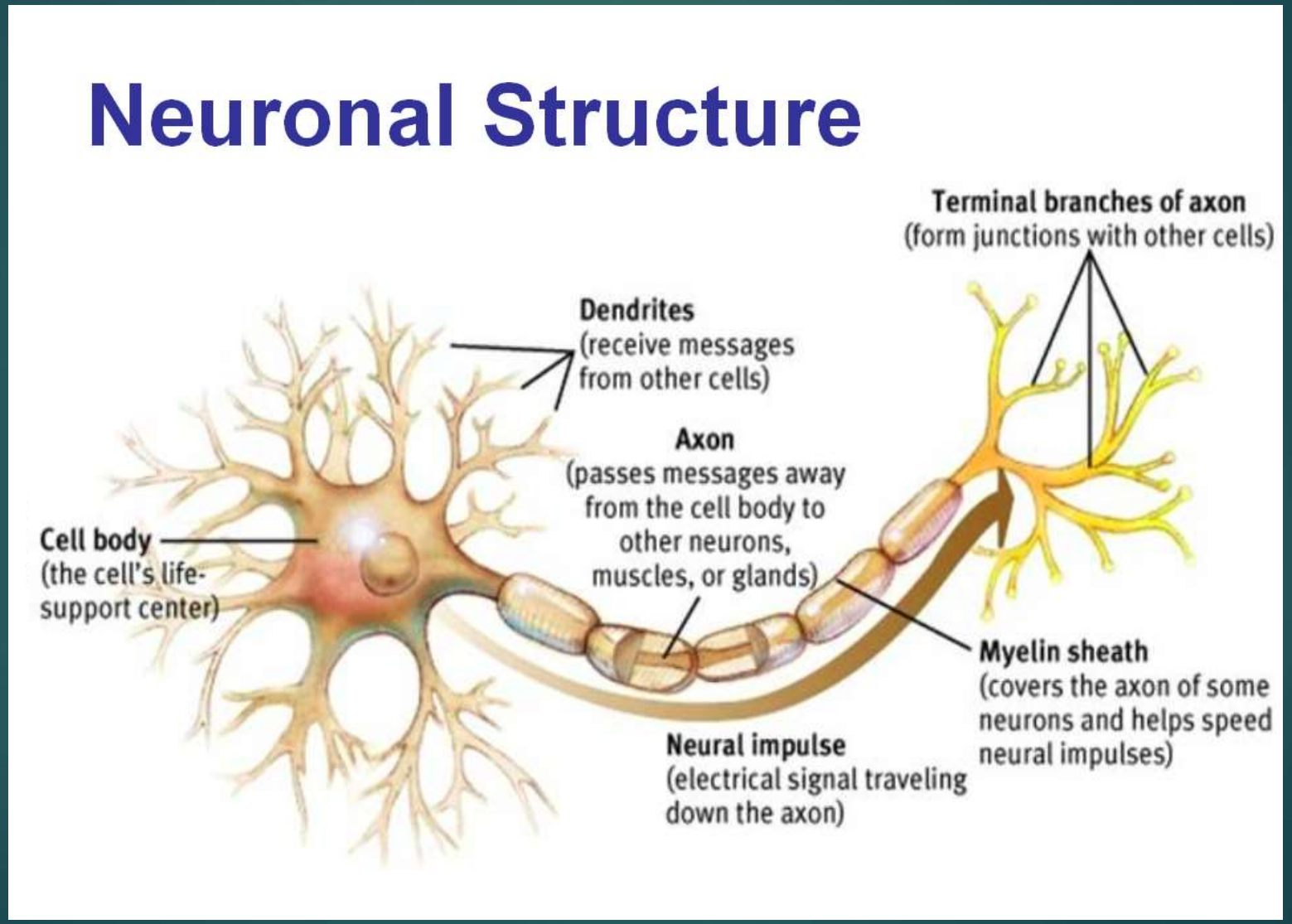
Memory in Brain

- **Hebb Rule**:
  - If neurons fire together, they wire together.
  - Memory is formed by neuronal synaptic interactions.
  - If synapse between 2 neurons repeatedly activates, the postsynaptic neuron fires and structure or chemistry of synapse will change

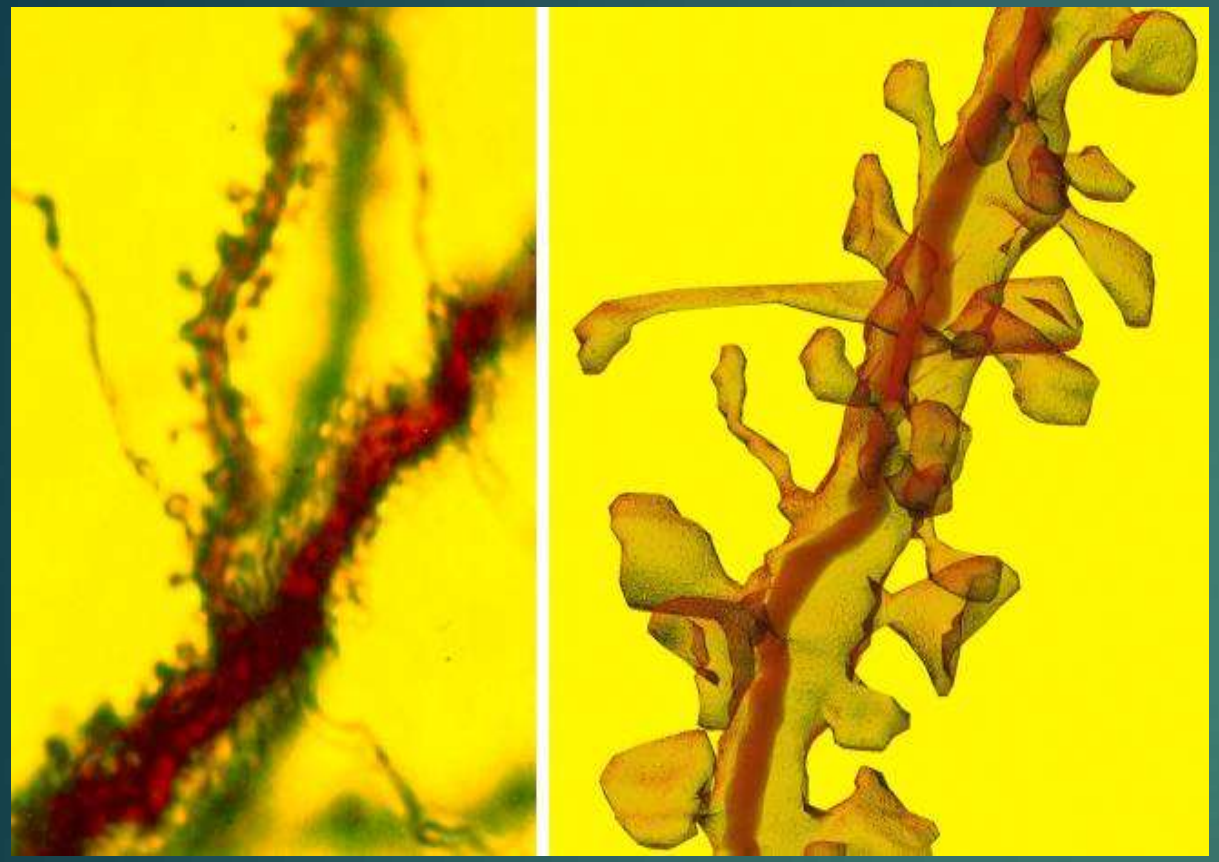
Neuroplasticity: new synaptic connections

- Memory: Connections between neurons rewire based on experiences
- Brain is less ‘hard-wired’ than we used to believe
  - Neuroplasticity is fundamental property of brain:
    - Capacity of nervous system to modify its organization
    - Experience changes in neuronal structure and function
    - Changes occur largely within the synapse

Neuron informational input (dendrite) and output (axon)



Dendrites under Electron Microscope



Dendrites connect via synapse to other neuron & receives information.
Highly dynamic: can appear in hours to days and also disappear

Synaptic changes store memories

- Current dominant theory: Long-term potentiation (LTP)
  - Long lasting increase in synaptic strength between neurons following high-frequency stimulation
- "*The molecular and cellular changes mediating the induction of LTP in the hippocampus are widely considered to provide a basis for memory*" (McGaugh, 2000)

Memory is based on neuron connectivity

- Neurons are linked by synapses, structures in which terminals of the axon of the presynaptic neuron communicate with spines on dendrites of the postsynaptic neuron via neurotransmitter release.

- Increase strength of a memory: If the presynaptic synapse activates the postsynaptic neuron, the synapse's strength increases through long-term potentiation (LTP).

- Forget a memory: If the activities of the neurons are poorly correlated by nonactivation, the connection weakens through long-term depression (LTD).

Synaptic plasticity is core of memory

- The representation of memory in the brain is one of the unresolved questions in neuroscience. How memory is mapped in the brain has been elusive.

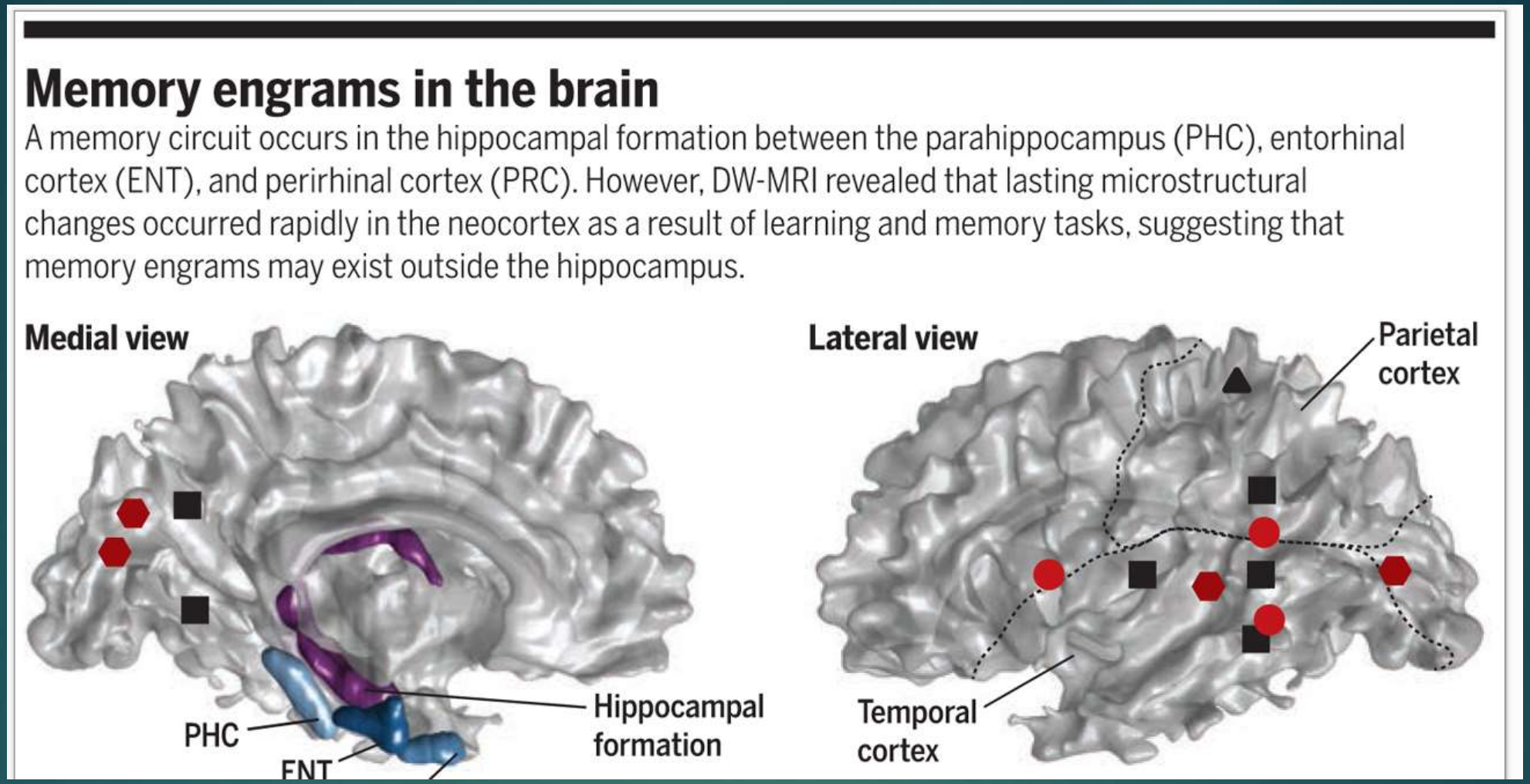
- A key feature of learning and memory is the process of neuroplasticity—the ability of the brain to remodel structurally and functionally as a result of cognitive and behavioral experience, to create a memory engram.

Memory engram: physical manifestation of memories stored in the brain

- A memory engram has four defining features:
- 1 - it must relate to a specific experience (learn to type)
- 2 - it must engender an enduring change in the neural substrate; it must induce persistent structural plasticity (a real change in the brain)
- 3 - it can lie inactive/dormant for extended periods
- 4 - it must enable memory recall, thus having an impact on behavior
- Learning induces rapid microstructural changes in the neocortex

Synaptic plasticity is core of memory 2

- Models of systems memory consolidation postulate:
  - a fast-learning hippocampal store (frequent hippocampal reactivation over extended periods to create memory encoding)
  - And a slowly developing, stable neocortical store.
- Early neocortical contributions to memory are deemed to reflect a hippocampus-driven online creation of encoding activity.
- Recently finding that learning can rapidly create an enduring memory engram in the human posterior parietal cortex (90 min after learning in the precuneus)



Brodt *et al.* 2018 used DW-MRI after an object-location memory task and found that brain plasticity occurs in the posterior parietal cortex (PPC) rather than in the hippocampus

But wait: Transfer of Memory in a snail: Move of a Memory From One Snail to Another via RNA transfer

- Injecting RNA molecules from a sea slug that received tail shocks into one that didn’t, made the recipient animal behave more cautiously.
- If confirmed, could shift scientific opinion about how memories are made—rather than cemented in nerve-cell connections, they may be spurred on by RNA-induced epigenetic changes.
- Suggests that memory wasn’t stored at the synapse but somewhere else.
- Recent experiments suggesting long-term memory was stored in the cell bodies of neurons, not synapses

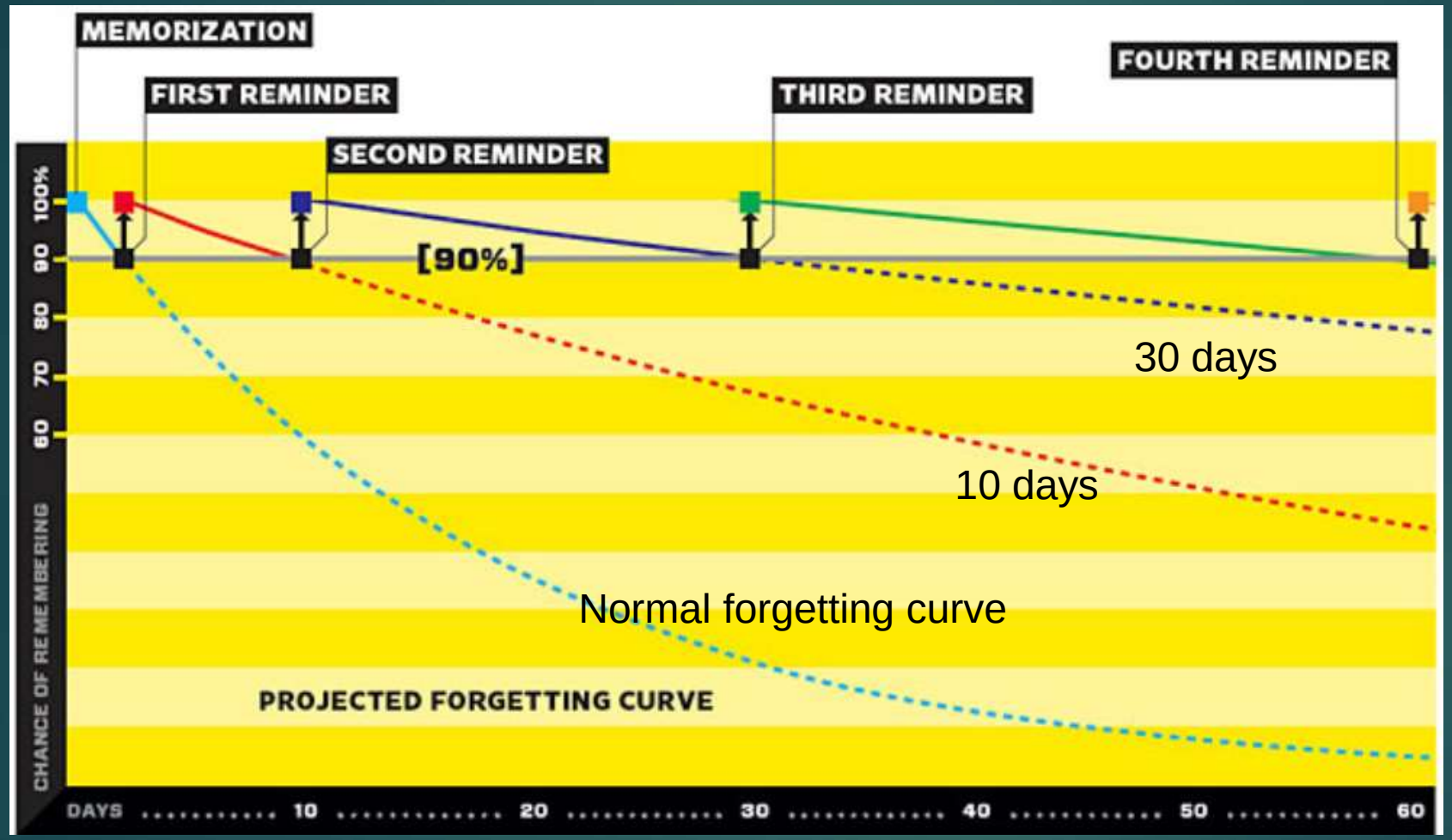
A. Bédécarrats et al., *2018*

Retrieving information

- Actively and repeatedly retrieving information, compared to merely restudying it, improves long-term retention

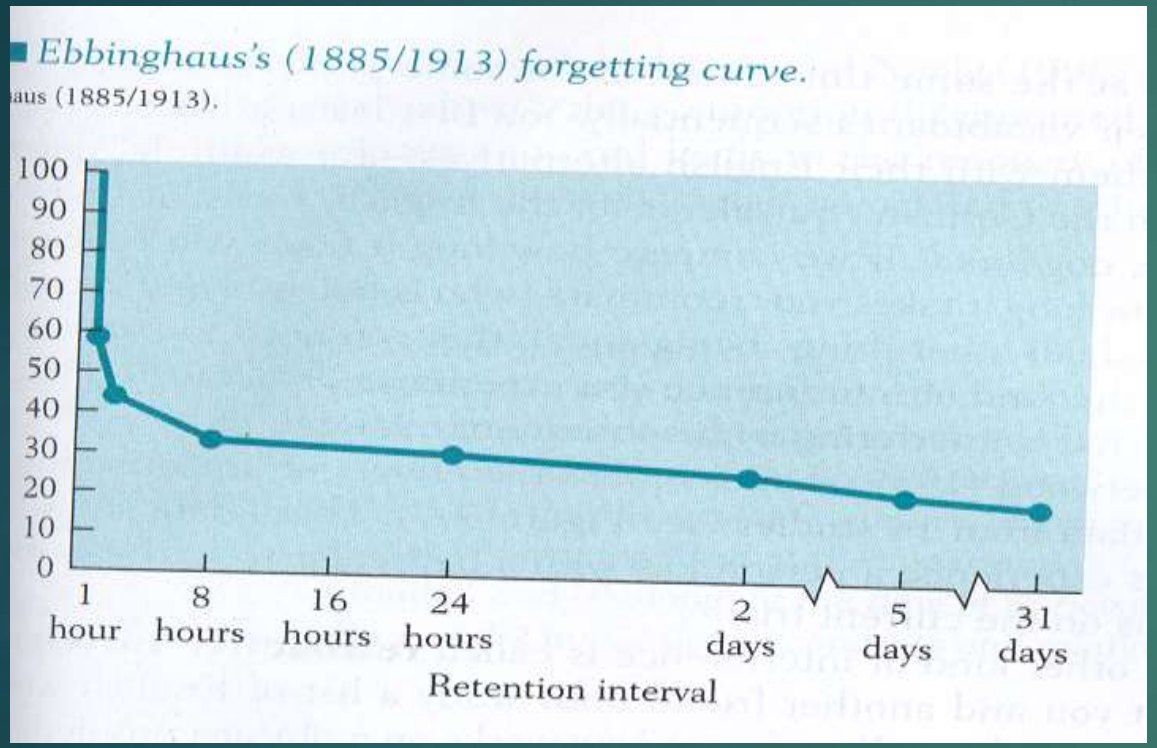
- 4 spaced repetitions increases memory by 90%

Tip #5: Rehearsal (repetition) increases memory



Even better: Spacing out repetitions significantly improves retention.

Forgetting Curve: Time reduces Recall



The Forgetting curve:

People forget:
42% after 20 min
56% after one hour,
67% after one day,
79% after 31 days
Maintain after 2 days

Information is lost over time when there is no attempt to retain it

Forgetting

- The ability to forget, however, is a feature rather than a flaw of how our brains work.

- As the celebrated author Jorge Luis Borges wrote about a man incapable of forgetting, *Funes the Memorious*:
  - “I suspect, however, that he was not very capable of thought. To think is to forget differences, generalize, make abstractions.”

- By forgetting, we prioritize and separate the useful from the irrelevant and more easily reorganize information to learn

Forgetting

- So why do we forget:
  - 1 - In a constantly changing world old information becomes outdated and not as important to remember.
  - 2 - There must be some forgetting of details in the data involved in order to prioritize the core information that is necessary for decisions.

Why your brain forgets the details

- We are better at recalling vague pieces of information than precise details

- Study:
  - recall 128 pairs - a scene and 2nd unrelated item, i.e. mountain and a kiwi;
  - recall 2 days later – see image only, must recall 2nd item

- Correctly recall category of item 79%, i.e. a fruit

Catarina S. Ferreira, Ian Charest, Maria Wimber
doi: https://doi.org/10.1101/458687

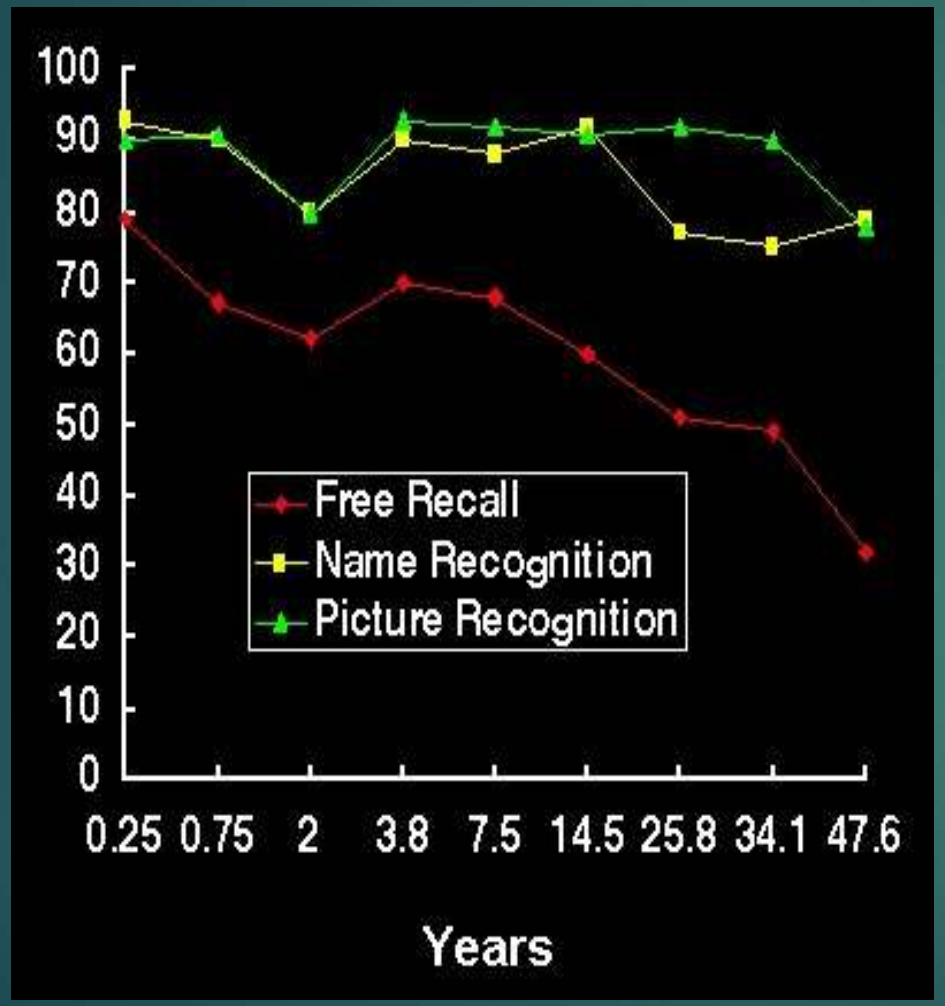
Why your brain forgets the details

- If recall category, recalled item, 75 to 88%
- When recalling memories, you need the frontal neocortex to activate
- In encoding, first use perceptual visual centers to assess low-level specific features (shape, color), then info sent to neocortex to abstract (category)
- When recalling, reverse process (neocortex 1st, perceptual 2nd): easier to recall general category, rather than specific identity

Why your brain forgets the details

- During encoding, visual processing at 100 ms before category encoding in cortex
- During recall, reversed: peak in neocortex activity 300 ms before you identify the item
- Stronger memory for abstract generalities than for specifics
- Advantage: Need to remember that any dog may bite, not specific dog

Spontaneous Recall and Cued Recognition of High School Classmates



Picture recognition is best;

Name recognition is good;

Free recall is worse

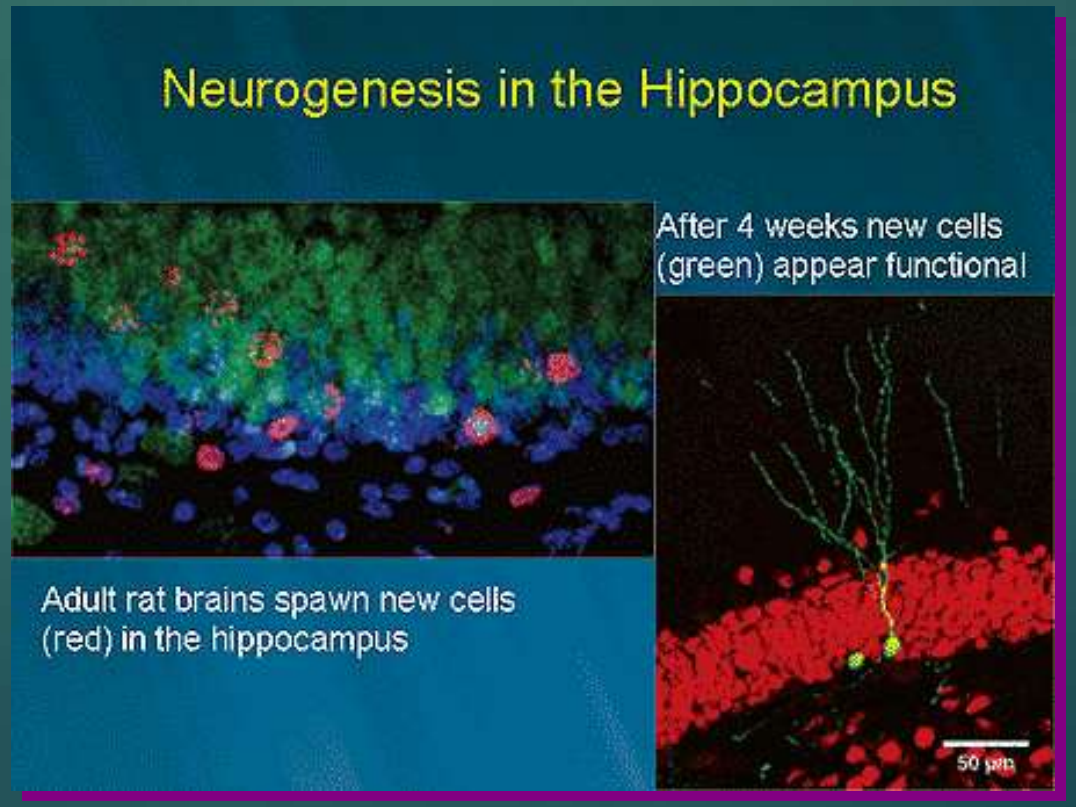
Bahrick et al., 1975

Tip #6 – Harder it takes you to retrieve, better the memory

- Remembering and naming a person increases memory strength;
- Forgetting for awhile can add to memory strength;
- Harder you work to retrieve, greater the increase in the strength of the memory
- Self testing increases storage strength

Neurogenesis

- Neurogenesis: growth of new neurons in the adult brain; Stem cells can become new adult neurons;
- 1,400 cells a day, esp. in dentate gyrus of hippocampus



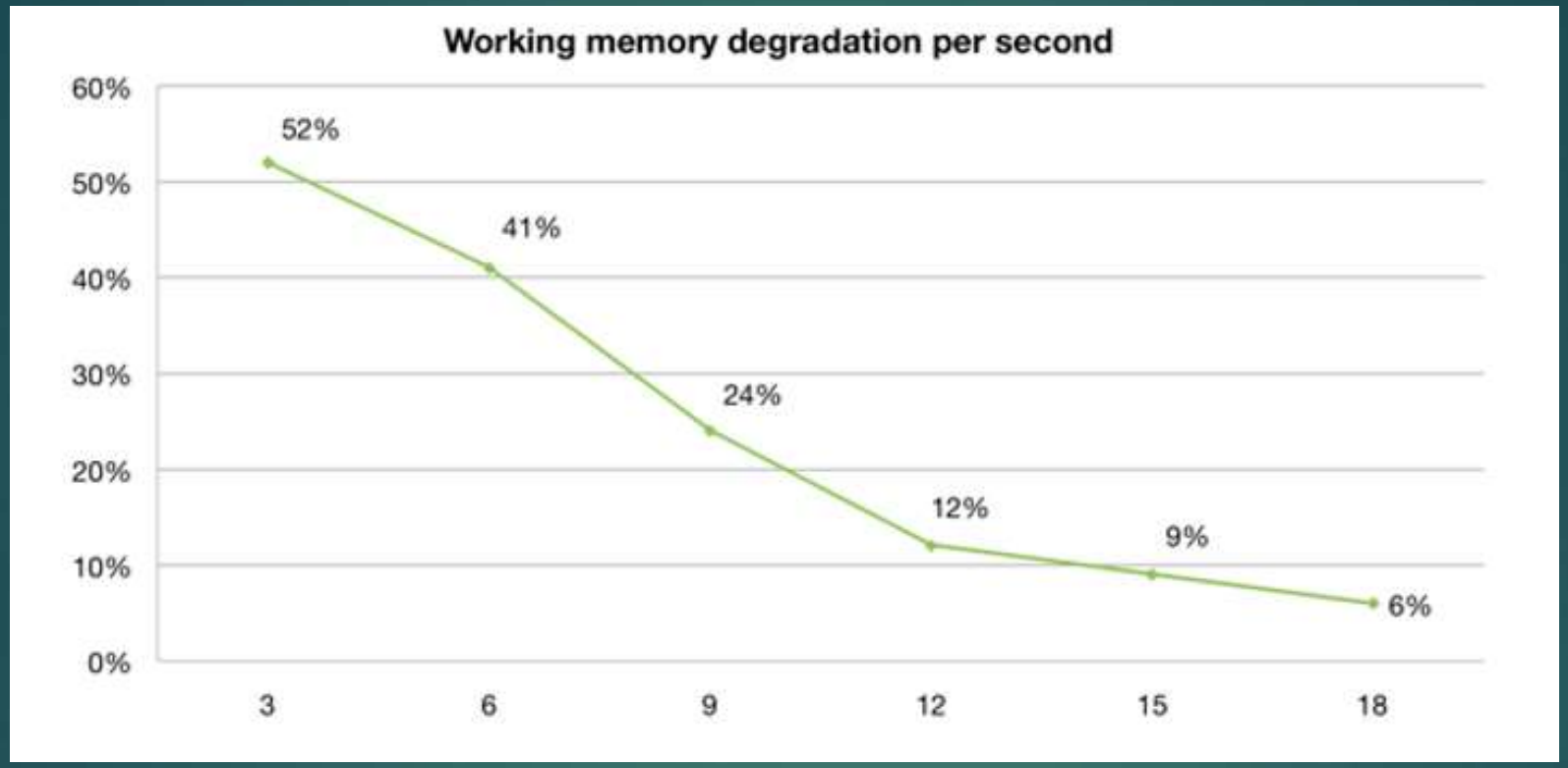
There are multiple memory systems in the brain

- 1 Working Memory: short term: telephone number
- 2 Factual (Declarative) Memory:
  - Episodic (Personal) Memory: first kiss
  - Semantic (Knowledge) Memory: Cleopatra
- 3 Behavioral Memory: How to…
- 4 Prospective Memory: remembering future intention

Short Term Memory/Working Memory = 7 +/- 2

- **STM or WM** = limited short term capacity storage, maintained via rehearsal; = online RAM in computer
- Temporary storage and manipulation of information
- Capacity: Miller's Constant -- 7 +/- 2
- Modern Research: Seven for digits, around six for letters, and around five for words
- Decays if unrehearsed in 20 seconds
- Time to use a phone number

Working Memory degrades, especially with distraction

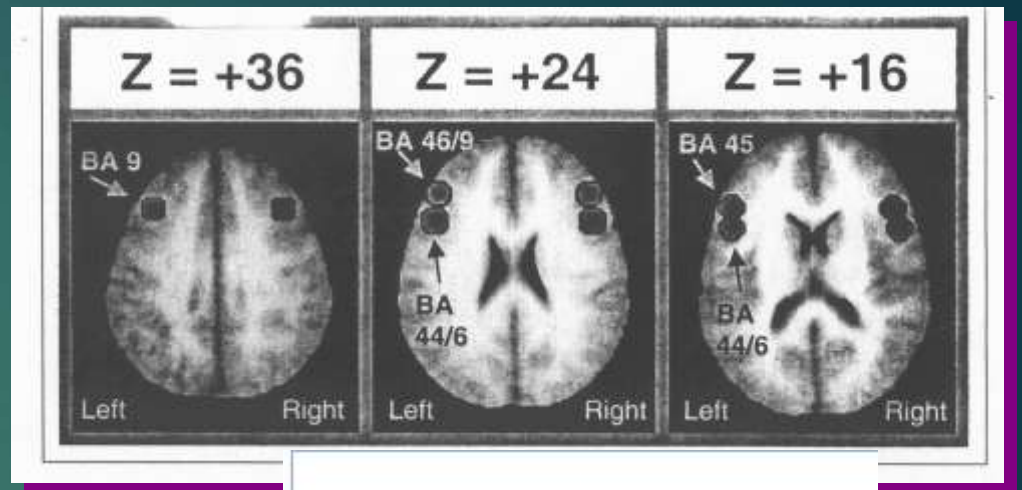


After 15 seconds, less than 10% of original memory is preserved.

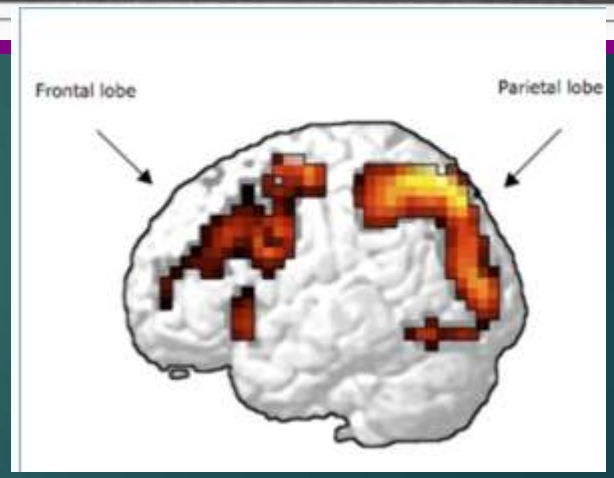
Distractions cause dramatic losses in WM.

Neuroanatomy of Working Memory

Dorsolateral Prefrontal Working Memory (WM):



- Neurons turn on during delay period (~ 1 min)
- Good WM requires optimal dopamine function
- Most WM tasks use a network of PFC and parietal areas. During WM task connectivity b/w areas ↑↑



P. Goldman-Rakic (1995)

WM can hold only so much info: choking up

- Size of WM correlates with higher IQ and academic achievement.
- High pressure testing situations can cause person to choke up under pressure
- Worrying about a situation (such as solving an arithmetic problem in front of a group of people) takes up the WM that is available for figuring out the math problem

Tip #7: Defeat Stereotype threat

- Negative stereotypes hinder stigmatized individuals' performance on difficult tasks.

- Examples: being reminded you are African American before a test; reminded that you are elderly before a memory test; that you are a woman before a math test

- Threat leads to lower than normal ability performance by reducing WM capacity

- Tip – reset WM buffer: Writing about your thoughts and feelings about an upcoming math exam for 10 minutes, improves test performance.

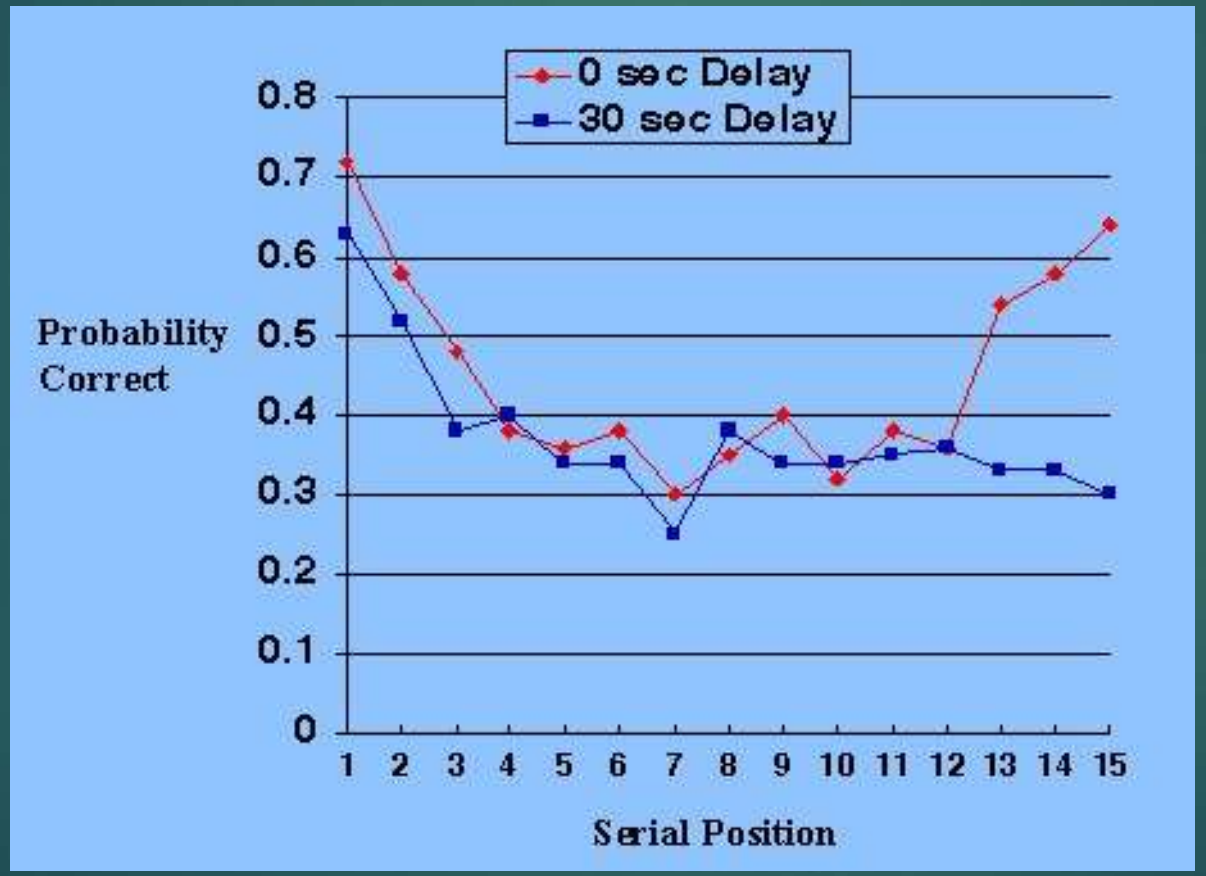
Childhood Poverty: Worse Working Memory

- Chronic stress from growing up poor appears to have a direct impact on working memory.
- The longer the children lived in poverty:
  - the higher their stress load
  - the lower they tended to score on working-memory tests
  - Those who spent their entire childhood in poverty scored about 20 percent lower on working memory than those who were never poor;
  - 20% thinner cortex

G. Evans, 2009

Tip #8: Serial Position Effect – primacy & recency

We remember 1st and last parts of lists better than the middle



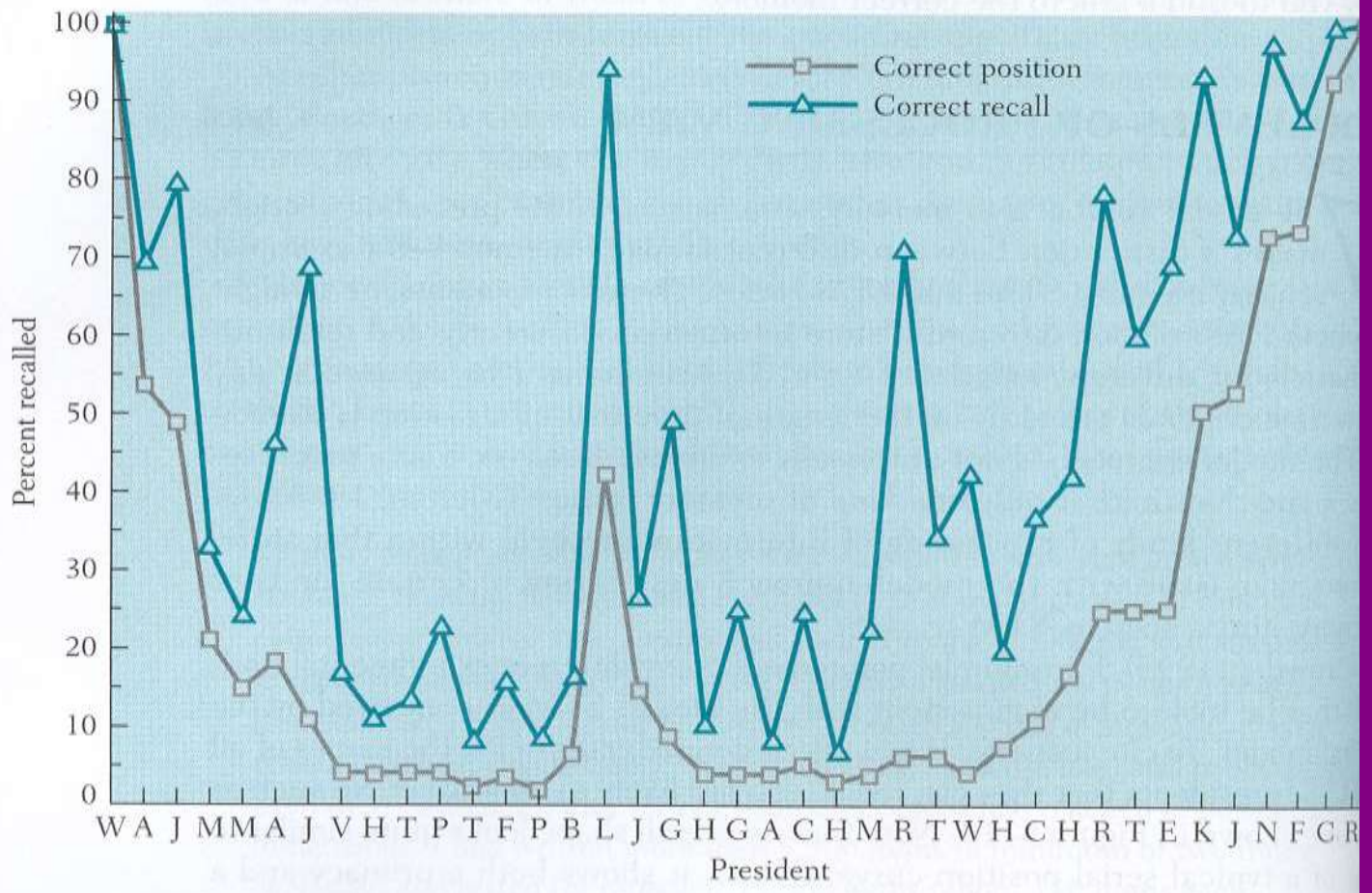
0 sec. delay

30 sec delay

Memory impaired remember only last part.

Unusual Recall of United States Presidents

FIGURE 5–10 ■ *Recall of the names of U.S. presidents as a function of their ordinal position.*
SOURCE: Crowder (1993, p. 143).

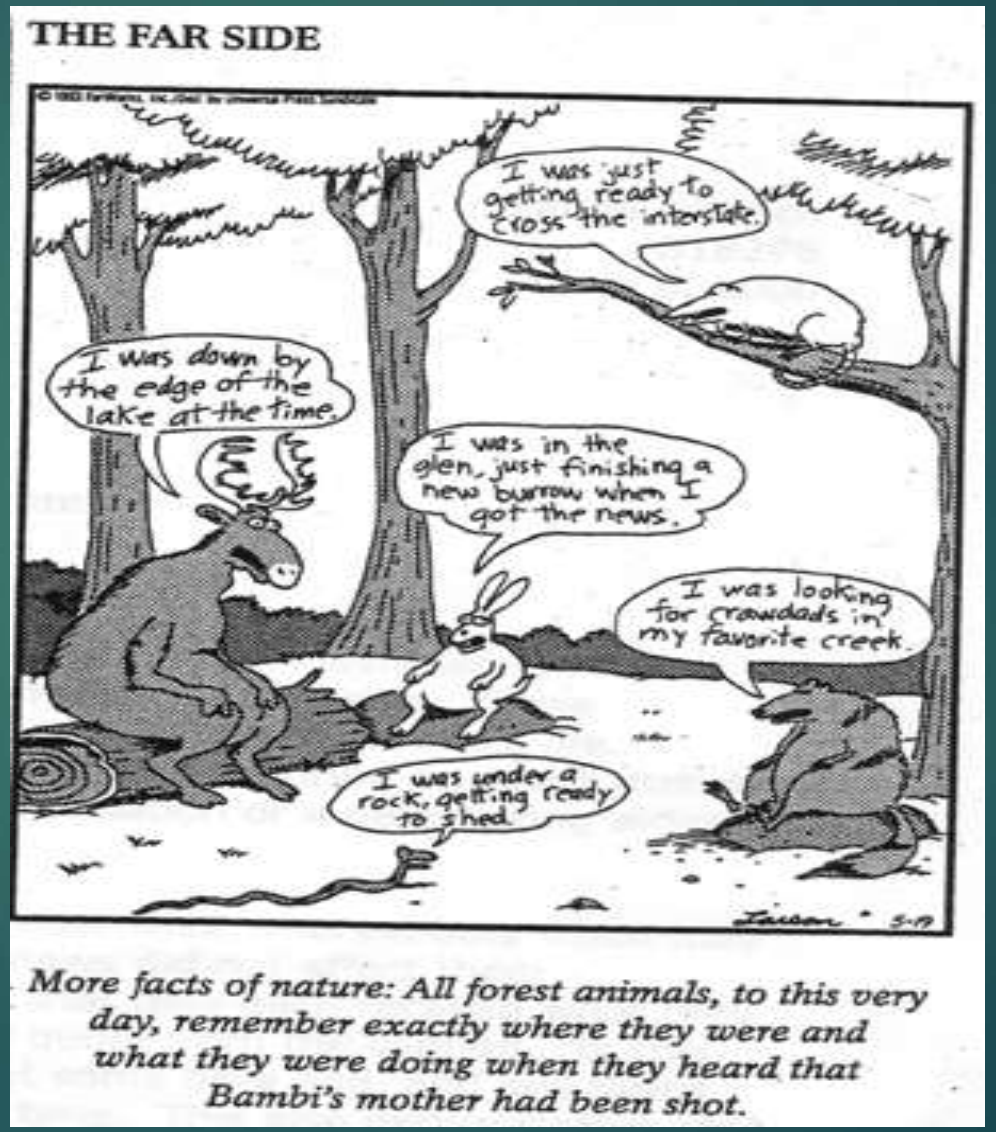


“An impression may be so exciting emotionally as almost to leave a scar upon the cerebral tissues.”

William James (1890)

Flashbulb Memory: My Daughter Lea at age 4 & Bambi's mother

All animals know where they were when Bambi's mother died.

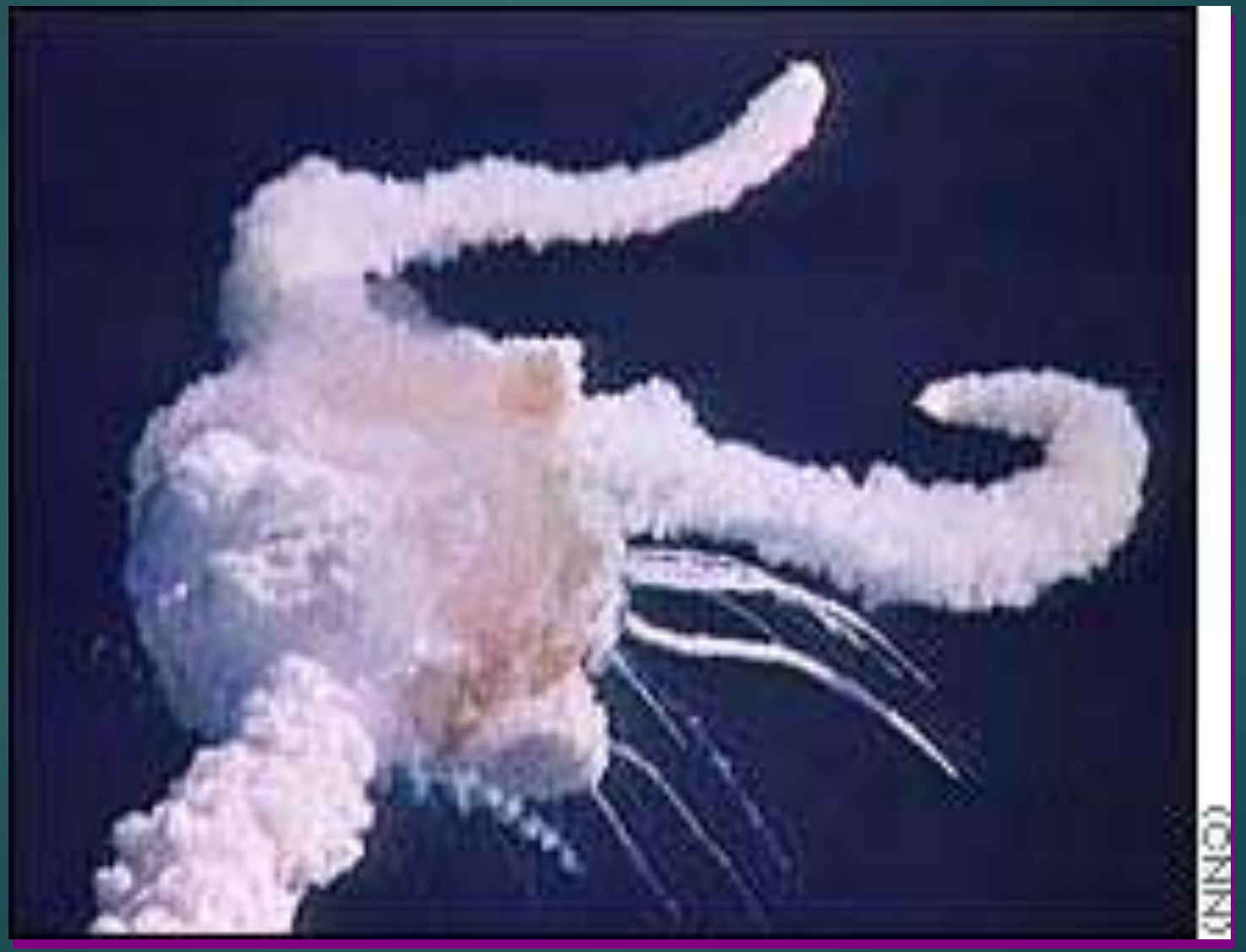


Flashbulb Memory 1: Nov. 22, 1963 - JFK

CJV: 2 pm in classroom two at Mission San Luis Rey College

Flashbulb Memory 2: April 4,1968 – MLK Jr

Flashbulb Memory 3: 1986 - Challenger



Flashbulb Memory 4: 1989 – Loma Prieta

Flashbulb Memory 5: 9/11/2001

9/11/ 2001: 97% of Americans "can remember exactly where they were or what they were doing the moment they heard about the attacks"

Tip #9: More emotional an event, the better the recall

- Flashbulb Memories - Where were you when?: JFK or MLK killed, Challenger (1/26/86), O.J. Trial Decision, 1989 SF earthquake, 9/11/2001, cancer dx, trauma happened
- Flashbulb Memory: what, where, who with, doing what
- Traumatic memories are basically really intense flashbulb memories.
- Marked by vividness, immediacy, visual primacy and emotionally intensity
- More emotional the reaction (Amygdala), stronger the memory
- But can become distorted

Trauma and Memory

- Severe personal trauma: rape, assault, etc.
- Traumatic Memory:
  - fragmentary sensory components of traumatic event
  - with no linguistic narrative of event
  - mediated by Amygdala, not Hippocampus
- As a result, these memories are generalized and decontextualized.

Development of Memory

- Infants
  - recognize mother within hours;
  - deferred imitation by 1 year;
  - references to past events by age 2;
  - recall at 2-3 locked to vocabulary level
- Capacity: WM increases with age

  (age 4 = 3 items; age 12= 7 items)
- Rehearsal ability develops from age 5 to 10
- Use of memory categorization to remember develops

Patricia J. Bauer, 2007

Development of Memory 2

- Parental reminiscing style influences child's autobiographical memory: talking a lot, questions, details, emotions

- Adult women have longer, more detailed, more vivid, more emotionally laden autobiographical memories than men

- Individuals from Western cultures have earlier age of first memory and have longer and more detailed memories of childhood than those from Asian cultures (related to social emphasis on importance of the individual vs. social)

Fivush & Nelson, 2004

Culture and Family talks effect early memory

- How different cultures reflect on their past: In cultures where family storytelling is a cherished pastime, people are more likely to retain early childhood memories; European & North Americans talk more about individual experiences than east Asians; their children have better childhood memories

- More detailed family conversations help develop is your ability to tell a good story; better autobiographical memory.

- When recalling past events, Westerners exhibit greater episodic specificity than East Asians, and women exhibit greater episodic specificity than men.

Tip #10: Self Generation effect

- If you personally generate a memory, you will remember it better. 30% better recall post self generation
- Read section of poem, then try to recall it
- Talk about it to others or in front of mirror or use flashcards

Neuroanatomy of Memory Functioning

Hippocampus: Dentate, CA1, CA3

Entorhinal Cortex

Subiculum: 1st 15 seconds

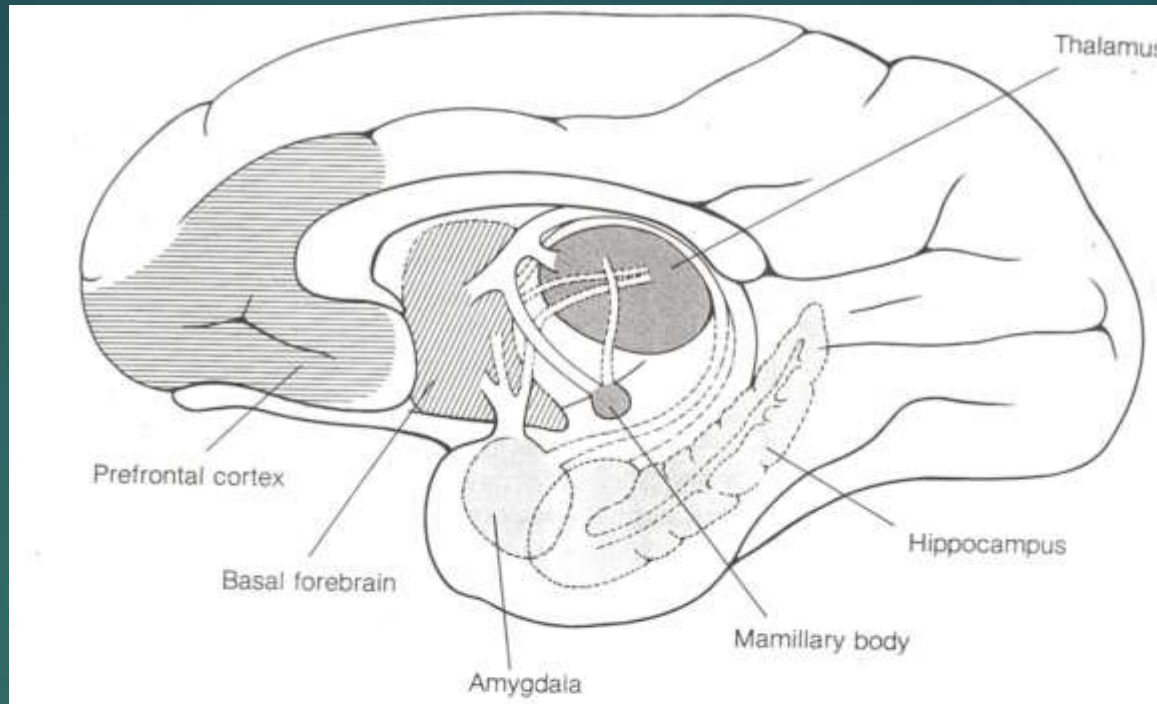
Parahippocampal Cortex

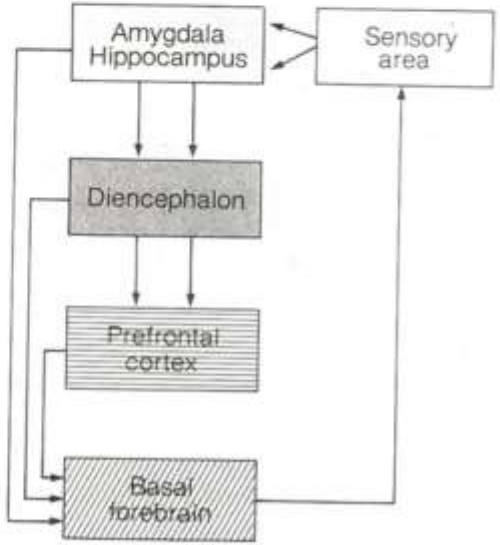
Perirhinal Cortex

Amygdala

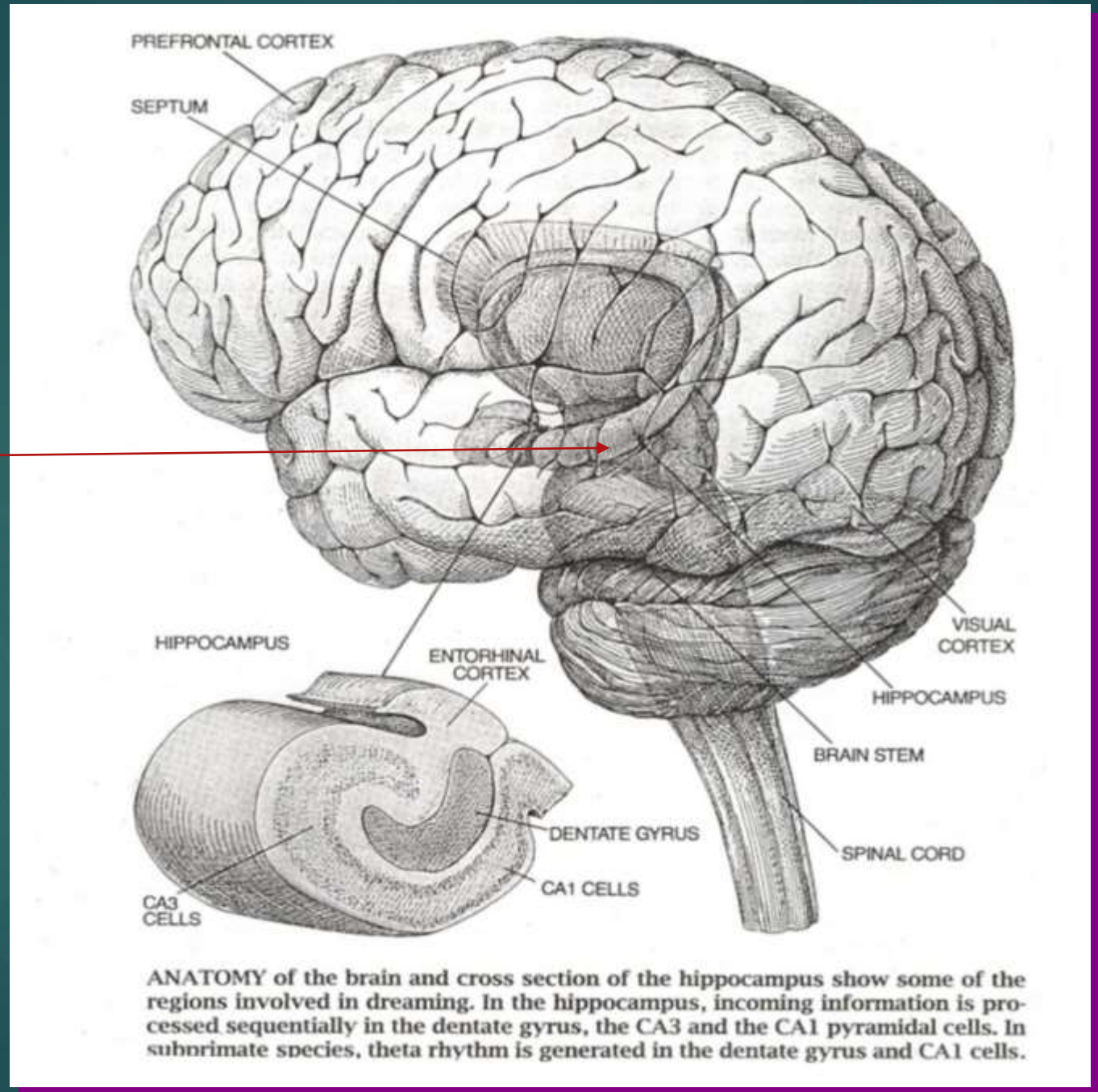
Diencephalon: Thalamus & Hypothalamus: Mammillary Bodies

Ventromedial Prefrontal & Basal Forebrain

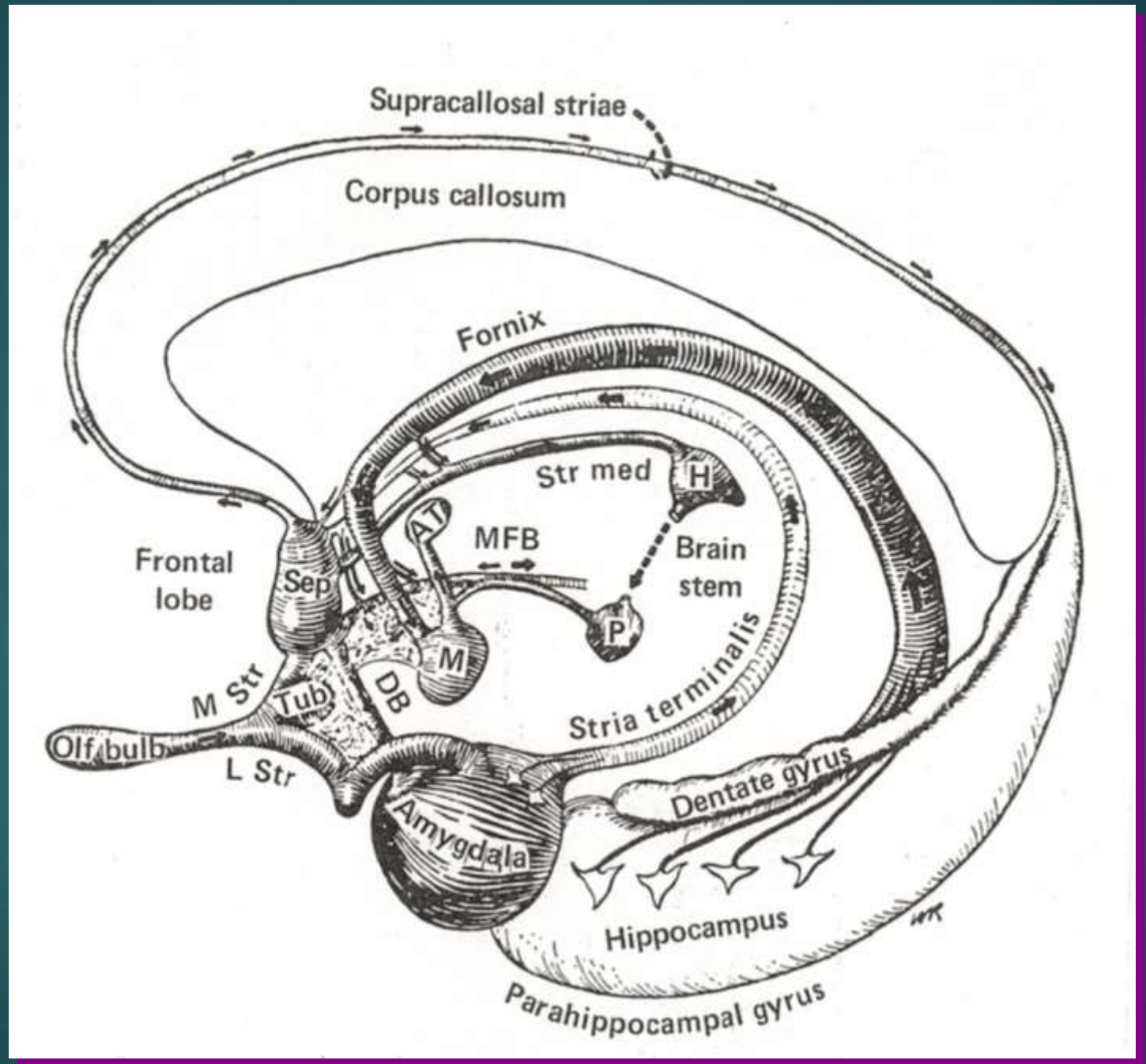

Thalamus
Prefrontal cortex
Basal forebrain
Amygdala
Mamillary body
Hippocampus


Amygdala
Hippocampus
Sensory area
Diencephalon
Prefrontal cortex
Basal forebrain

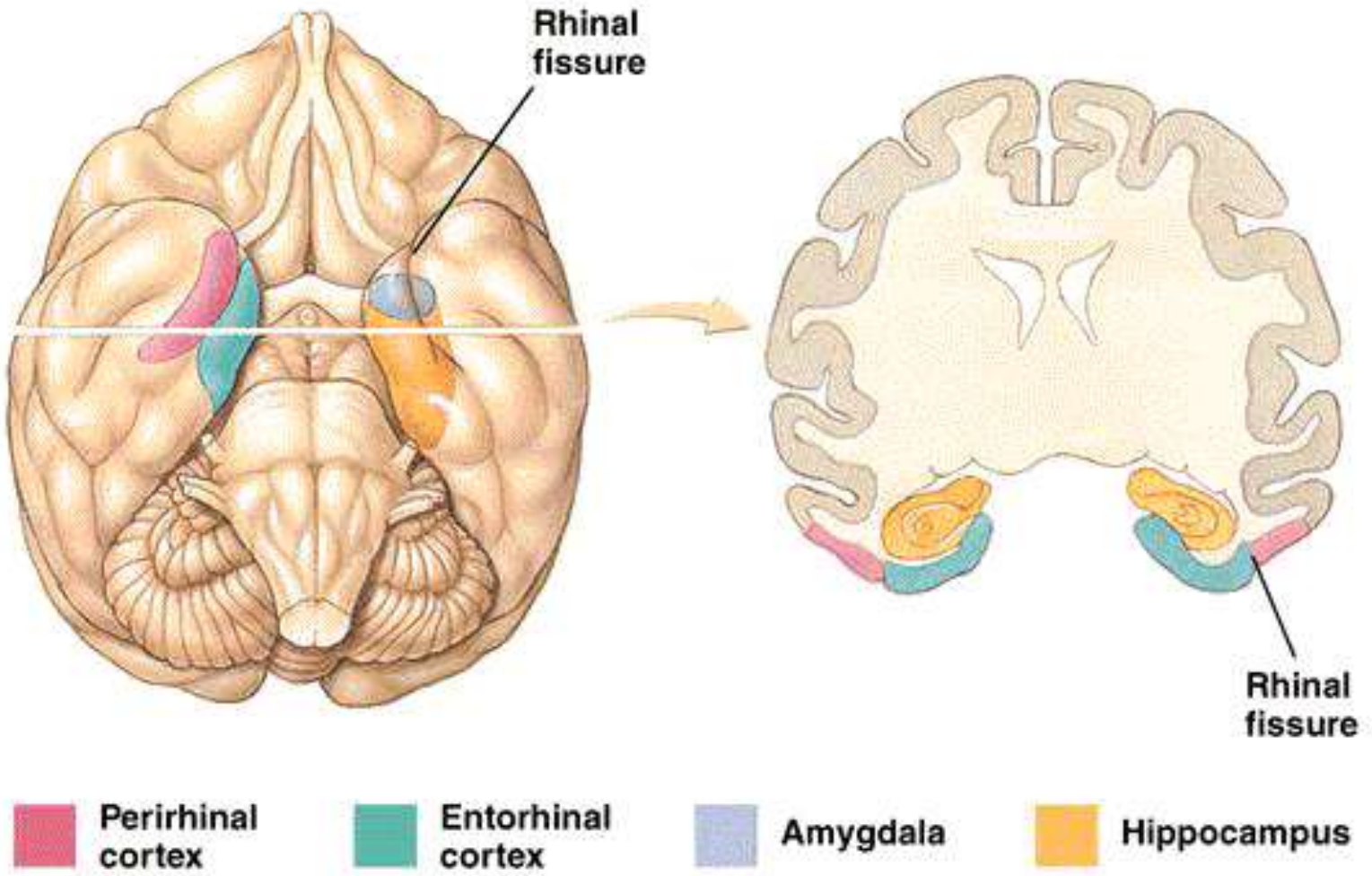
Hippocampus



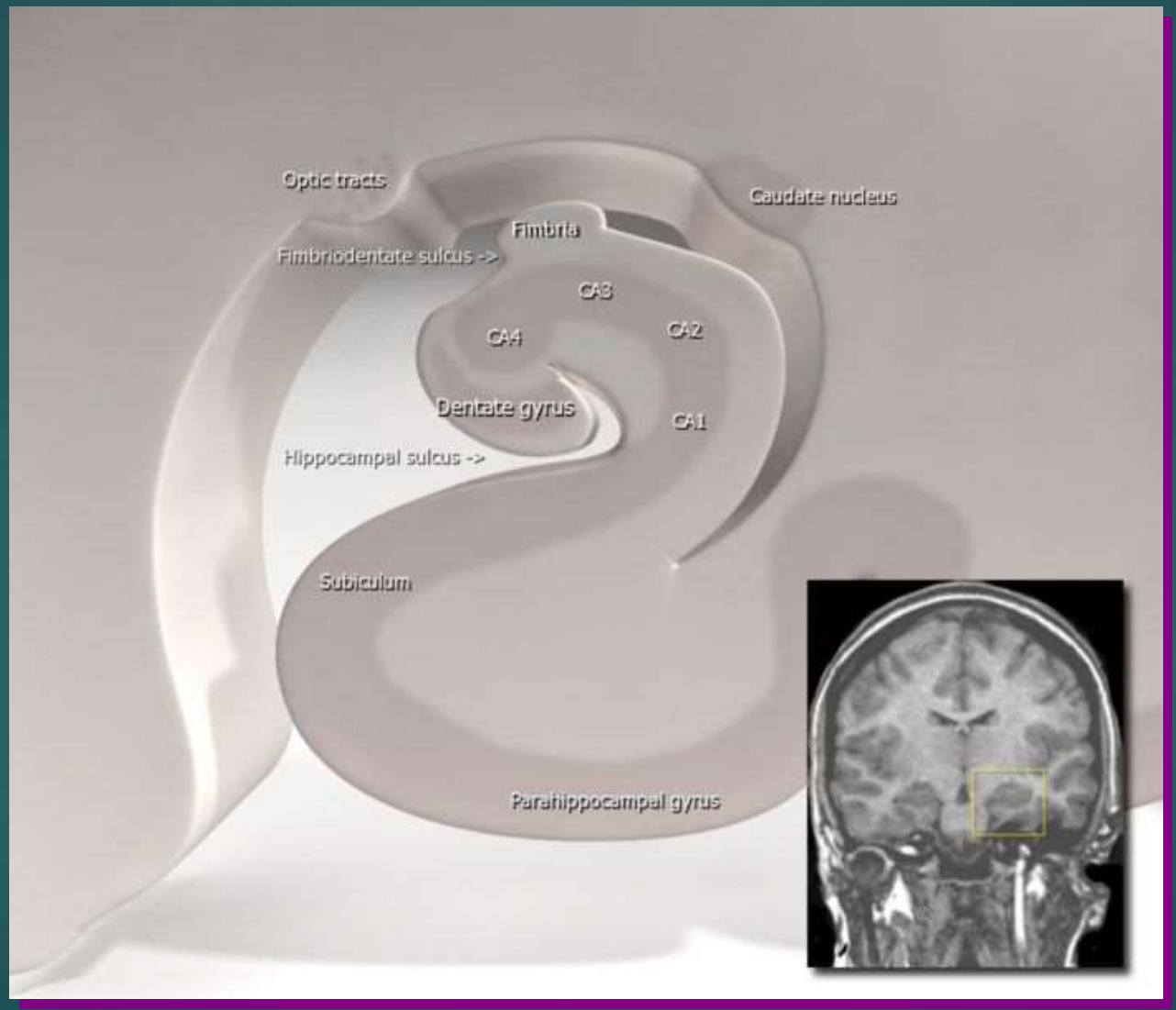
ANATOMY of the brain and cross section of the hippocampus show some of the regions involved in dreaming. In the hippocampus, incoming information is processed sequentially in the dentate gyrus, the CA3 and the CA1 pyramidal cells. In subprimate species, theta rhythm is generated in the dentate gyrus and CA1 cells.


Supracallosal striae
Corpus callosum
Fornix
Str med
H
AT
MFB
Brain
stem
Frontal
lobe
Sep
P
M
M Str
Tub
DB
Stria terminalis
Olf bulb
L Str
Dentate gyrus
Amygdala
Hippocampus
Parahippocampal gyrus

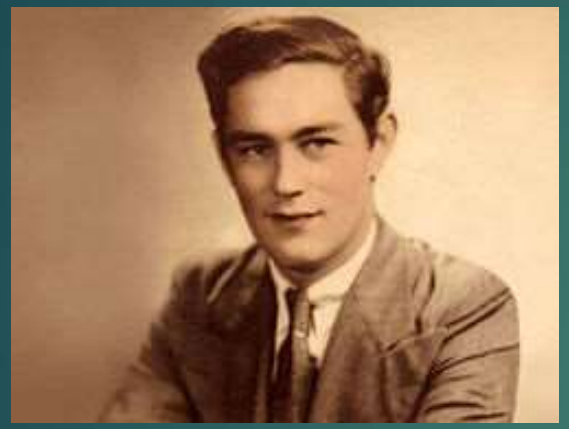
► The Three Major Structures of the Medial Temporal Lobe

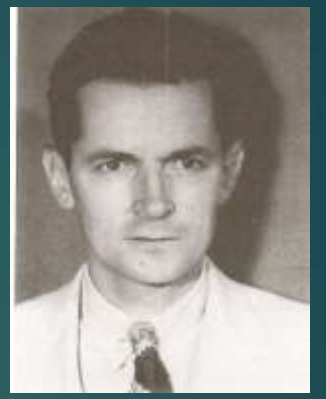


Hippocampus, Subiculum, Parahippocampal Gyrus



Henry Gustav Molaison, 1926-2008





William Scoville MD

Brenda Milner PhD

Patient H. M.

The most important patient in the history of neuroscience.

100 researchers studied him

***Permanent Present Tense* -** Suzanne Corkin

H.M.

- Because of his severe epilepsy (due to bike accident at age 10) that had foci in the medial temporal lobe, he had a bilateral medial temporal lobectomy in 1953.
- The good news was that it greatly reduced his epileptic problems.
- The bad news was that he showed a severe anterograde amnesia – no more new learning.
- In last 54 years, 100 investigators have studied him.

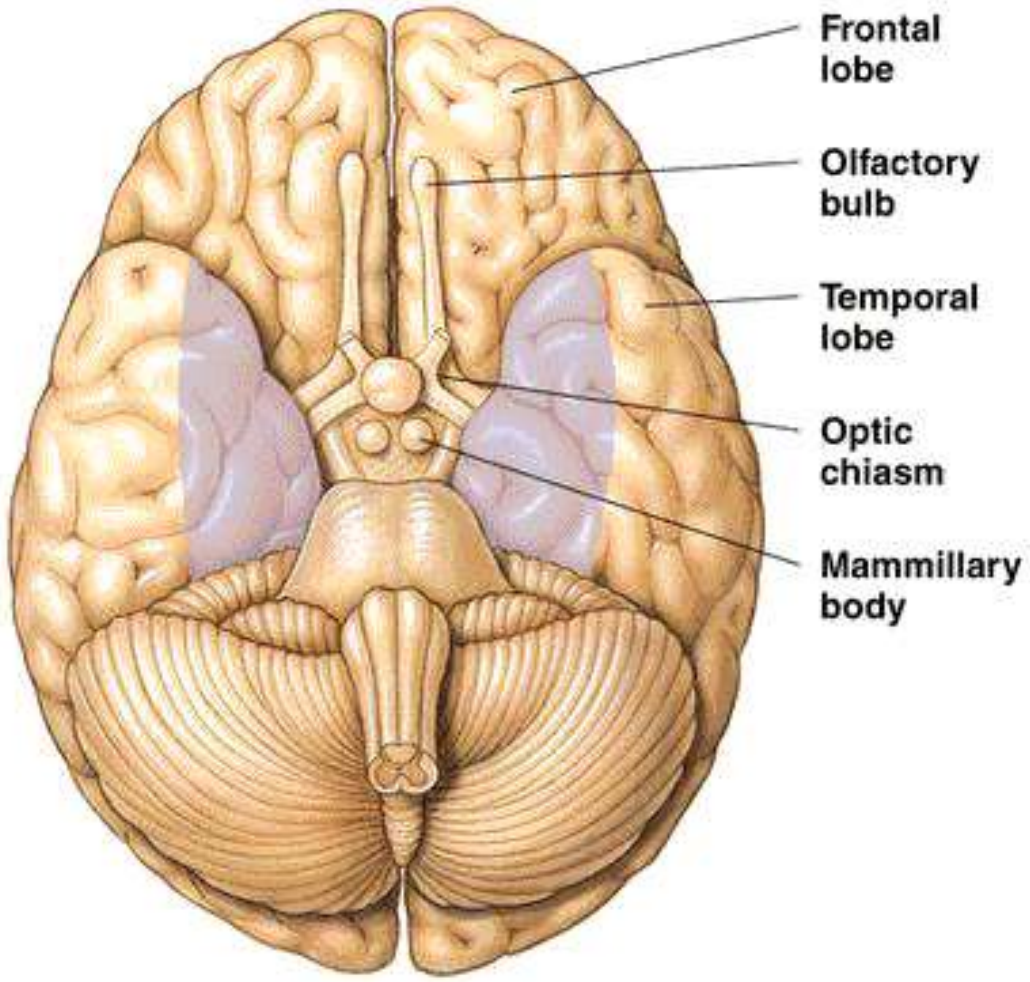
Milner et al., 1968; Corkin, *Perfect Present*

H.M. 2

- Absence szs at 10; GM szs at 16; bilateral medial temporal surgery at 27
- H.M.'s fame began in 1957 with publication of Scoville & Milner's paper, "Loss of recent memory after bilateral hippocampal lesions." (cited 1744 x since 1957)
- Their conclusion: Severity of amnesia (loss of new learning ability) correlates with size of hippocampal removal

Scoville & Milner, *JNNP,* 1957

► Medial Temporal Lobectomy



Assessment of H.M.

Brenda Milner

Suzanne Corkin

H.M.’s brain was sliced into 2400 pieces on internet

Hippocampus

- Important for formation of new episodic (personal) memories
- Important for encoding perceptual aspects of memories
  - Novel events, places, and stimuli
- Important for declarative memory (conscious permanent memory)
  - Involved in recollection, but not familiarity

H.M.’s Hippocampal Amnesia

- Global declarative (factual) amnesia, irrespective of:
  - Kind of memory test
  - Kind of verbal, visual, spatial stimuli (words, digits, faces, tones, mazes, events)
  - Kind of sensory modality (5 senses)

- Deficit episodic (personal) and semantic (knowledge) memory

- But Normal
  - working memory
  - language (lexical and grammatical) processing
  - Premorbid semantic knowledge

Knowledge Gained from H.M.

- Memory is not simply and diffusely represented across the brain
- Importance of hippocampus
- STM (WM) and LTM are different forms of memory
- Need medial temporal lobes for memory encoding and consolidation
- Two memory systems discovered: Declarative (Explicit) vs. Behavioral (Procedural) memory:

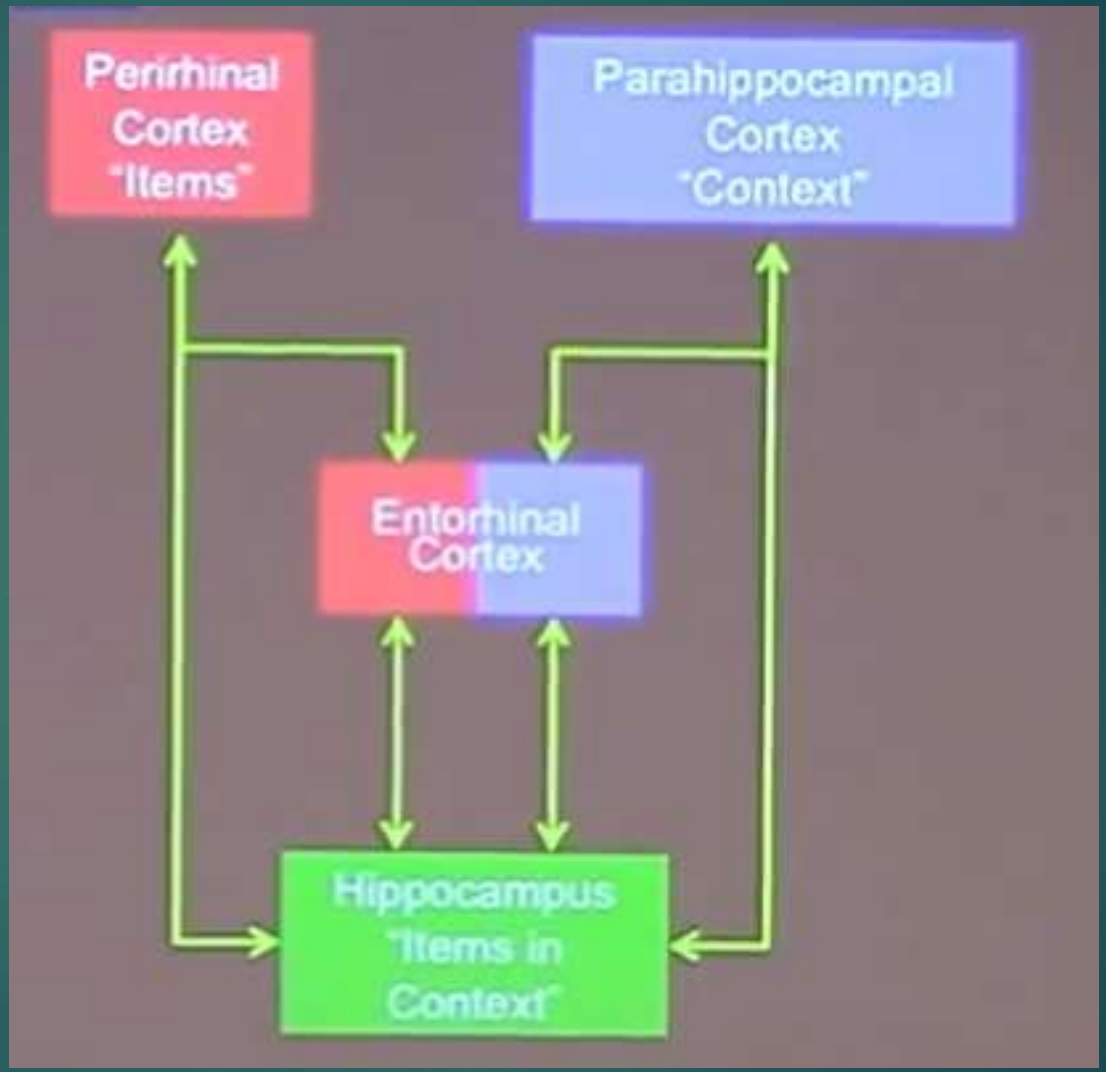
Role of Hippocampus 2

- Spatial information: right hippocampus is larger in taxi drivers
- Anterior hippocampus indexes generic novelty: adds new to old info
- Posterior hippocampal responses index familiarity to stimuli that have behavioral relevance

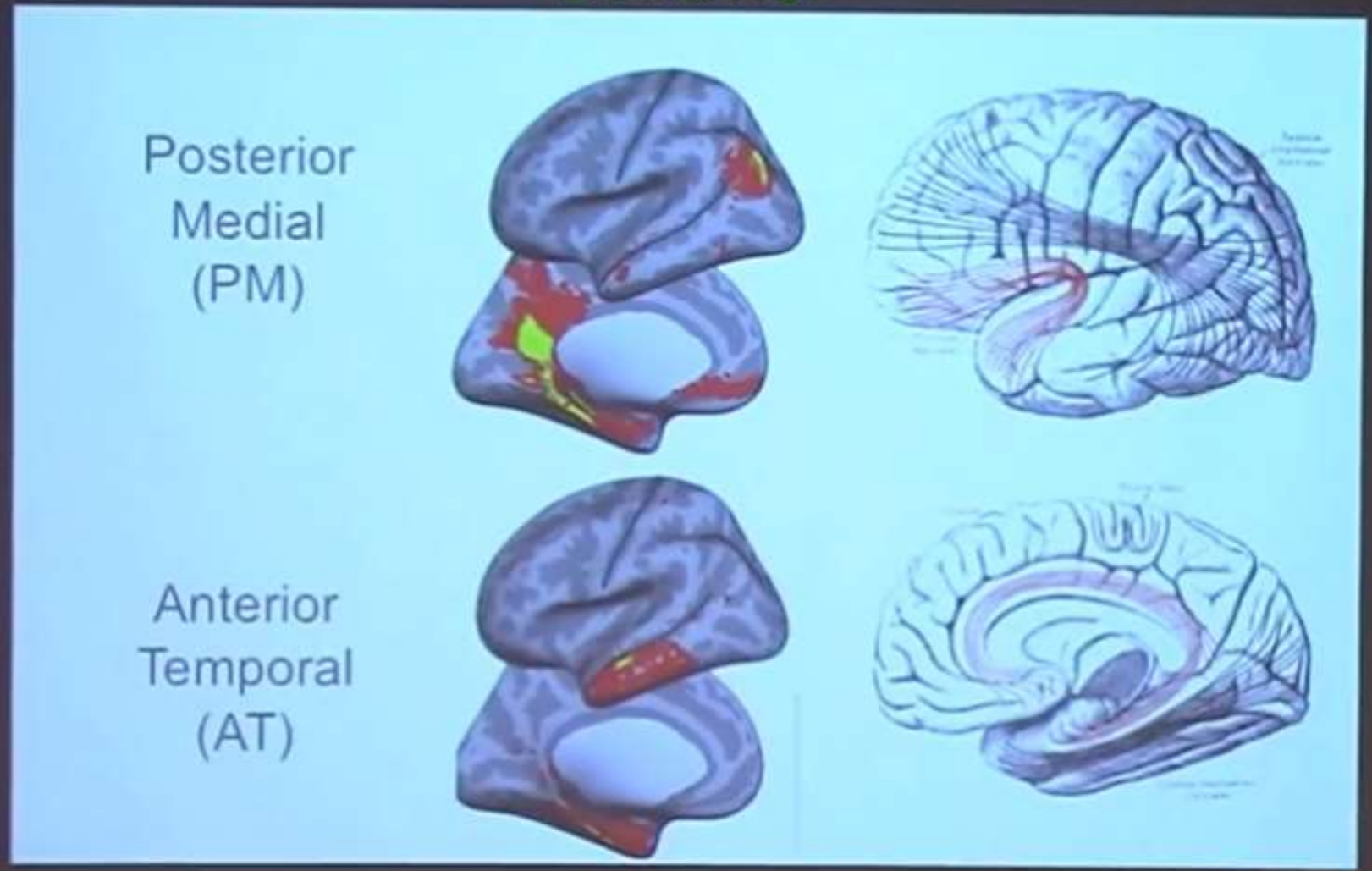
What, Where, When: a network of memory systems

Hippocampus captures the context:

I had dinner (what)
last Thursday (when)
at Chez Panisse (where)



Two Pathways for Memory-Guided Behavior



Kahn et al., (2008). J. Neurophys.

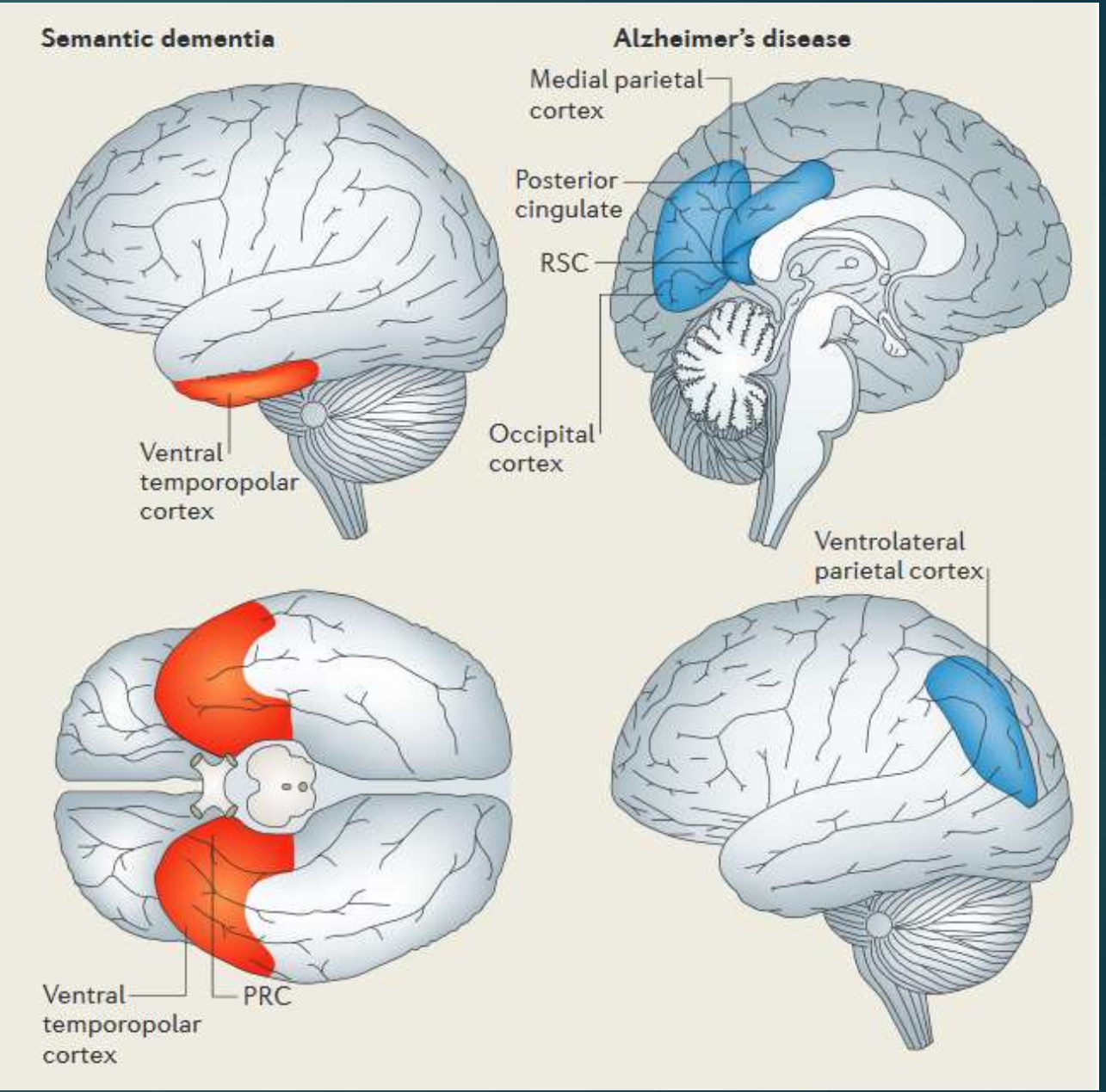
Libby, Ekstrom, Ragland, & Ranganath (2012) J. Neurosci.

Anterior Temporal = specific items, semantic & familiarity network for Semantic Dementia & Herpes Simplex Encephalopathy & cortical atrophy in patients with temporal lobe epilepsy

Posterior Medial = contexts, episodic & recollection, DNM network for AD & Korsakoff's

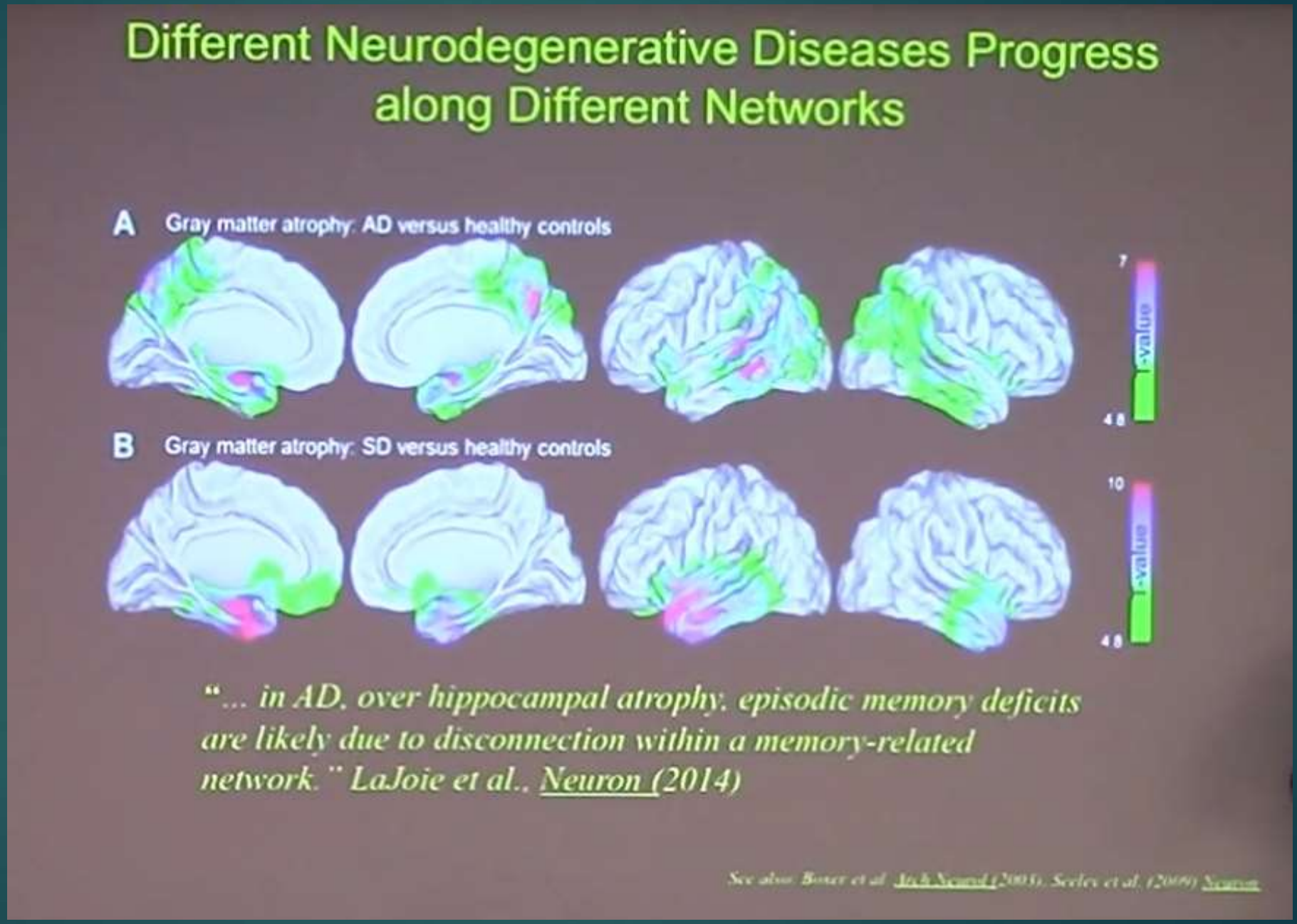
AT network

PM network



A= the Posterior Medial System – Episodic Memory: Alzheimer's

B – the Anterior Temporal System – Semantic Dementia



Neuroplasticity: Experience changes our brains:

London Taxi Drivers

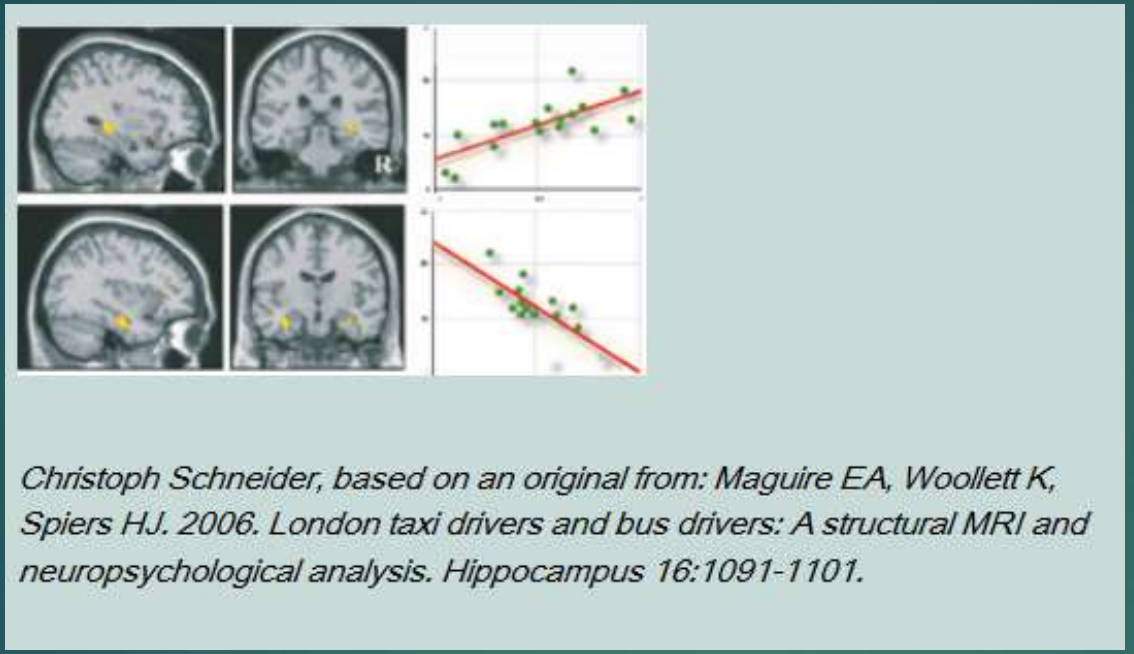
If you lived in London, and wanted to grow your hippocampus, which driving job would you choose?

Knowledge exam: 3 of 10 pass

25,000 streets
1400 landmarks

Study of London Taxi cab drivers (vs. bus drivers): To earn their licenses, cab drivers in training spend three to four years driving around the city on mopeds, memorizing a labyrinth of 25,000 streets within a 10-kilometer radius of Charing Cross train station, as well as thousands of tourist attractions and hot spots. "The Knowledge" exams that only about 50 percent of hopefuls pass.

Larger Right Posterior Hippocampus in London Taxi Drivers: 7% larger , but otherwise normal memory



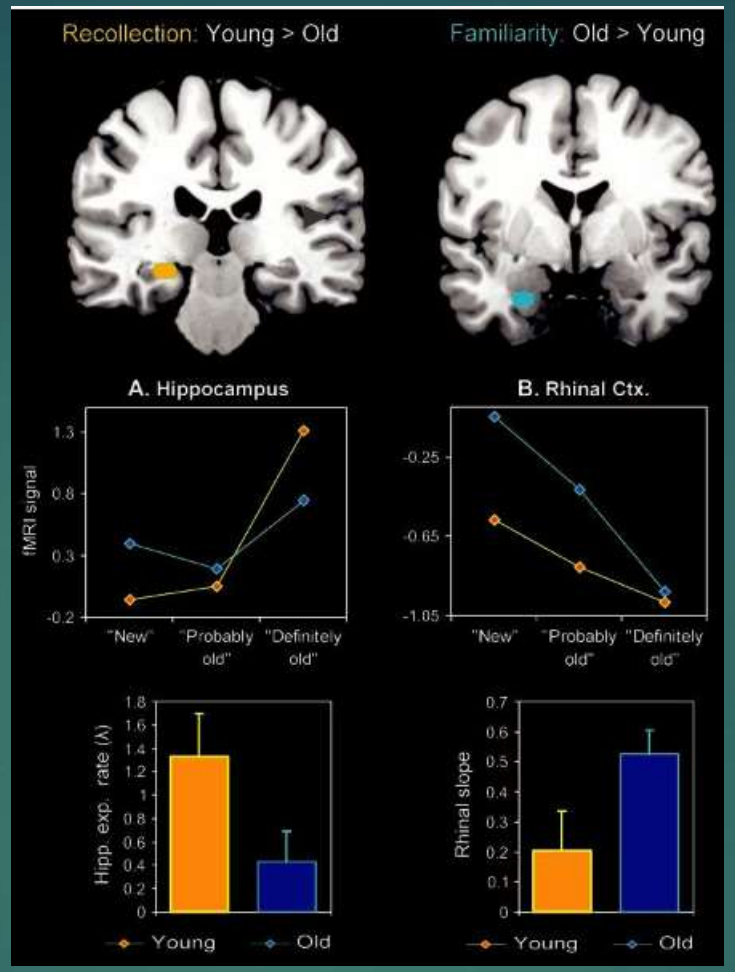
Christoph Schneider, based on an original from: Maguire EA, Woollett K, Spiers HJ. 2006. London taxi drivers and bus drivers: A structural MRI and neuropsychological analysis. Hippocampus 16:1091-1101.

Enlarged the posterior hippocampus at the expense of the anterior

London taxi drivers who earned their licenses performed far better than those who failed—even though they had performed equally four years earlier. And MRIs showed that the successful trainees' hippocampi had grown over time.

The successful trainees did not perform better on all tests of memory, however. Licensed taxi drivers did worse than non-taxi drivers on the Rey-Osterrieth Complex Figure Test.

Aging decreases recollection in hippocampus



Aging increases familiarity in perirhinal cortex

The effects of aging:
Recollection in the hippocampus was decreased by aging,

Familiarity in the rhinal cortex was increased by aging.

Amnesia: Present = Past ≠ Future; no time travel or future

- Amnesia: inability to record and store new information.
- If we have amnesia, you lose ability to make a plan.
- Plans are our memories of what we intend to do.
- People with amnesia live in the present and in the long past.
- Cannot imagine a scene of what might happen to them in the future; can imagine an object, but not a scene

D. Addis, et al., Psy. Sc, 2008

Amnesia means no future

- Hippocampus plays an important role in envisioning the future.
  - On MRI, it is activated when individuals imagine potential future events.
- A decline in ability to imagine: People with amnesia have difficulty imagining future events with any richness of detail and emotion.

- Amnestics are really stuck in the present

E. McGuire, et al., 2018

Role of Hippocampus: Memory index

- Hippocampus is needed temporarily to bind together distributed sites in neocortex that together represent a whole memory.
- Index, connection central, search engine to database of memory
- Novelty detector: compares incoming sensory info to stored knowledge; if difference, triggers dopamine increase.
- Specialty is binding new to old information
- Ceases to play a crucial role in the retention of a specific memory after about 2 years.

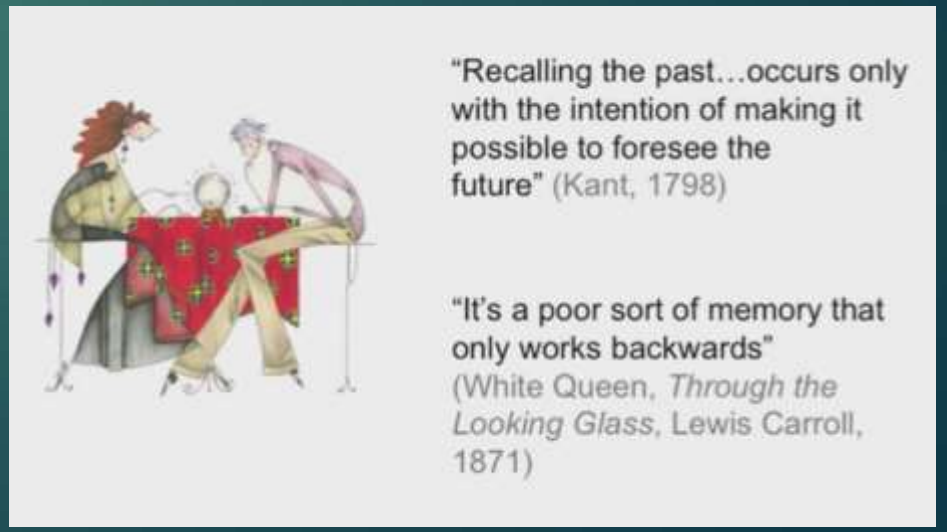
Hippocampus & Prefrontal Cortex Work Together

- The hippocampus is our memory search engine,
- The prefrontal cortex is the filter determining which memory is the most relevant to current task
- Storing information alone is not enough for a good memory.
- PFC gives you ability to access the relevant memory information without being distracted by what is irrelevant to current task.

Role of Hippocampus: Future prediction –
"It's a poor sort of memory that only works backwards"

- Actual reason for memory and function of hippocampus: memory is not about the past; it's about the future

- Memory is about helping predict and infer from previous experience and prior knowledge, what to do next, where to go, what to expect, & how to survive



Memory retrieval is a reconstruction

- Memories aren't just stored in the brain, but are instead created anew each time you try and recall one
- Memory is not an exact storehouse or copy, i.e. apple not located in 1 neuron, not byte on hard drive
- Memory is an active, reconstructive process, that can be constructed, elaborated, distorted, and lost.

Factual Memory: Remembering What…

- Fact Memory
- Explicit information
- Remembering faces
- Remembering telephone numbers
- Remembering names
- Recalling dates
- Visualizing maps and locations

Declarative Memory:
Medial Temporal/Hippocampus and Frontal Diencephalon

- Initial input into LTM: both episodic & semantic
- Fast process
- Conscious & Effortful
- Specialty: 1 trial rapid acquisition
- Sensory multimodal
- Poor reliability (forget; retrieval errors)

Episodic Personal Memory:
Mental Time Travel - Need Frontal Lobe

- Episodic or Specific Event Memory:
  - Who, what, where, when, how?
- Memory for personal experience
- Where, when, how of acquisition of the memory
- Personal, subjective experience
- Temporally and spatially dated
- Context of a memory

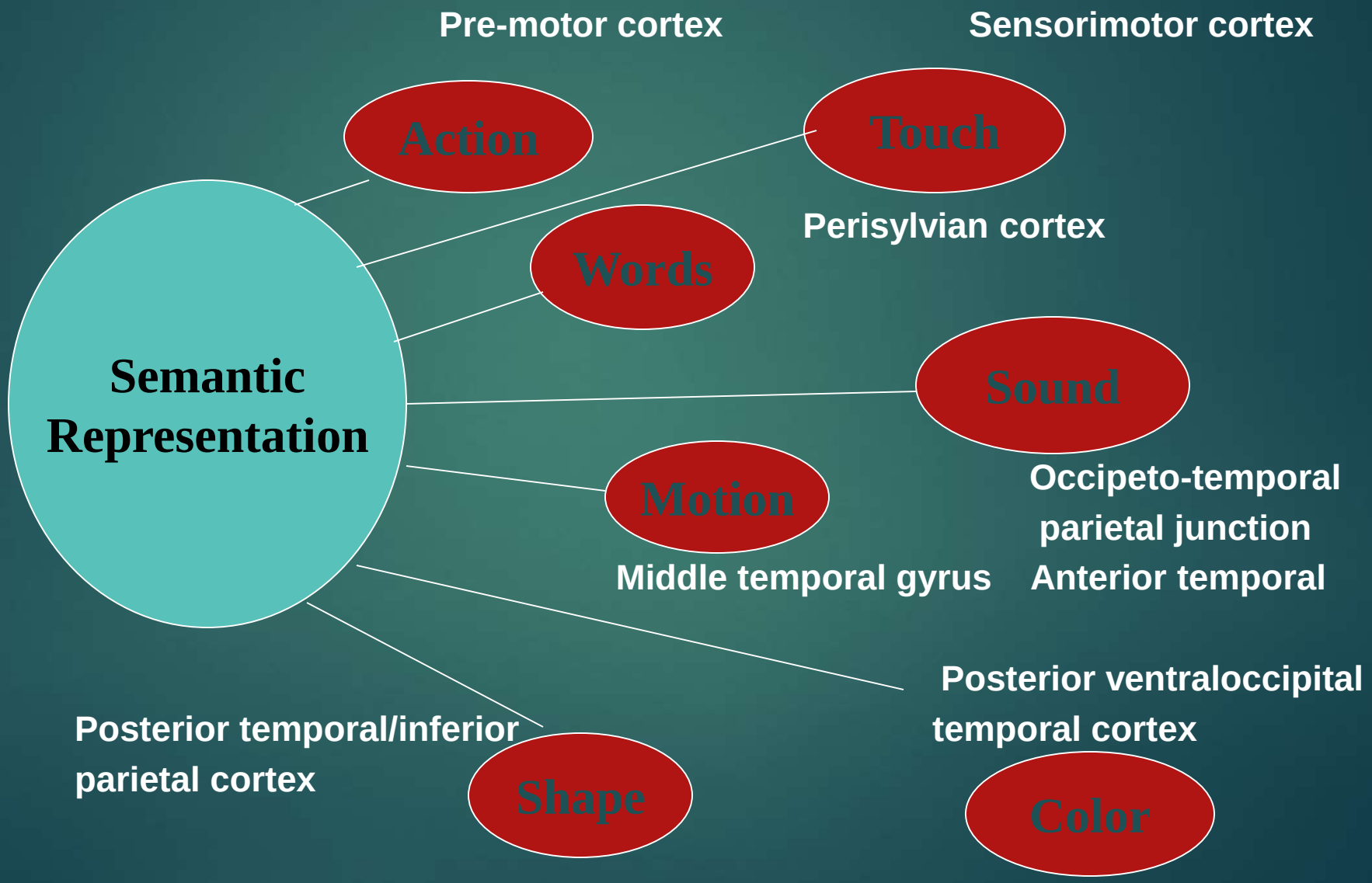
- Requires Frontal processing & bilateral anterior and right posterior hippocampus

Tulving, 1972,1983, 2002

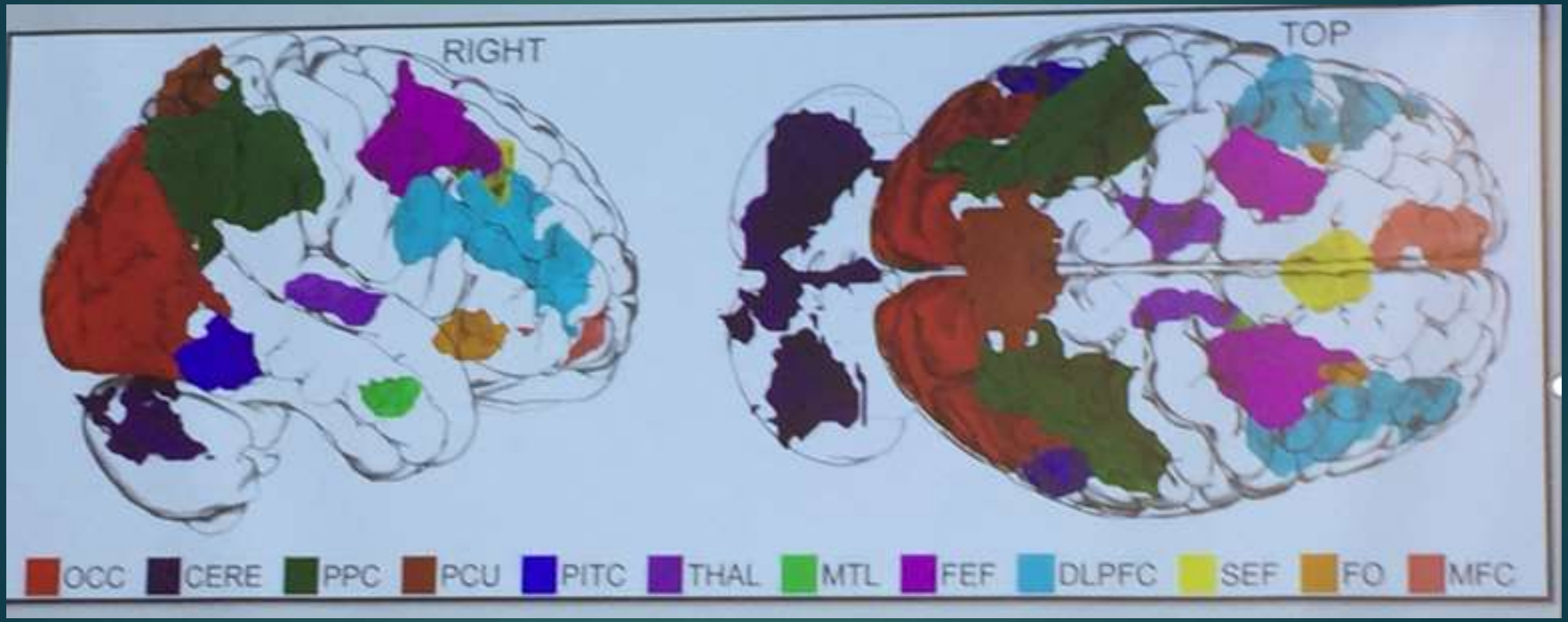
Semantic Memory: Knowledge

- Our Knowledge: What we "know"
- General Knowledge
  i.e. Cleopatra, 1492, Buddha
- Organization in brain based on meaning, semantic networks
  - lexical (Animal Naming)
  - 1st letters of words (FAS)
- Research results from Fluent Dysphasia and Visual Dissociative Agnosias cases

Locations of Semantic Memory



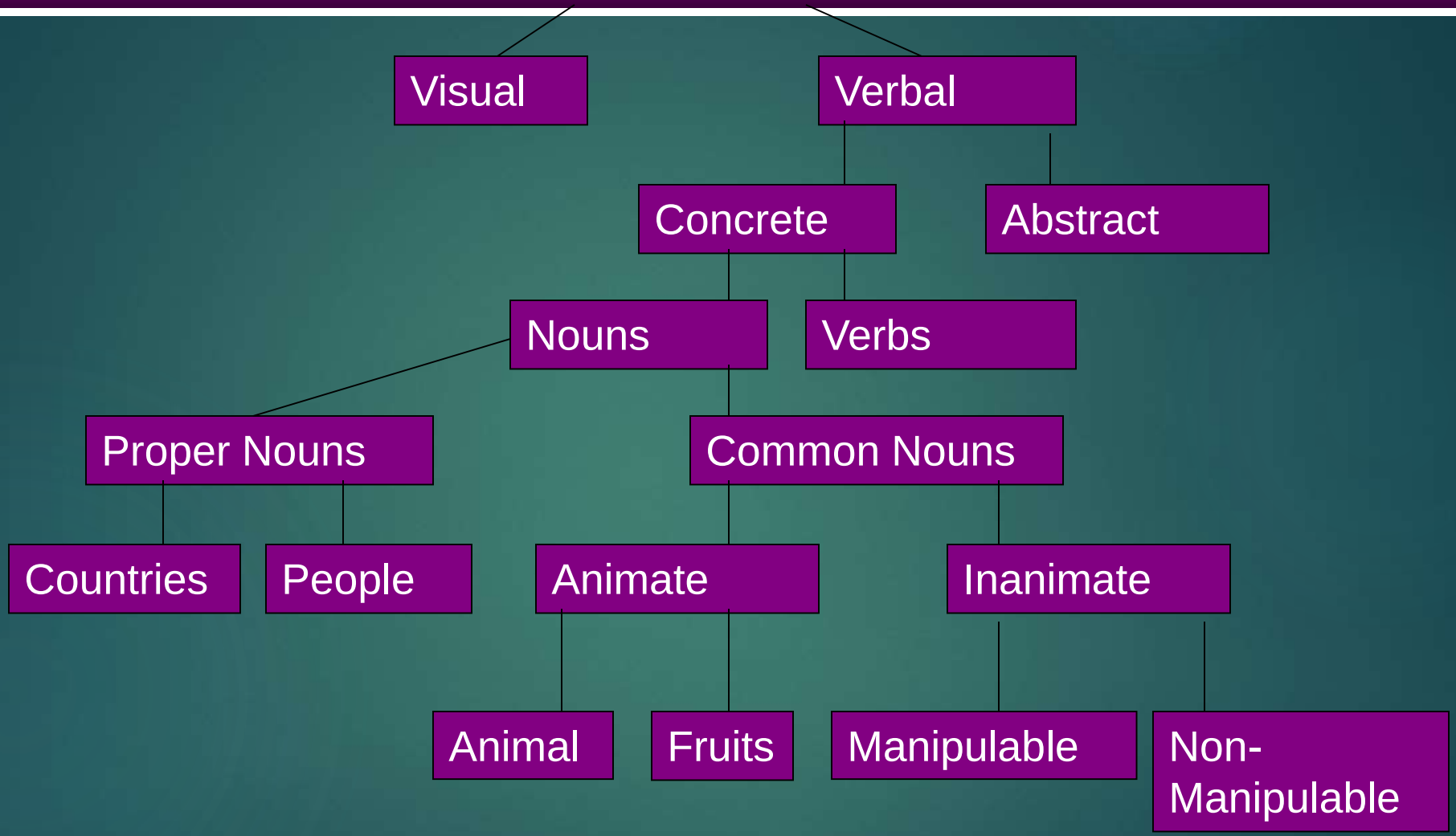
Reading activates more brain areas than any other activity



Reading Harry Potter: sentence reading activates all brain areas

- Statistical model is able to classify which of two novel passages of the story is being read with an accuracy of 74% based on neural activity while reading.
- Brain areas involved:
  - Angular Gyrus: lexical semantics (bilateral); physical motions of story characters
  - Fusiform Gyrus
  - Inferior frontal: high level word integration (right); semantics of individual words (left); Physical motions of story characters; dialog among story characters (right)
  - Inferior temporal
  - Middle temporal: semantics of individual words (bilateral), identities of different story characters
  - Superior temporal: sentence length (L), syntax (R); semantics of individual words (R); Physical motions of story characters; identities of different story characters , protagonist's perspective (right)
  - Temporal pole: high level word integration (bilateral)
  - Occipital: word length (left Visual Word Form Area)
  - Precentral Gyrus
  - Precuneus
  - Temporal Parietal Junction: sentence length/syntax (left & esp. right); dialog among story characters (right)
  - Supplementary Motor Gyrus

Topography of Semantic Knowledge revealed by strokes



Other Known Categories: indoor / outdoor, vegetables

Tip #11: More meaningful a memory, the better we remember it

Schachter: Depth of Processing Theory

Level of Processing	Type of Encoding	Example
Shallow	Structural/visual	Written in upper or lower case letters?
Intermediate	Phonemic/acoustic	Does word rhyme with bog, bar, etc.?
Deep	Semantic (meaning of a word)	“Does the word go in this sentence: You buy candy in a _____ .”

Tip: Remembering names

- Meet man named Ronald wearing loud shirt who is a car salesman who loves fishing and wants to sell fishing gear
- You need to create a web of associations.
- First, you should repeat any name said to you. “Ronald, why do you love fishing.”
- Link the name you have just learnt to something you already know. Ronald Reagan was president.
- Link their name to something else about them. Ronald McDonald always wore bright colors.
- Imagine Ronald McDonald hitting Ronald Reagan with a fish.

Use your visual imagination

- 1 What was the man’s name?
- 2 What kind of shirt was he wearing?
- 3 What did he like to do?

Old vs new advice about learning

- Classic recommendation for studying and memorizing a topic:
  - Find a quiet, isolated study space
  - study same topic for several hours
  - later review your underlined or highlighted material,
  - especially on the night before the test;
  - review your material by rereading it.

How we learn by Benedict Carey

New research says: Learning is more powerful

- with distractions,
- having distraction periods,
- taking a test before you know anything,
- mixing up the learning,
- changing locations,
- spacing study times,
- finding meaning,
- napping,
- falling asleep.

What does not work in learning

- Reviewing highlighted text
- Rereading text: you crucially fail to know that you have not learned specific material
- Only by testing do you realize what you do not know

Tip #12: Repeatedly self test yourself

- **Quiz yourself** – When it comes to learning, reviewing the material isn't enough. You need to test yourself repeatedly too.

- "Retrieval practice"—correctly producing a studied item—increases the likelihood that you'll get it right the next time.

- Repeated retrieval is good for memory. (40 Swahili words: 80% (w/ self testing) vs 36% recall at 1 week)

- Testing is a memory strengthener.

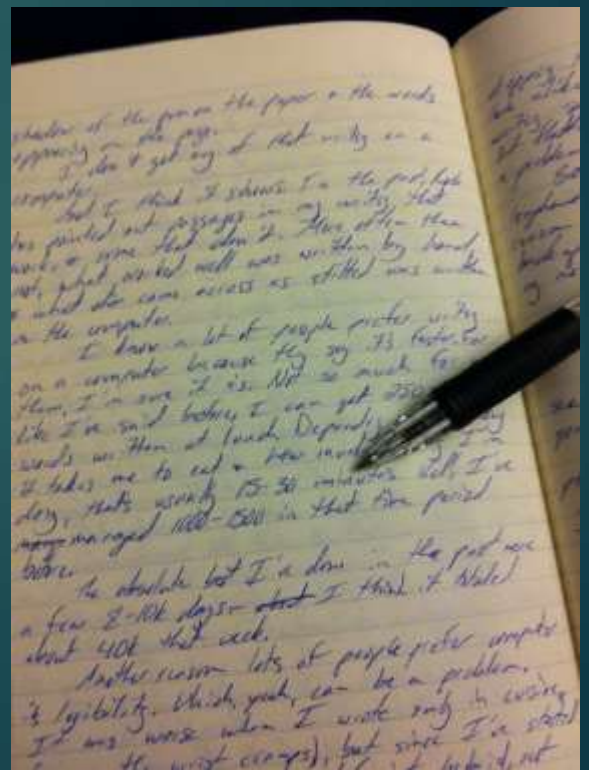
Karpicke, Science, 2008

Self Testing 2

- Self Testing or retrieval practice = forces you to choose an answer and gives you immediate feedback about what you know or do not know
- Self-testing offers an accurate assessment of what has not been learned and whether one needs to keep studying.
- Yet only 50% of students use this technique.
- All the evidence indicates that self testing should be at the core of any study regime.

The Pen Is Mightier Than the Keyboard
Advantages of Longhand Over Laptop Note Taking

- Taking notes on laptops rather than in longhand is common, but may not help your memory.
- Even when laptops are used solely to take notes, they may still be impairing learning because their use results in shallower processing.
- In three studies, students who took notes on laptops performed worse on conceptual questions than students who took notes longhand.
- Whereas taking more notes can be beneficial, laptop note takers' tendency to transcribe lectures verbatim rather than processing information and reframing it in their own words is detrimental to learning.



Technology & memory: Outsourcing memories

- Smartphones as external memory prosthesis
- People on tours: those who take pictures had a poorer memory of the tour at a later date.
- People who rely on GPS to get around are also worse at working out where they have been than those who use maps.
- When we think something can be accessed later, we have lower rates of recall of the information itself and better recall instead for where to access it. We don’t need to remember content, but instead, where to find it.
- Screws up our meta-memory (the ability to know what they remember or whether they have forgotten sg)

Tip #14: Chunking – mentally grouping details

- **Chunking** (adding meaning) leads to better recall

- N L B I A T F C S R M V

  Versus

- N F L- C B S- I R A- M T V

- Examples: Your phone number or Social Security number

Coming Up Next:
Example of Procedural Memory

- Old typewriting skills are procedural memory

Over learned Skill

Procedural/Behavioral Memory: Remembering how…

- Skills, habits
- Playing a musical instrument
- Playing sports
- Riding a bicycle, driving a car
- Reading mirror-reversed word
- Playing Chess, bridge
- Grammatical structures
- Interpersonal Skills
- Depression
- Transference in psychotherapy
- Cognitive Behavioral Therapy

Procedural/Implicit/Nondeclarative Memory

- Heterogeneous nonconscious systems: perceptual systems, striatum, cerebellum
- Gradual behavioral repetition culminates in nonconscious behavioral change, i.e. tennis, opening a door, knitting
- No access to learning episode or context
- Reliable, highly resistant to change
- Sensory modal hyper specific (typing ≠ piano)

Habits: autopilot memory

- Brain no longer encodes the details of a repeated behavior, so while you remember how to lock the door, there's no specific memory of when you last did it.

- Forgetting to drop a child off and leaving them in the car

Tip #15: For behavioral memory: Do it – don't think about it.

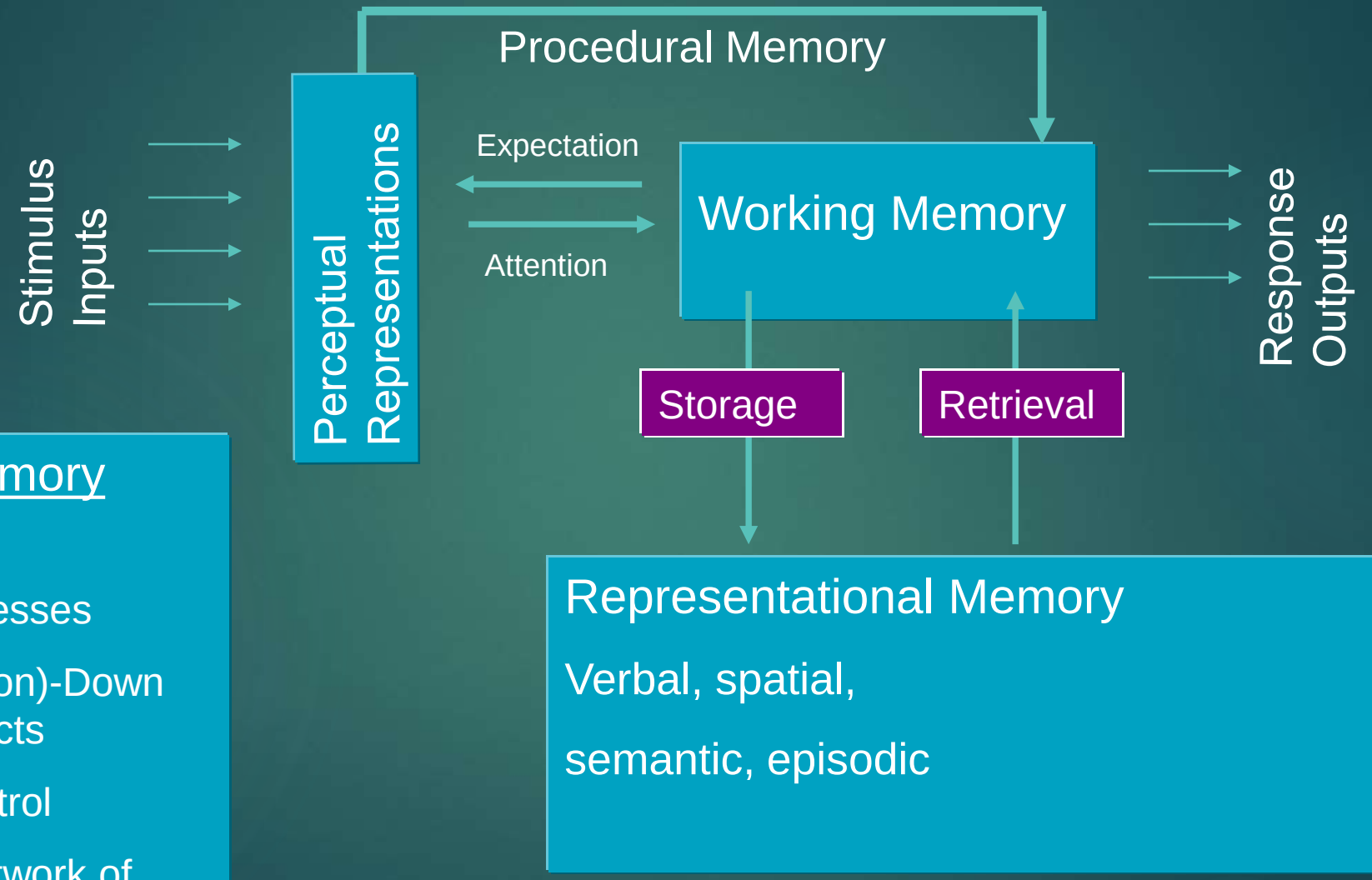
- Yogi Berra (NY Yankee catcher & manager) and Behavioral Memory:
  "You can't think and hit a baseball at the same time."
- If you make an implicit process explicit, you can wreck it.
- Lesson: Do it. Don't think about it.

Prospective Memory: Remembering a delayed intention

- PM = remember to execute an intention at an appropriate later time
- First you must form the intention, then remember it, then activate it at the right time
- Research: Airline industry – major cause of pilot error
- Relies upon executive (frontal) as well as mnemonic (hippocampal)resources.
- Prospective memory is one of the best predictors of the ability to live independently

- Rostral prefrontal cortex (Brodmann's area 10) plays a critical role in prospective memory (remembering to do something after a delay).

An Information Processing Model of Memory



Revised Memory Model

Dynamic Processes

Top (Expectation)-Down (Sensory) Effects

Executive Control

Distributed Network of Associations

Source: A.P. Shimamura, 2003

Will ____ improve my memory?

Maybe if you believe:

- Ginkgo Biloba
- Fish Oil
- Vitamin B12
- *Blueberries*

It depends:

- Brain Games
- Puzzles
- Action Video Games

Most promising:

- Aerobic Exercise
- Sleep
- Motivation to learn

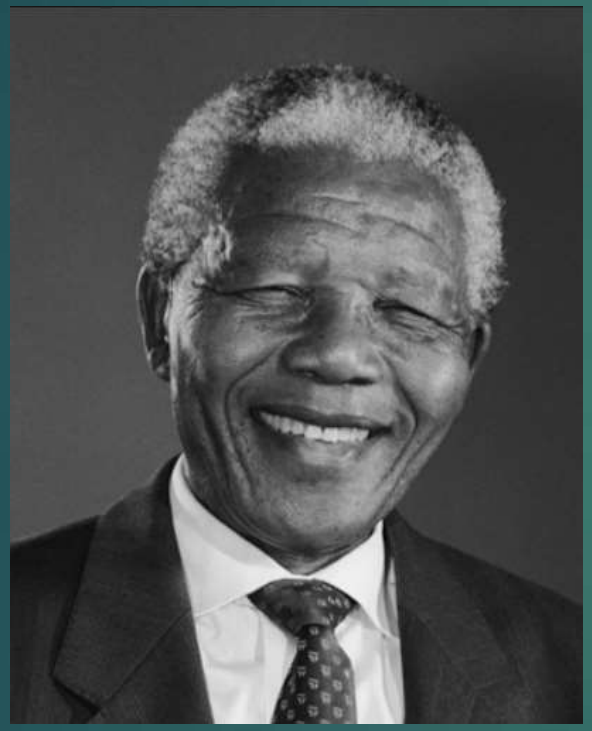
What to avoid:

- Chronic Stress
- Hypertension
- Diabetes

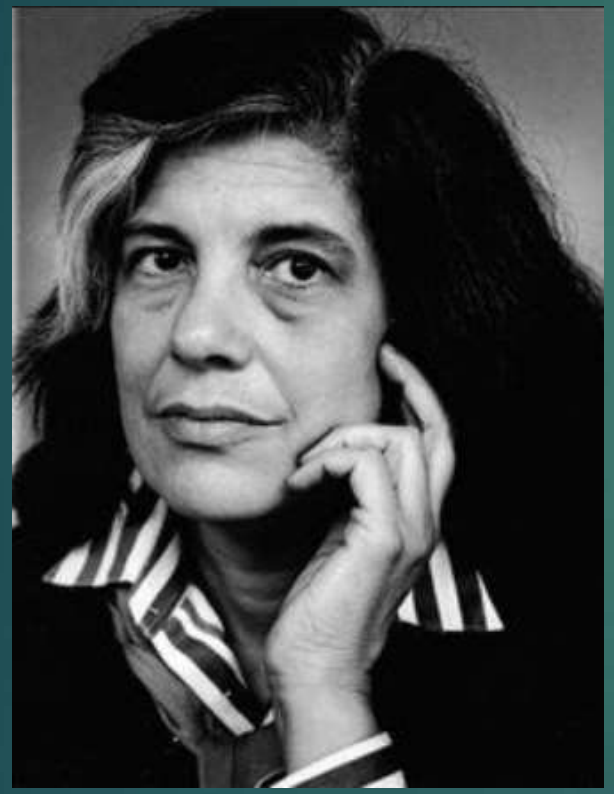
Remember those 15 pictures you saw before?

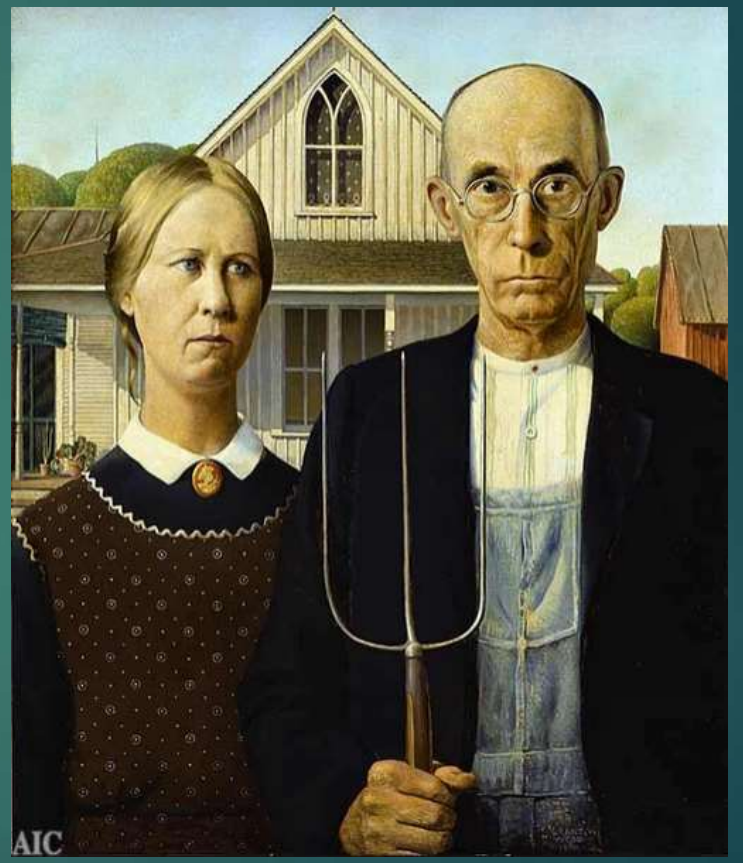
Which of next 2 pictures was the one presented ~30 minutes ago?

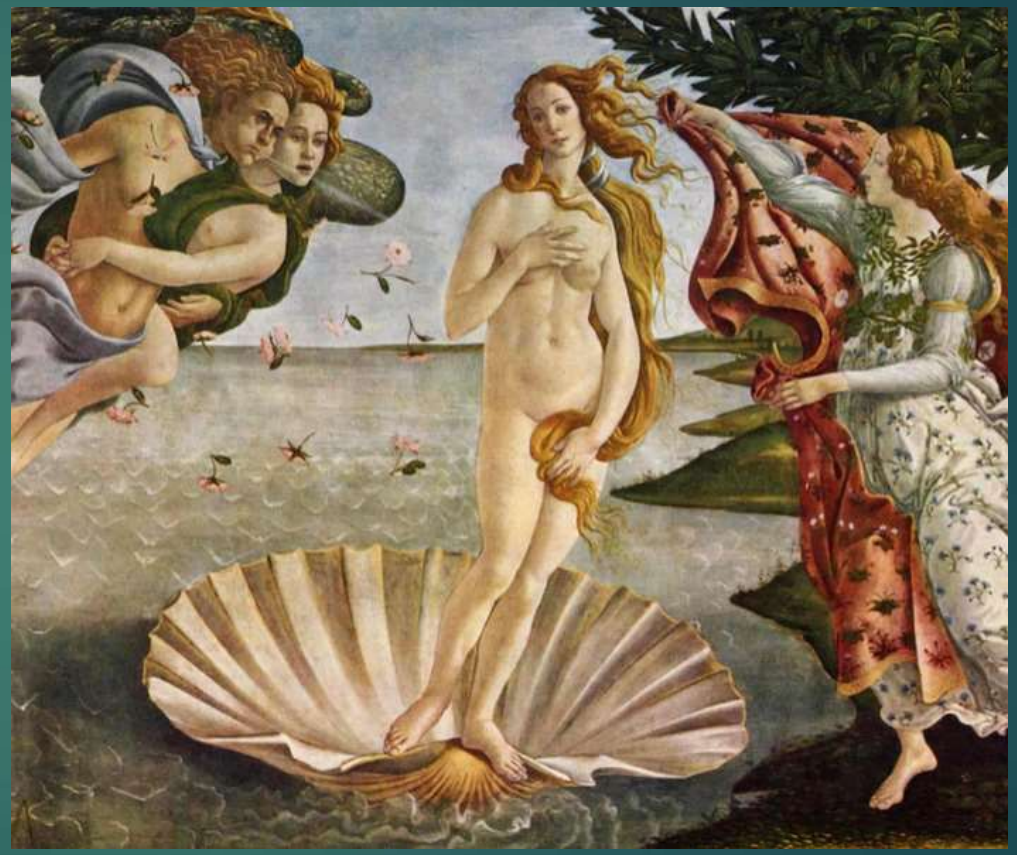
This symbol () will identify which picture you saw before after you look at the two pictures.




Everett Collection / Rex Features




AIC



Oh sorry. That was 2 years ago!

I assume you remembered all of the 15 pictures. Correct?
Your visual memory is amazing!

Tip #16: Use Visual Imagery to remember

Picture superiority effect in Memory

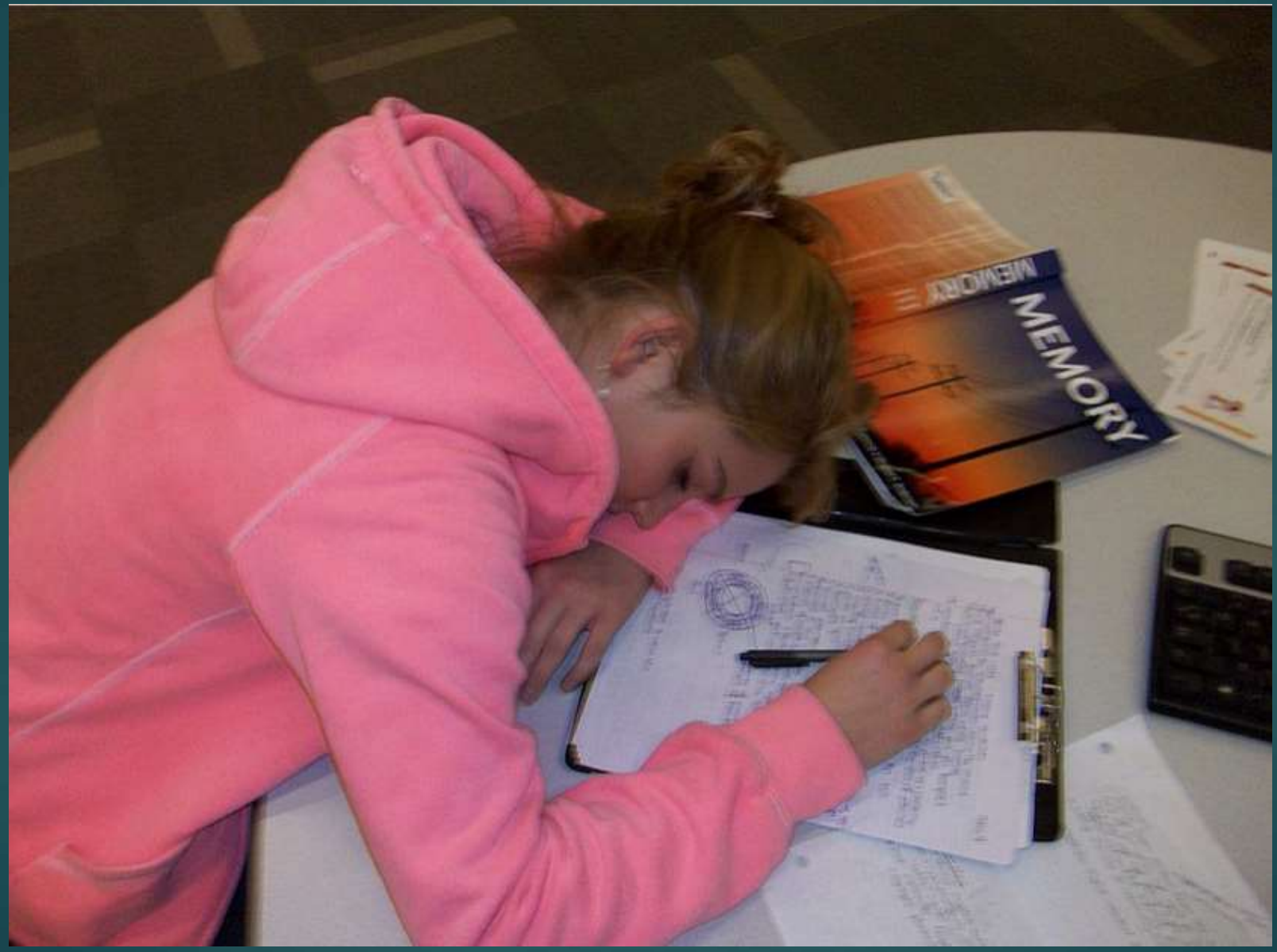
- Almost perfect memory for visual images.
- Pictures are remembered better than words
- Studies for 30 years: picture superiority effect has demonstrated that subjects are more likely to remember items if they are presented as pictures versus words
- Older individuals use this phenomena more than younger
- Standing (1973): 10,000 images over 5 days; 2 days later, 2 image choice, 83% recognition of original images
- MIT study: 2000 images for 3 seconds in 2.5 hours; 92% accuracy

Shepard, 1976; Mintzer & Snodgrass, 1999

Example of using visual imagery to remember a name: New psychologist at work: Christa Hogan

+

Napping and memory



Tip #17: To Sleep is to Remember:
A primary function of sleep is to consolidate memory

- Sleep shortly after learning new facts or skills helps the brain reinforce its memory traces – whether that sleep is a good night's heavy slumber or just a well-timed afternoon nap.
- Waking brain optimizes memory encoding (get them into storage)
- Sleep optimizes memory consolidation (make them permanent)
- Sleep: repeated reactivation of the new memories during off-line time (sleep)
- Current Conclusion: Sleep improves retention & comprehension of what one has studied the day before. Memory improvements with sleep = 10 to 30% better.

Giuditta et al., 1995; Mednick, et al., 2003

A Nap is as good as a Night

- Naps of 60 or 90 minutes contain slow wave deep sleep and REM.
- People who study in the morning (any type of factual content) do ~30 percent better on an evening test if they had a 60 minute nap than if they haven't.
- 90 minute nap significantly enhances prior procedural learning, i.e. dance sequences, piano sequences, etc.;
- A 60 to 90 minute nap may give same benefits in memory consolidation that you would from sleeping for 8 hours at night.

Sara Mednick, et al., 2003

Sleep prioritizes memories

- You don’t need sleep to create a memory
- Sleep determines what goes into long-term storage.
- It can also select which parts of a memory to retain.
- And it links new memories with established networks of remembrances.
- The brain plays back and prioritizes high-reward events for later retrieval and filters out the neutral, inconsequential events, retaining memories that will be useful to future decisions.

Sleep and memory

- There is repeated conversation between regions key to memory,
  - the hippocampus, where recent memories are stored,
  - the cortex, where long-term memories end up.

One of the functions of sleep: To Forget

- Sleep may help the brain prune back unneeded synapses: to forget some of the things we learn each day.
- Brain produces more synapses than required.
- Gene Homer1A appears to turn on the synapse pruning machinery.
- Sleep helps us remove unneeded synapses

Memory Prioritization during sleep

- When storing memories, brain prioritizes those experiences that are most rewarding
- Brain:
  - plays back and prioritizes high-reward events for later retrieval
  - filters out the neutral, inconsequential events,
  - retaining only memories that are useful to future decisions.
- The prioritization of rewarding memories requires time for consolidation;

Sleep and emotional memories

- Sleep helps to modulate emotional memories.
  - Memories with an emotional component get preferential treatment
  - especially negative emotions (need to remember mistakes) or that were really intense.
  - Sleep will help to preserve the memory, but decrease the emotionality

- Post traumatic stress disorder: direct consequence of failures of those sleep-dependent processes that weaken the intensity of emotional responses to memories

- It could also help explain why getting too little sleep is so bad for you. Negative memories become dominant over neutral and positive ones

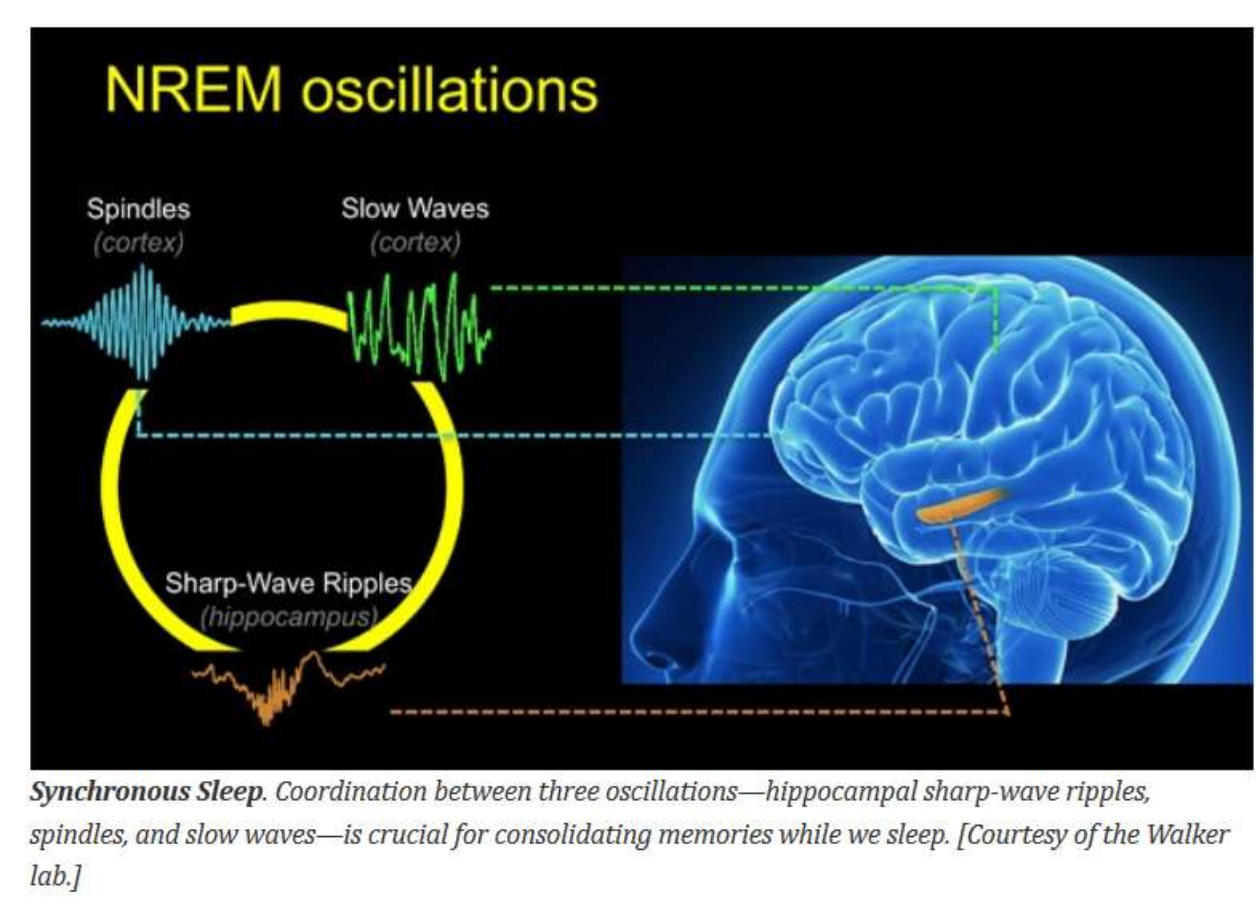
Slow wave sleep (SWRs) and memory

- Study: In mice, sequences of place cell activity that were formed during spatial exploration when awake are replayed in the exact same order during slow-wave sleep.

- Sharp waves and ripples (SWRs) are deep sleep/non-REM brain wave oscillation patterns in the mammalian brain hippocampus seen on an EEG during immobility and sleep.

- During SWRs, replayed neuronal activity patterns are transferred from the hippocampus into distributed neocortical networks.

STM to LTM transfer during sleep



Synchronous Sleep. *Coordination between three oscillations—hippocampal sharp-wave ripples, spindles, and slow waves—is crucial for consolidating memories while we sleep. [Courtesy of the Walker lab.]*

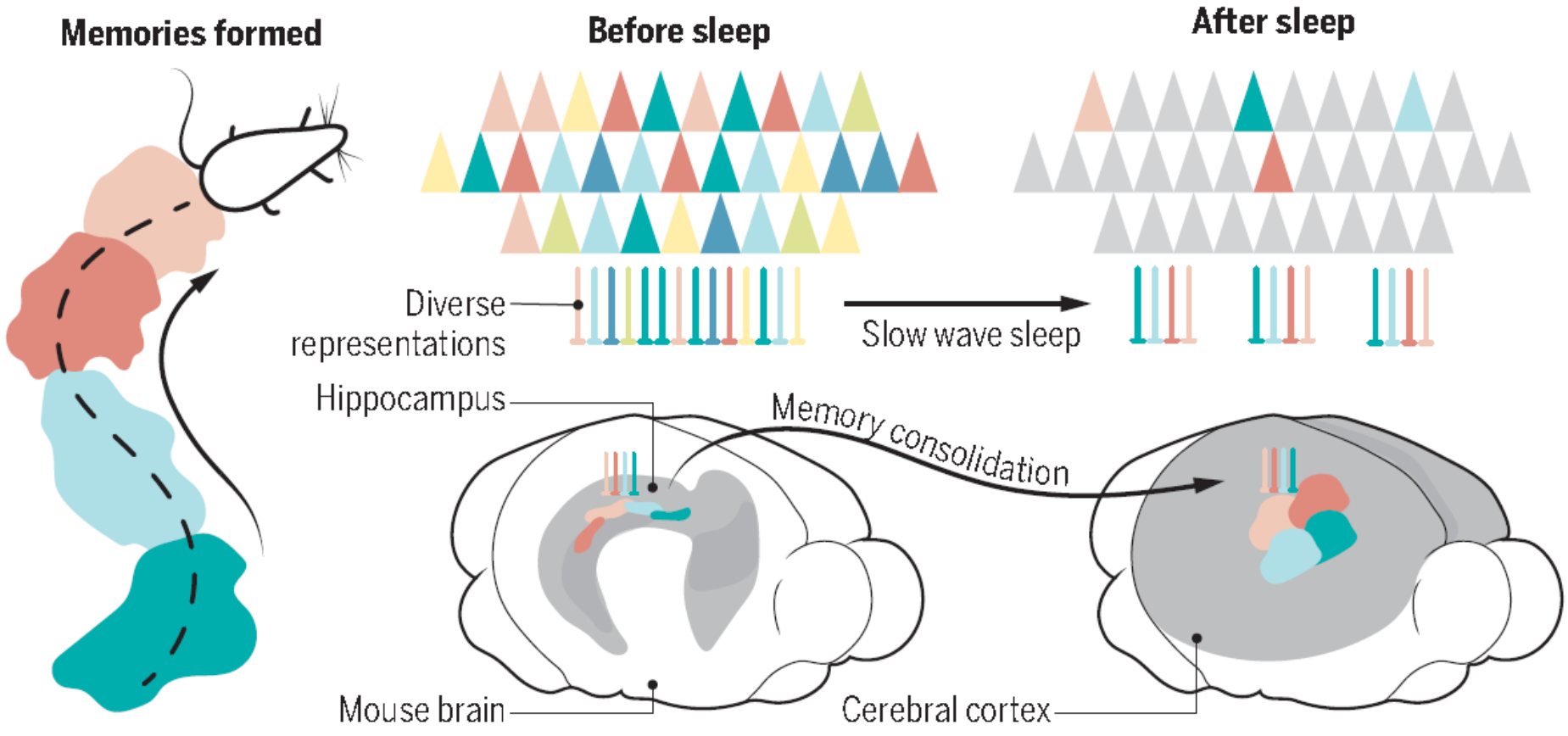
- Non-rapid eye movement (non-REM) sleep makes up about 80 percent of our sleeping hours.

- During NREM sleep, a trio of neuronal oscillations coordinates to consolidate memories formed during the day
- when these both align with the hippocampal sharp wave, then the brain is poised to convert short-term memories to long-term ones

The more out of synch the two oscillations were, the worse the person performed on the memory task. Increases with age due to atrophy of medial prefrontal cortex

Processing of engrams in the rodent brain

Firing of place cells during spatial exploration leads to the formation of coactive neuronal ensembles. During subsequent sleep, engrams of old ensembles are erased, which increases the distinction of newly formed ensembles. Memory consolidation occurs through hippocampal-cortical cross-talk, indicated by SWR-like activity patterns during sleep.



Things We Normally Forget

“Forgetting Symptom”	Percentage
Telephone numbers	58%
People’s names	48%
Where car is parked	32%
Where car keys are	31%
Groceries	28%
Reason for entering room	27%
Directions	24%
Appointments	20%
Store location in mall	20%
Lose items around the house	17%
Wallet	17%
Content of daily conversations	17%

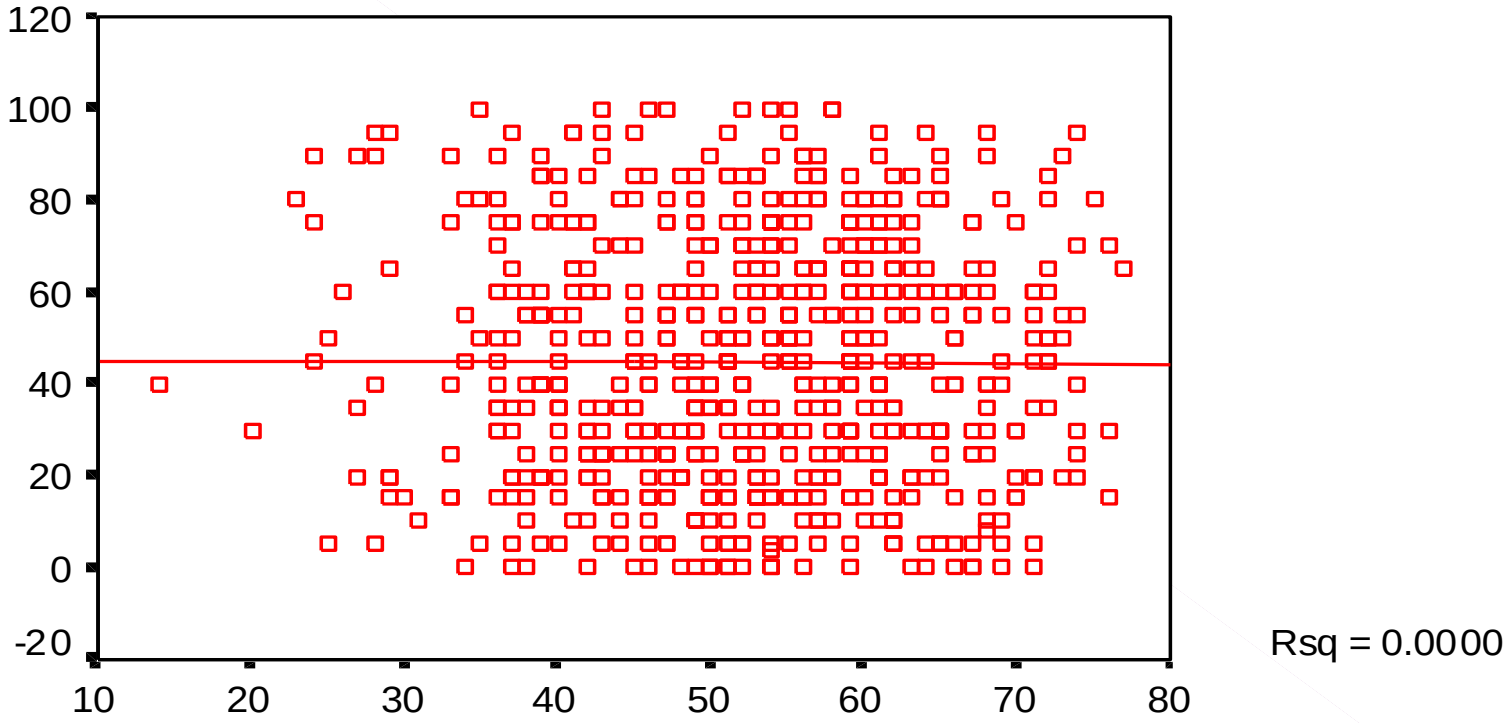

"ON THE CONTRARY, I CAN'T RECALL A THING FROM FIFTY YEARS AGO, BUT I REMEMBER EXACTLY WHAT I HAD FOR LUNCH YESTERDAY."

Phillip's Milk of Amnesia

for people who can't remember shit.

Verbal memory complaints versus verbal memory test scores

Zero correlation in 995 cases



Green, 2003

Age related memory Decline

Number recalled after 1 trial

Normal Aging and Memory

- Intact Working Memory, Semantic Memory
- With age, decrease in how much factual info you can learn, but normal forgetting rates: Learn less items, but don't forget them

  1 x exposure -- Recall: 12 new words, age 20,

  7 new words, age 80
- Frontal memory effects (intrusions, incorrect recognitions) increase
- Name-Face recognition decreases

Older have nicer pasts

2nd third

- Older people tend to see the past through rose-colored glasses
  - remember fewer negative images than younger participants
  - reduced interactions between the amygdala and the hippocampus, when shown negative images.

- Seniors are able to regulate emotion better than younger people, so they are less affected by upsetting events.

Memory Testing Tips

- Worried well (Attention vs. Memory):
  - If you forget where you put your car keys, don't worry.
  - If you forget you own a car, worry.
- Many “memory” problems are attention glitches: where are the keys
- Rarely see an Alzheimer’s patient come alone and voluntarily to my office
- Note the use of partners as external memory prostheses. Vella head turning sign of memory loss

Many Neuropathologies of Memory Functioning

- **Dementias:**
  - Alzheimer's
  - Parkinsonism
  - Huntington's
  - Pick's
  - Creutzfeldt-Jacob's
- **Infections:**
  - Encephalitis, esp.
    - Herpes
  - Meningitis
- **Vascular:**
  - Stroke
- **Head Trauma**
- **Toxic/Metabolic:**
  - Korsakoff's
  - Chronic Alcoholism
- **Neurosurgery:**
  - Temporal Lobectomy
- ECT
- Epilepsy
- Anoxia/Hypoxia
- Brain Tumors
- Hodgkin's lymphoma (paraneoplastic syndrome: antibodies attack brain cells

Medial Temporal Amnesia: Alzheimer's, H.M., severe TBI

- Severe Anterograde Amnesia: No new learning
- Some period of Retrograde Amnesia: loss some old memories; keep oldest memories, but not just made new memories

Anterograde Amnesia = No new learning

- Perceive but do not record
- Do not know they have a memory problem
- New person is always a stranger
- No memory for meals
- Eternal present, no worry, no plans: perfect Zen moment
- Able to learn new behaviors, but they don’t know that they know how
- Don’t read stories: can’t keep sequences in mind, or scenes
- No ability to image future scene

Anterograde Amnesia

- Affects LTM, new learning
- Impairs factual and episodic new learning
- Impairs new learning in all sensory modalities

But…

- Spares Working Memory
- Spares prior General Knowledge
- Spares behavioral memory
- Spares Music memory

TGA: Transient Global Amnesia

- Sudden loss of memory
- Know their identities, but cannot retain recent memory, where they were and how they got there. They show no other cognitive symptoms.
- TGA usually occurs after the person engages in strenuous activity -- such as having sex, vigorously exercising, suddenly immersing into icy or hot water, straining to dig a stuck car or even bumping the head.
- The unifying thing about each of them is they produce a sudden and significant change in blood flow
- Levitra, which is a pill for erectile dysfunction, lists TGA as a possible adverse reaction.

Herpes Encephalitis: AA & RA

- Herpes simplex encephalitis
- N = 10: Dense amnesia in 60%, and a less severe anterograde memory impairment in the others.
- Severity of amnesia related with severity of damage to medical limbic system structures such as the hippocampus, with bilateral damage

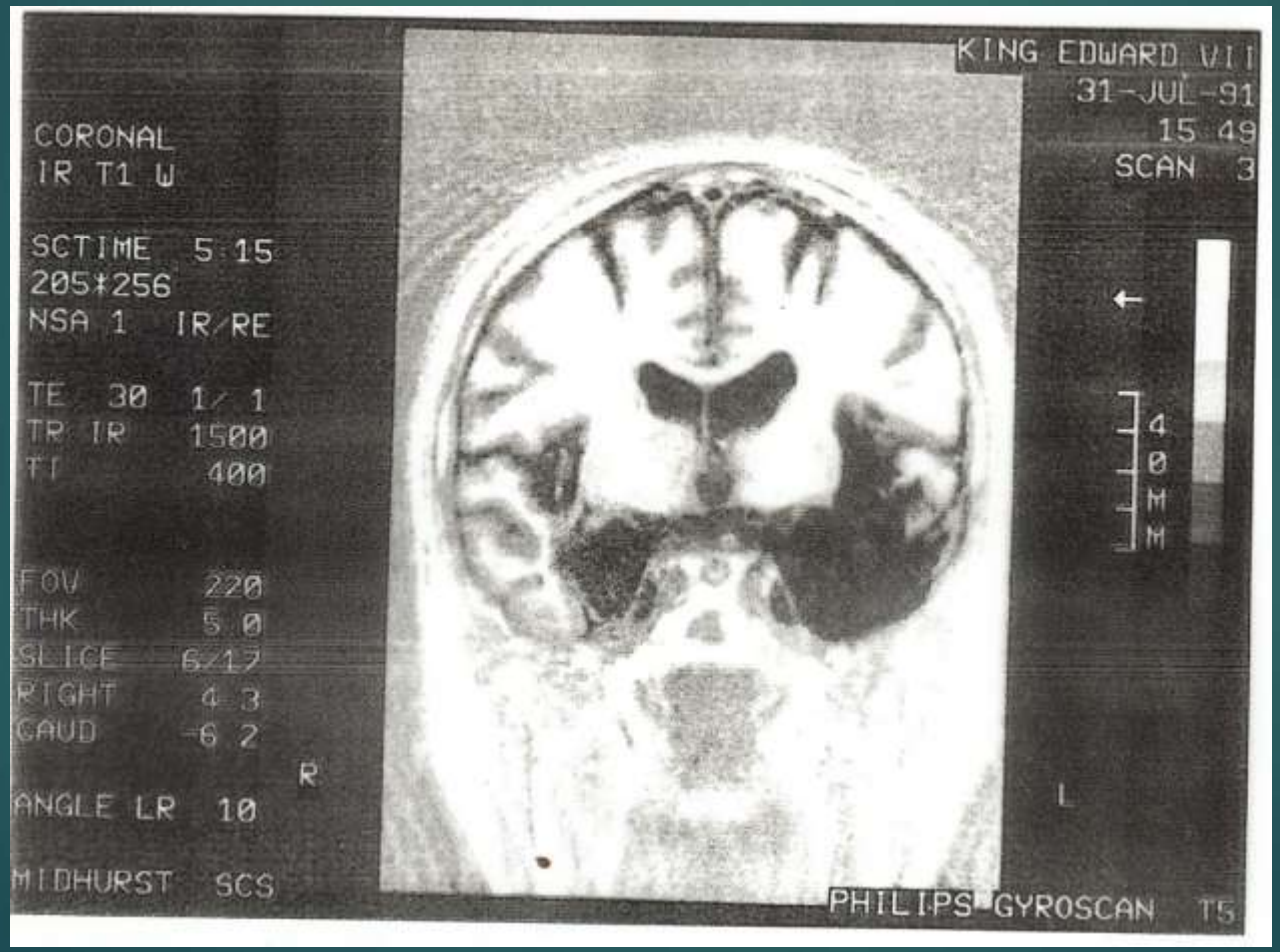
Kapur, 1994

Famous Amnesia Cases: Clive Wearing

- One of the worst cases of amnesia; due to Herpes simplex encephalitis, 1985:
- Conductor, encyclopedic musicologist and BBC music producer
- Severe AA and RA (90 second sensory store); normal implicit memory
- Plays Piano and Harpsichord and conducts and reads music
- Diary:

8:31 AM: Now I am really, completely awake.
9:06 AM: Now I am perfectly, overwhelmingly awake.
9:34 AM: Now I am superlatively, actually awake.

Clive Wearing CT:
No Left Temporal or Hippocampus



Medial Temporal Amnesia:

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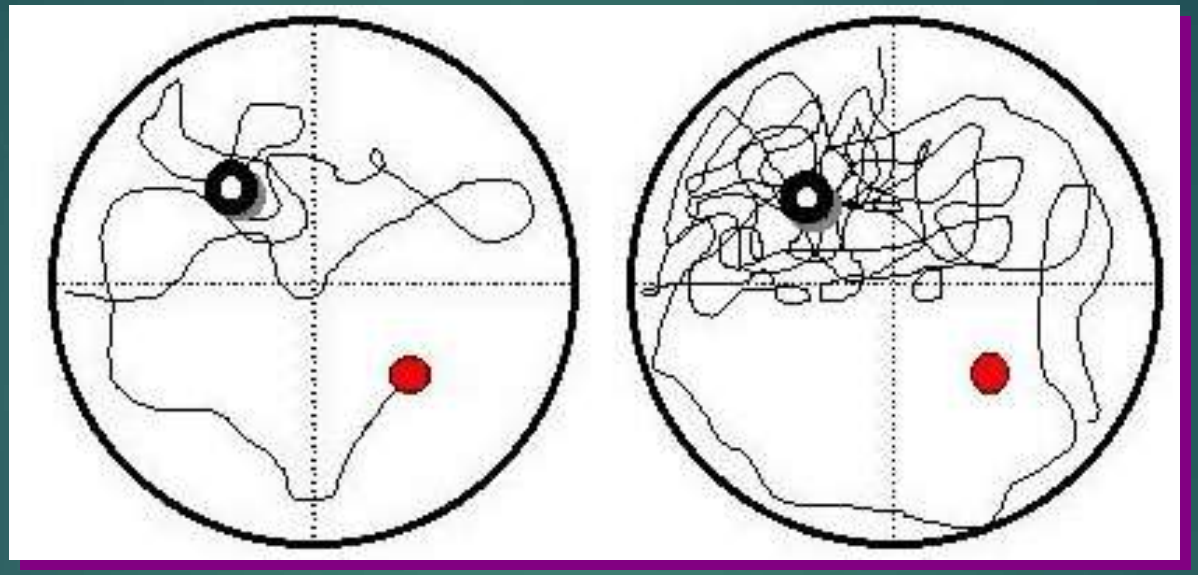
Gender and Memory

- Women superior in memory:
  - episodic memory.
  - Verbal episodic memory tasks, such as remembering words, objects, faces, pictures or everyday events
  - location of car keys
  - remembering faces, especially of females
  - remembering tasks requiring little to no verbal processing, such as recognition of familiar odors
  - remember better if info given by male baritone voice
- Female episodic memory advantage increases when women utilize verbal abilities and decreases when visuospatial abilities are required
- Men outperformed women in remembering symbolic, visuospatial information.

A. Herlitz & J Rehnman, Psych. Science, 2008

Memory and Alcohol: Finding the new underwater platform

Normal Control



Binger

The black, open circle is the old location and the solid red circle is the new location. Control rats (left) rapidly altered their behavior to find the new location.

Weeks after treatment when alcohol was no longer present, binge treated rats (right) perseverated on the old location. They never found the new location.

Korsakoff's Syndrome: chronic alcoholism

- Damage to the mediodorsal nuclei of the thalamus and mammilary bodies via
  - thiamine deficiency
  - fencing foils (Case N.A.) via nostril
  - snooker cues (Case B.J.) via nostril

- Anterograde and retrograde amnesia.

- If frontal deficits: lack of awareness of deficits (anosognosia)

Traumatic Brain Injury

- TBI: Most common cause of amnesia (permanent loss of new learning)
- PTA: Post Traumatic Amnesia (post confusion, retrograde amnesia for events prior to injury and anterograde amnesia for the accident itself and for all future learning)
- Often significant and permanent Anterograde amnesia and minor Retrograde amnesia

ADHD and Memory

- Impaired Working Memory and Sustained Attention
  i.e. Digit Span Backwards, IVA test
- Frontal executive dysfunctions
  i.e. WCST
- Trial one on list learning impaired:
  i.e. CVLT2
- One time only memory exposure poor, i.e. conversations

Alzheimer's Disease

- Age 85 = 37% of population
- No new learning (amnesia).
- Rapid forgetting (within 5 minutes) is core feature
- Intrusions and False Positives increase on list learning memory tests;
- Semantic Knowledge deterioration
- Working Memory and implicit memory deficits occur later.

Tip #18 : Physical exercise protects memory

- The Dentate gyrus of hippocampus linked to diabetes implicated high blood glucose as a pathogenic mechanism
- The Entorhinal cortex (CA1 & subiculum) linked to infarcts suggested transient hypoperfusion as a pathogenic mechanism
- These results show how diseases of late life differentially target the hippocampus, identify elevations in blood glucose as a contributing cause of age-related memory decline
- Physical exercise is a protection for good memory in older people

Physical exercise improves memory function

- **Get active, but later, for specific learning** – Exercising after learning will help facts stick. For best results, wait several hours before working out.

- Appropriately timed physical exercise can improve long-term memory. Performing aerobic exercise 4 hr after learning improves associative memory

- Exercise performed immediately after learning has no effect on memory retention

Risk Factors for Memory Decline

- Age: greatest risk factor
- Genetics/family hx – 3-4 fold increased risk; earlier, faster
- TBI: 2 x if moder-severe; WWII soldiers – 10x
- Down's syndrome
- Mild Cognitive Impairment (Mild Neurocognitive Disorder)
- High blood levels of homocysteine (heavy diet of meat) : 2x
- Apolipoprotein (Epo4)

Risk Factors for Memory Decline 2

- Gender: women (live longer) > men
- Pot belly in middle age (2.7 greater risk)
- Not finishing high school (80 % greater risk vs. completion)
- Prolonged stress = more fibrillary tangles
- Chronic worry = 40% more MCI
- Obesity (42% greater dementia; 80% Alz); being underweight (36%)

Memory Killers

- Cardiovascular conditions, esp. high blood pressure
- Smoking
- Malnutrition (Thiamine/B1↓↓)
- Binge drinking
- No exercise

Happy childhood memories

- There is a positive relationship between good memories and good health in adults, including higher quality of work and personal relationships, lower substance use, lower depression and fewer health problems
- People who have fond memories of childhood, specifically their relationships with their parents, tend to have better health, less depression and fewer chronic illnesses as older adults
- Those who reported remembering higher levels of affection from their mothers in early childhood experienced better physical health and fewer depressive symptoms later in life.

William J. Chopik, 2018

Subcortical Neurocognitive Disorders (White Matter Dementias)

- Huntington's, Parkinson's, HIV, Multiple Sclerosis:

- Normal encoding
- Poor spontaneous recall
- Unlike Alzheimer's, Normal recognition memory(cues help)

- Some Behavioral Memory deficits

Depression and Memory

- Decrease in Working and Episodic Memory
- Effort decreases
- Normal Acquisition/encoding
- Decreased spontaneous recall
- Normal recognition memory
- Memory complaints!

Cancer: chemotherapy & cancer itself

- N = 1,305 participants reported they had cancer or a history of cancer. 14% of participants who had cancer reported memory impairment
- Brain releases anti-inflammatory proteins to fight cancer that can affect brain
- People with a history of cancer have a 40 percent greater likelihood of experiencing memory problems that interfere with daily functioning.
- “Cancer related cognitive dysfunction," suggesting that it goes beyond the "chemobrain" label

Pascal Jean-Pierre, 2010

Electroconvulsive Shock

- Temporary Anterograde Amnesia
- Retrograde amnesia
- Subsequent work showed that the amnesia gradients may stretch back as long as 3 years.

Hippocampal Atrophy in Mood Disorders

- The relationship between chronic severe depression and the hippocampus is essentially toxic.
- The more intense the history of depression, the smaller the hippocampus.
- Hippocampal size is inversely correlated with illness duration, number of hospitalizations, recurrences.
- Decreased neurogenesis may underlie hippocampal atrophy

Gorwood, et al., AJP, 2008

Antidepressants: Increase Hippocampal Volume

Sleep well!

- Aging disrupts the neural activity that solidifies memories during sleep.
- Alzheimer's pathology also alters memory-consolidating neuronal waves during sleep.
- Skimping on sleep kills neurons in mice and pumps up p-tau and BA
- Sleep loss increases BA & Tau.

Curiosity

- Neuromodulators like dopamine improve memory functioning
- Dopamine: pay attention, seek out chemical; source of addiction
- Enhanced learning during states of high curiosity
- The more curious you are, the more dopamine expressed

Schizophrenia and Hippocampal Atrophy

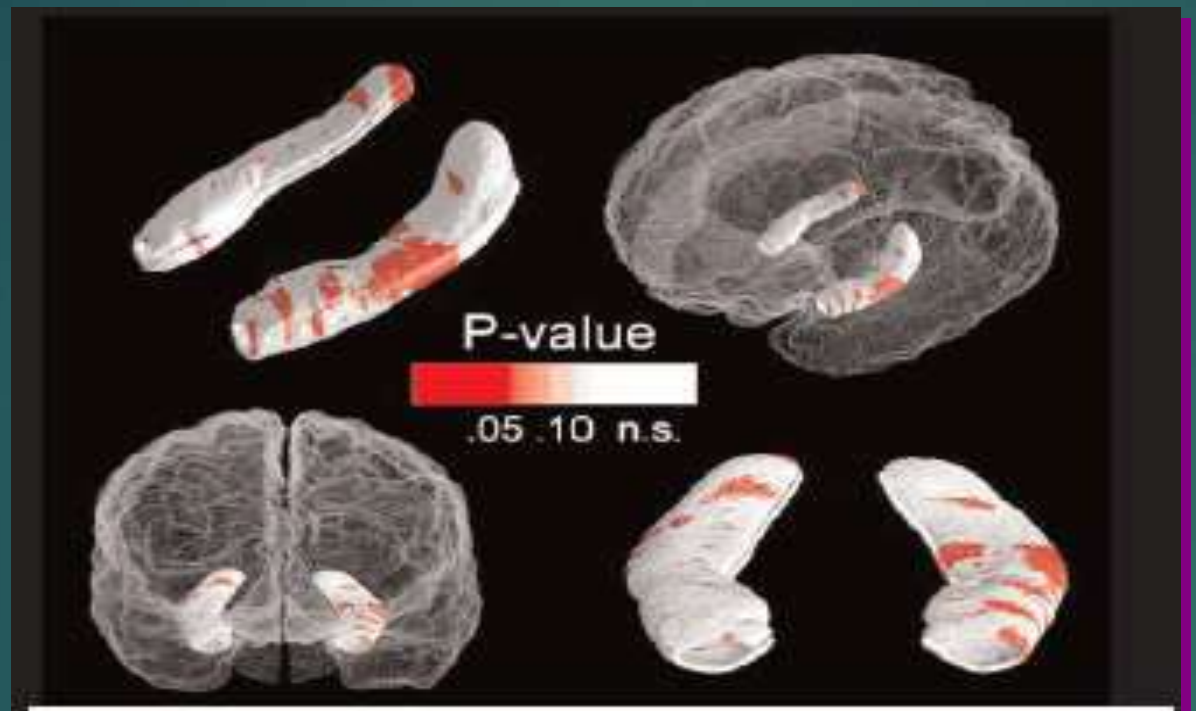


Figure 2. Statistical mapping of deformations in the hippocampal formation that distinguish individuals with schizophrenia (n = 62) from healthy volunteers (n = 60). Note that the deformations (corresponding to volume reductions) in patients are most prominent in the mid-to-anterior hippocampus and appear greater in the left hemisphere.

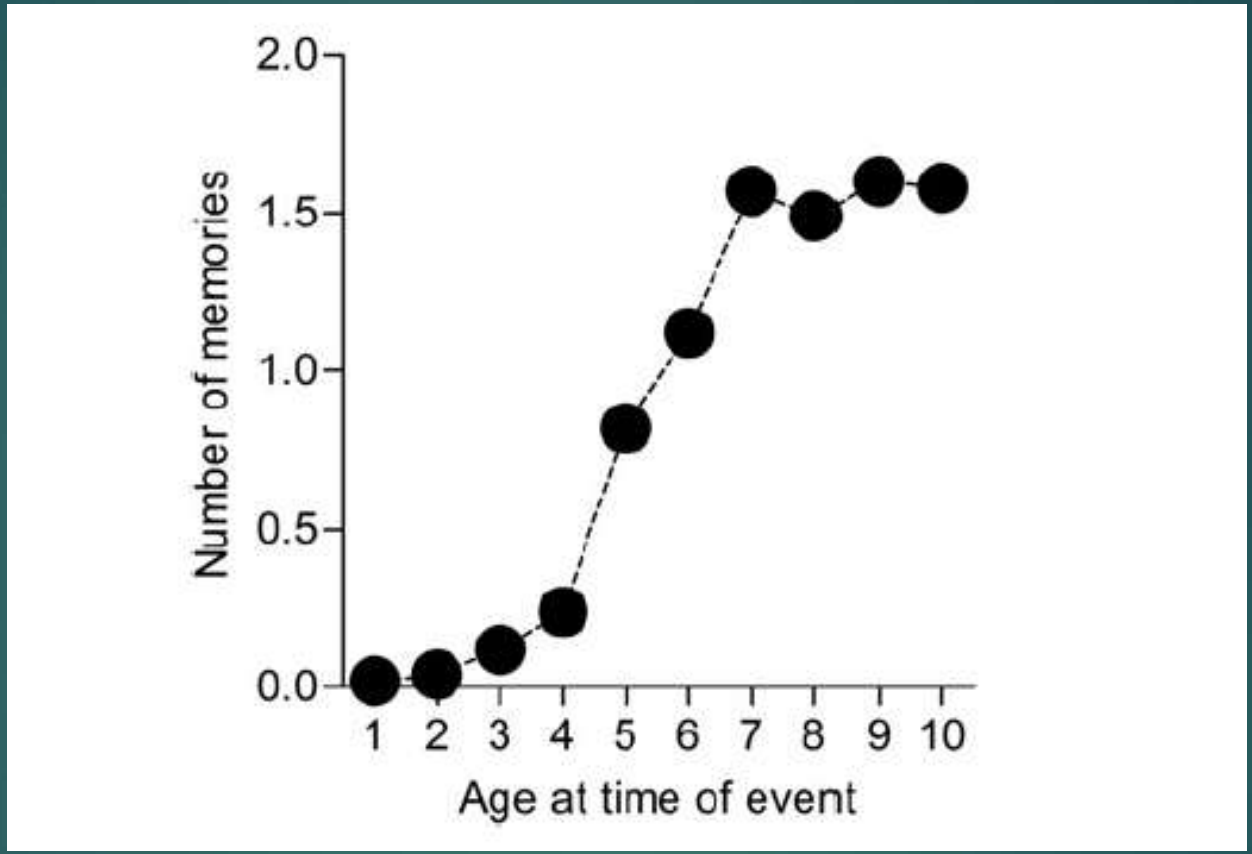
Schizophrenia and Memory

- Working Memory deficit (dopamine deficit effect)
- Executive dysfunction
- Episodic Memory impairment
- No use of semantic categorization
- Normal Procedural memory
- Cognitive Types:
  - 35% ~Normal
  - 50% Subcortical Type: poor free recall, normal recognition
  - 15% Cortical Dementia Type: poor free recall and recognition
- Cognitive deficits predict life outcome better than psychiatric symptoms

Childhood amnesia

- Despite being phenomenal learners as children, memories of specific events in our childhood are lost to us in adult life.
- Average age at which autobiographical events are remembered is just over 3 years; and poor recall for the following 3 years.
- Freud thought it was sexual repression;
- Dentate gyrus (gateway to hippocampus & memory consolidation) does not fully mature until age 4 or 5
- National differences in date (east Asians at 4.8, Europeans at 3.5)
- Ability to describe a memory is locked relative to level of language at the time of the event; need to know word to describe event

Infantile Amnesia: autobiographical memory only after age 3



Distribution of autobiographical memories from the first decade of life showing two phases of infantile amnesia. Participants (20, 35, and 70 yr of age) reported very few memories before the age of three. The number of memories reported to have occurred from the ages of 3–7 yr increased linearly and leveled off from 7–10 yr of age.

Infantile Amnesia

- Adults rarely recall memories before age of 3-4
- Continuous autobiographical memory from age 3 ½ on
- Old theory: Availability of verbal encoding in childhood correlated to later verbal expression of memory in adulthood; ability to describe a memory is locked to language level at the time of the event; need to know word to describe event
- New theory: high neurogenesis levels negatively regulate the ability to form enduring memories, most likely by replacing synaptic connections in preexisting hippocampal memory circuits

More Neurogenesis with Exercise

New dentate gyrus hippocampus neurons, in mice that have unlimited access to wheels and running, is twice that in mice living in standard cages. Exercise related to blood flow: more fit, more blood flow oxygenation.

Factors that Decrease Neurogenesis

- Aging
- Recurrent Major Depression
- Disrupted sleep
- Chronic Stress
- Chronically high Cortisol
- Radiation
- TBI

Factors that Increase Neurogenesis

- Physical Exercise
- Antidepressants (in depressed & normals) (> in young than old); & ECT
- Fewer calories consumed
- Fasting
- Type of food content (omega-3 fatty acids from algae)

Neurogenesis and Prozac

- 4-6 week lag time of SSRIs for full antidepressant effect
- Lag time due to time it takes Serotonin to stimulate neurogenesis in hippocampus
- More new neurons in dentate gyrus of hippocampus
- More dendrites as well

R. Hen, J Neuroscience, 2008

Psychogenic Amnesia: Dissociative Fugue

- Loss of autobiographic information or personal identity in absence of dementia or delirium; Victims lose only the memories tied to their identity; a loss of episodic/autobiographical memory.
- Never neurologically based (except in most severe dementia)
- First case: Ansel Bourne, a Rhode Island preacher in 1887. Its most famous sufferer is the fictional Jason Bourne, the secret agent made flesh on film by Matt Damon.
- Characterized in part by sudden and unexpected travel combined with an inability to recall one's past

Memory is unique: Individual differences in remembering

- There are strong individual differences in how people remember.
- When you argue with someone about what really happened, remember that you may both be right
- People can experience the same event but recall it so differently. Especially if feelings during the event differed.
- fMRI study: Those who are better at remembering facts have more physical links between the hippocampus, and the prefrontal cortex.
- Those with richly detailed “autobiographical memories”, by contrast, had more connectivity between the hippocampus and areas involved in visual processing.

Memories are reconstructions, not replays

- Memories are:
  - Not recordings, but rather re-codings, reconstructions
  - They are not audio or visual recordings, but a recombined blend of events from the external world, as interpreted by each person's unique cognitive schemata/inferences.
  - False and misleading information can be integrated into memory.

Memory is Malleable

- We tend to think of memories as information stored in the filing cabinet of the brain for future use.
- In fact, memories are only built when we retrieve them.
- Our memories are malleable. Memory, it turns out, is an illusion – one we create every time we recall the past
- Memory retrieval acts as a fast memory consolidation mechanism, stabilizing memories through online reactivation
- Every time we recall a past event, its reencoding in our neuronal synapses creates malleability, and thus the memory is potentially subject to change.
- Every time you test newly learned material you add new contexts.

Conversations can alter existing memories

- Every time you tell a story from memory, and change a detail, there is possibility that you will remember that version, not the original version.

- Social taboos about what to say and not to say in a conversation may play a noteworthy role in shaping memories, particularly collective memories, through socially shared retrieval-induced forgetting

- How you are questioned can determine what you remember, i.e. police interrogation

Hirst & Echterhoff, 2008

Eyewitness Testimony

- Jury Trial: witness points to defendant and says "It's him."
- Eyewitness testimony, especially if confident, has disproportionate effect on belief by juror
- But memory can be altered by presenting misdirecting questions
- Answering the question "How fast was the white sports car going when it passed the barn while traveling along the country road?" increases witnesses' later reports of having seen a nonexistent barn in an earlier video (Loftus, 1975, p. 566).
- Studies: Convincing evidence that eyewitness testimony is poor.
- Newer study: ok if reported near event

Fallibility and malleability of memory

- Police's type of question and feeding misleading information can cause distorted memory
- Convictions based on false memory: 300 people have been convicted, yet later exonerated by DNA data; 75% due to faulty eye witness testimony
- Memory is not a recording device; it is constructive & reconstructive
- Question: "car hit" vs "car smashed" – people remember broken glass for latter; difference between yield or stop sign
- Implanted false memory: lost in the mall – 25% recall; nearly drowned, attached by dog (50%), satanic abuse, sick as child due to dill pickle (later did not want)
- Memory, like liberty, is a fragile thing.

Repressed Memories

- Debate over repressed memories of childhood abuse is not resolved.

- The central question in this controversy is whether attempting to help clients to recover purportedly repressed memories of abuse leads to memory distortions that harm rather than heal clients appears:
  - to have introduced the belief that memories of traumas are often repressed—
  - and this belief still persists among the general public as well as a majority of clinicians,
  - yet is more rarely endorsed by experimental psychologists

Memory Wars: Repressed Memory vs False Memories

- Controversy surrounding repressed memory came to a head in the 1990s.

- Some believe that traumatic memories could be repressed for years only to be recovered later in therapy, others questioned the concept, noting that lack of scientific evidence in support of repressed memory. It is possible *not* to think about something for a long time, even something unpleasant that happened to you; but not to repress it.

- Gap between clinicians and researchers:
  - 60-80% of clinicians, psychoanalysts, and therapists: traumatic memories are often repressed and can be retrieved in therapy,
  - less than 30% of research-oriented psychologists.
- Belief in repressed memory is still prevalent among the general public.

Implanted False Memory

Implanted False Memories 1:
Lost in Mall at age 6

People remembered or knew they had met Bugs Bunny when they visited Disneyland

Except for the fact that Bugs is Warner Brothers character

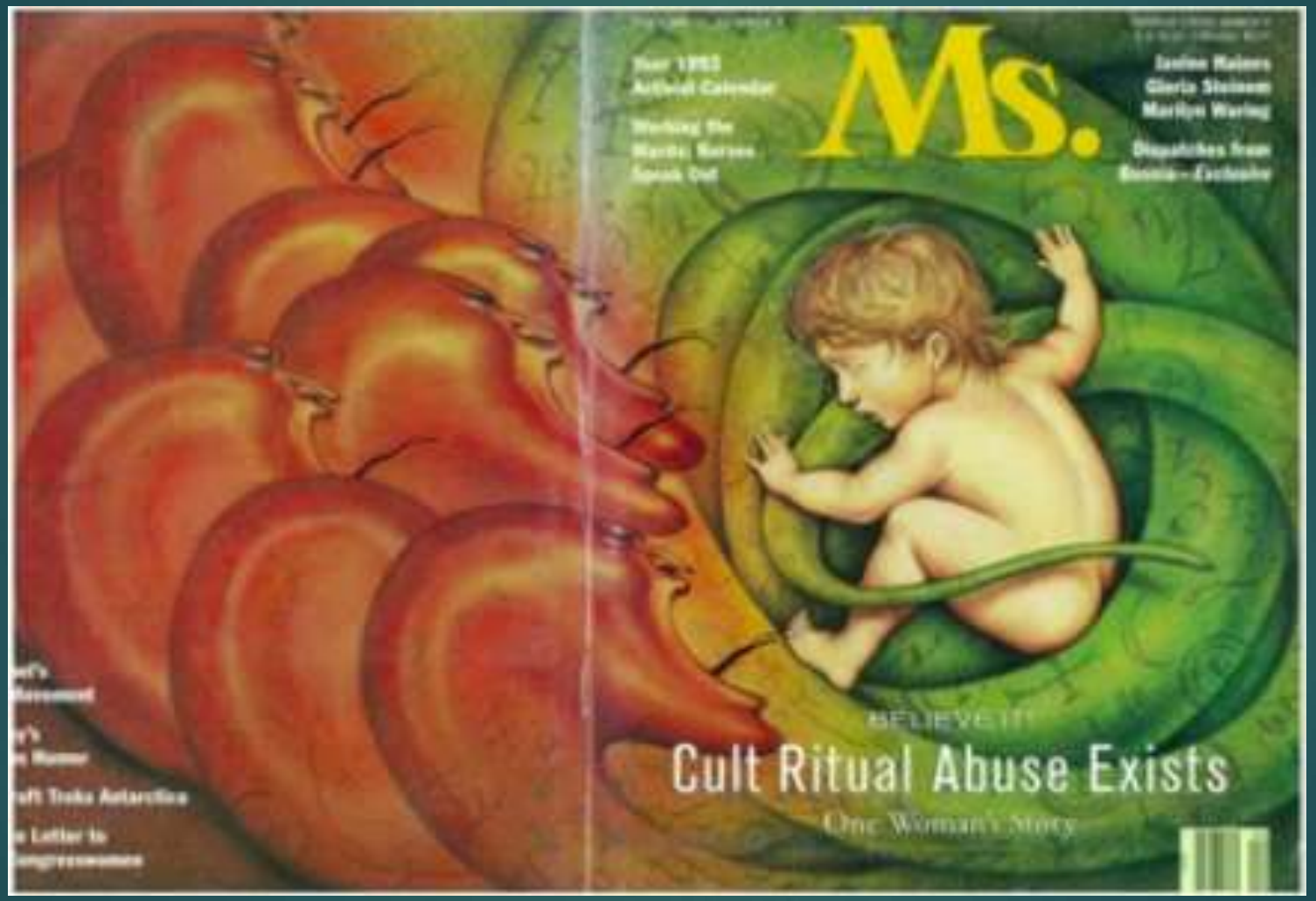
Types of Implanted False Memories in studies

Near drowning

Attack by vicious dog

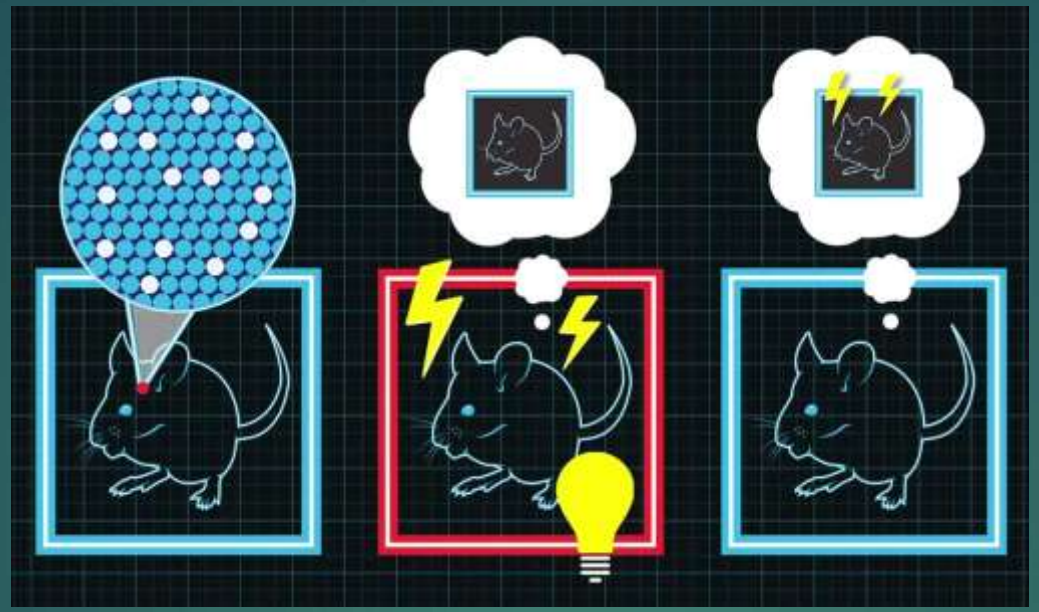
Demonic possession

Ritual Satanic Abuse: Nonexistent Therapeutic Invention



Without independent corroboration, little can be done to tell a false memory from a true one.

Can now create a false memory in a mouse



Steve Ramirez, et al., 2013

- Three steps to plant a fake memory in a mouse.
- First, let the mouse build a real memory of a safe room (left).
- Second, put the mouse in a room with an electrified floor. Shock the mouse — but add the memory of the shock to the memory of the first room (via optogenetic reactivation of memory engram–bearing cells).
- Third, put the mouse back in the safe room — which the mouse now incorrectly “remembers” as dangerous.

Repressed Memory Controversy

- Brain has no spam filter for false vs. true memories.
- According to - Rosanne Arnold, on "Oprah“:

  "When someone asks you, "Where you sexually abused as a child?" there are only two answers: One of them is "yes," and one of them is "I don't know." You can't say "no."
- Elizabeth Loftus: Memory is distortable, malleable; eye witness/leading question effects
- Lenore Terr: The severer the abuse, the more repressed memory
- James McGaugh: decades of research on war induced PTSD: More traumatic an event, the more the recall – emotional arousal solidifies memory; need to recall future threat

2019: First large study of recovered memories

- N = 2,326 adults; 50% sought therapy
- 9% reported seeing therapists who discussed the possibility of repressed abuse
- 5% reported recovering memories of abuse in therapy for which they had no previous memory (74% emotional abuse; 2% satanic abuse).
- Participants who reported therapists first discussing the possibility of repressed memories of abuse were 20 times more likely to report recovered abuse memories than those who did not (only 2% recovered memories). Many recovered memories in therapy are clearly iatrogenic.
- Recovered memories of abuse occurred in most therapy types. Therapist discussing the possibility of repressed memories: attachment therapy were most likely, and CBT least likely. Most associated with those who reported starting therapy in the 1990s

Lawrence Patihis & Mark H. Pendergrast, 2019

Recovered Memories

- 42% cut off family; majority of reporters of recovered memories (92.6%) still believed their memories to be accurate.

- Recommendation of informed consent: “Clients entering therapy should be given information about the potential hazards of recovered memories of abuse as part of informed consent”

1996 Crime Victims Compensation Program in WA: Recovered Memory Therapy – Be Careful

- 183 claims of repressed memories of childhood abuse:
- 100% report torture/mutilation (no evidence), 97% satanic ritual abuse; 76% infant cannibalism; 69% torture with spiders
- 100% in therapy 3-5 years after 1st memory
- 10% SI before therapy; 67% following therapy
- 7% hospitalizations → 37% following; self mutilation 3% →27%;
- 83% initially employed → 10% employed 3 y into therapy
- 77% married → 48% divorced/separated
- 23% lost parental custody
- 100% estranged from families

Trauma and Memory

Conclusions:

Traumatic events are most often not repressed or forgotten

It is harder to forget trauma than to repress it; need memory for survival

False memory can be formed by suggestion (therapists can induce false memory)

Autobiographical memory is not a video camera, faithfully recording events; it is malleable by latter events and questions.

You can't trust memory in a tortured brain

- Coercive interrogation techniques to extract information from terrorist suspects
- Extreme stress has a deleterious effect on the frontal lobe and is associated with the production of false memories.
- The hippocampus and prefrontal cortex, are rich in receptors for hormones that are activated by stress and sleep deprivation and which have been shown to have deleterious effects on memory.
- Studies of extreme stress with Special Forces Soldiers have found that recall of previously-learned information was impaired after stress occurred.

O'Mara et al., 2009

PTSD and Memory

- Decreased hippocampal volume (7-25%): Vietnam Vets with most combat, women with repeated sexual abuse,
- Unclear if it is cause or consequence of PTSD (probably a risk factor).
- Extreme Amygdala arousal disrupts hippocampal function, leaving memory to be stored as affective states or sensorimotor memories
- Amygdala mediated memories are more indelible (PTSD, borderline PD)

Intrusive memory removal via Tetris after a trauma

- If you have intrusive memories:
- Play Tetris
- Playing Tetris for 2 hours after an immediate trauma, reduces PTSD sxs
- It also has been shown to control other intrusive thoughts
- Both Tetris and a memory cannot be in the same WM space
- Later, following a visual traumatic flashback, playing Tetris weakens visual memory

Medications for PTSD Reduction

- **Paxil** increases verbal declarative memory and hippocampal volume in PTSD

- Pitman (2002): **Propanolol** (40 mg qid) within 6 hours of trauma (10 day course); a beta-adrenergic (epinephrine) blocker
- 50% reduction in PTSD sxs; fewer nightmares & flashbacks
- Intravenous administration of **hydrocortisone** over a period of 6 days plus taper decreases the incidence of PTSD
- Quickly giving **morphine** to wounded troops: 53 percent lower risk of PTSD

- These drugs don't erase memory — rather, they prevent the overproduction of stress hormones that encode attach fear response.

A. Brunet, 2009; Herbst, 2004:

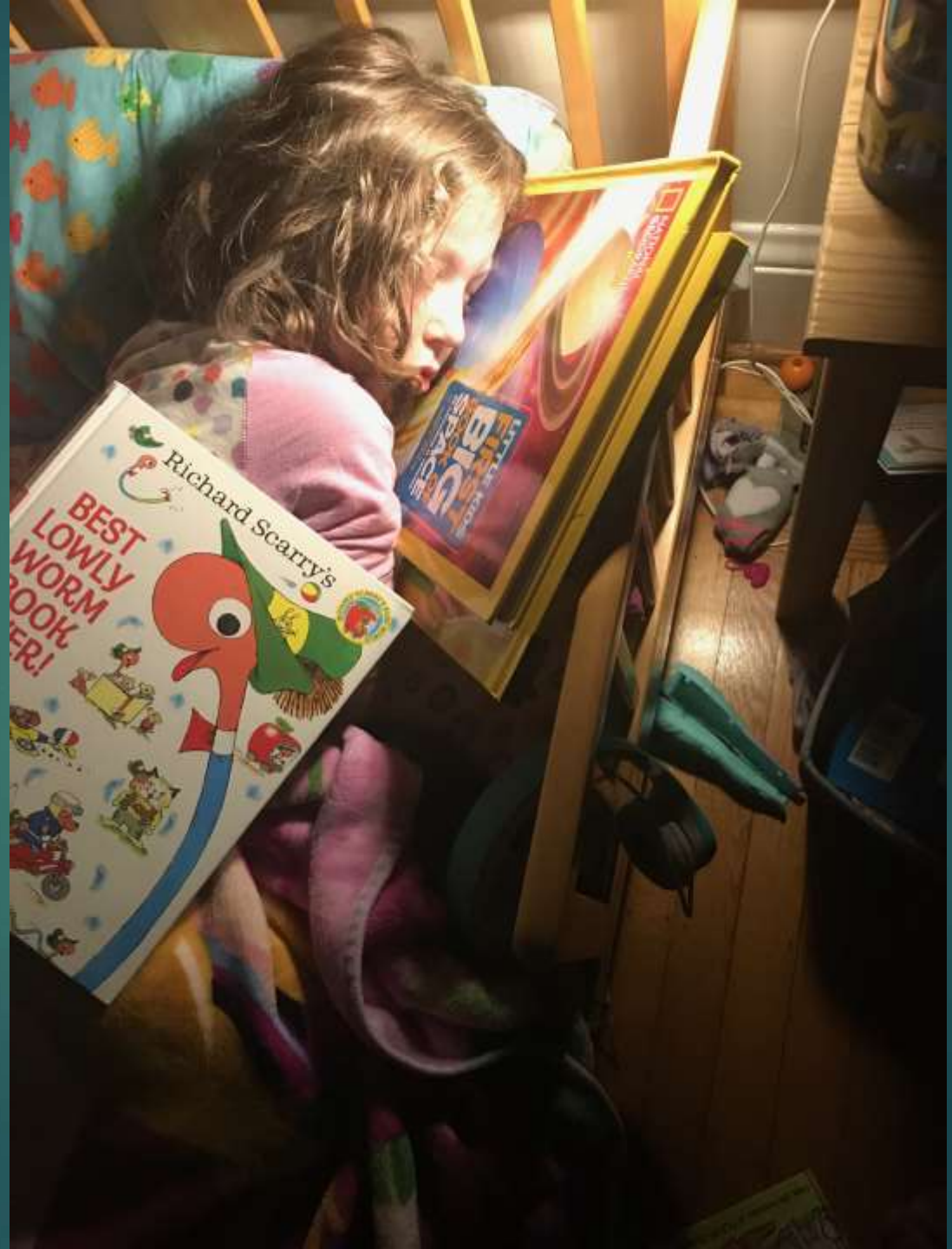
Erasing memories in rats: Reconsolidation of Memory

- Rats were shocked when tone played. They froze in fear.
- Days after consolidation of memory, tone replayed to reactive this memory.
- Drug given to prevent Amygdala from creating storage proteins.
- Rats stopped reacting to tone.
- Proving that some long term memory can be erased.

Nader, 2000

Learning Strategies

Unfortunately, learning through book osmosis doesn't make the learning strategies list.



My 7 yo Granddaughter Noelle trying to absorb knowledge; although she knows about planetary Goldilocks zones

Memory Tips

- Pay attention and don't get distracted. Attention is first step into memory.
- Make it a habit. When you put your keys down, stop and say out loud, "I'm putting my keys on my dresser." or use a Memory Box
- Memory box or place: same place all time near front door
- Create a visual cue, i.e. milk carton by door
- Repetition: When you meet people at a party and they give you their names, focus on the name and nothing else, and practice using that name in conversation, by saying the name back. Add a visual cue.

Memory Tips

- Most important: Repeated self testing
- Spaced, repeated practice, not cramming night before
  - Cramming = Speed-packing a cheap suitcase -- it holds its new load for a while, then most everything falls out.
  - When the neural suitcase is packed carefully and gradually, it holds its contents for far, far longer.

Learning from our Mistakes

- We learn more from our mistakes than from our successes
- Faster recognition of situations (brain signal appears only 1/10th of a second later) in which we previously made an error
- Errors result in better learning

Aristotle on Practice

"We are what we repeatedly do.

Excellence, then, is not an act, but a habit."

10,000 Hour Rule: Practice Makes Perfect

- Dr. K. Anders Ericsson: became curious about 7 +/- 2; With 20 hours practice, 20 digits; 200 hrs = 80 digits
- He investigated chess grandmasters and the stars of the PGA tour, Scrabble champions and brain surgeons, concert pianists and circus acrobats: average IQ of people at the top of their field
- Talent comes from learning by doing. When Ericsson studied classical pianists, he found that the winners of competitions had practiced over 10,000 hours by the age of 20, while less accomplished performers only practiced between 2,000 and 5,000 hours.

- The best performers are almost always the ones who practice the most.

- But this principle applies only to the extent your personal ability allows.

- See *Outliers: The Story of Success* by Malcolm Gladwell

Tip #19 : Move around/change the context of learning

- State-dependent or context-dependent learning:
  - Recall is best when retrieval environment is the same as learning environment, i.e. scuba diving, being drunk, etc.

Tip #20: The more cues, the better the learning

- The more places in which you study the same material, the better the later recall.

- Most people remember more if they vary their study or practice location. More environments in which you rehearse, the more lasting memory.

- Study: Students studied a list of 44 words for same amount of time in either in 1 or 2 rooms. When tested 3 hours later for 10 minutes in new room: 1 room = 16 word recall; 2 room = 24 word recall; 40% increase in recall from change of venue

Tip #21: Spacing Out: Break up study time

- Cramming isn't useless. The all nighter is time tested student behavior. You will not remember the material next semester. Massed practice (cramming) results in only one context.
- Distributed learning or the spacing effect: 50% better memory
- Spacing: Better retrieval if spaced learning, results in multiple contexts.
- Spacing study time is the most powerful and reliable technique known to science to deepen and extend memory.

YouTube and Memory

- Stephen Wiltshire draws Rome from memory
- Clive Wearing: Living Without Memory

Internet Memory Sites

- Braingle: http://www.braingle.com/mind/memory.php
- Memory Gym:

  http://www.memorise.org/
- Helpguide: http://www.helpguide.org/life/improving_memory.htm

Have a good Week

Memory biography

- *How We Learn* by Benedict Carey
- *Perfect Present* by Suzanne Corkin
- *Moonwalking with Einstein* by Joshua Foe
- *Make it stick* by Peter Brown, Henry Roediger, Mark McDaniel
- *The Memory Book* by Harry Lorayne and Jerry Lucas
- *The Art of Memory* by Frances Yates

- Art of Memory Website: http://artofmemory.com/

- www.charlesjvellaphd.com
- Go to Public Lectures