Scripps Research Alcohol Center Neuroscience Course

Learning & memory, decision making & executive functioning

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Interns

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Science Changing Life

What is learning?

- a relatively permanent change in behavior or knowledge that results from experience.
- involves a complex interaction of conscious and unconscious processes.
- allows an organism to adapt to its environment.

The 3 Major Types of Behavioral Learning

Classical Conditioning

A neutral stimulus is associated with a natural response

Examples:

- Fear response
- Taste aversions

Operant Conditioning

A response is increased or decreased due to reinforcement or punishment

Examples:

- Positive reinforcement (getting a good thing)
- Negative reinforcement (removing a bad thing)
- Punishment (getting a bad thing)

Observational Learning

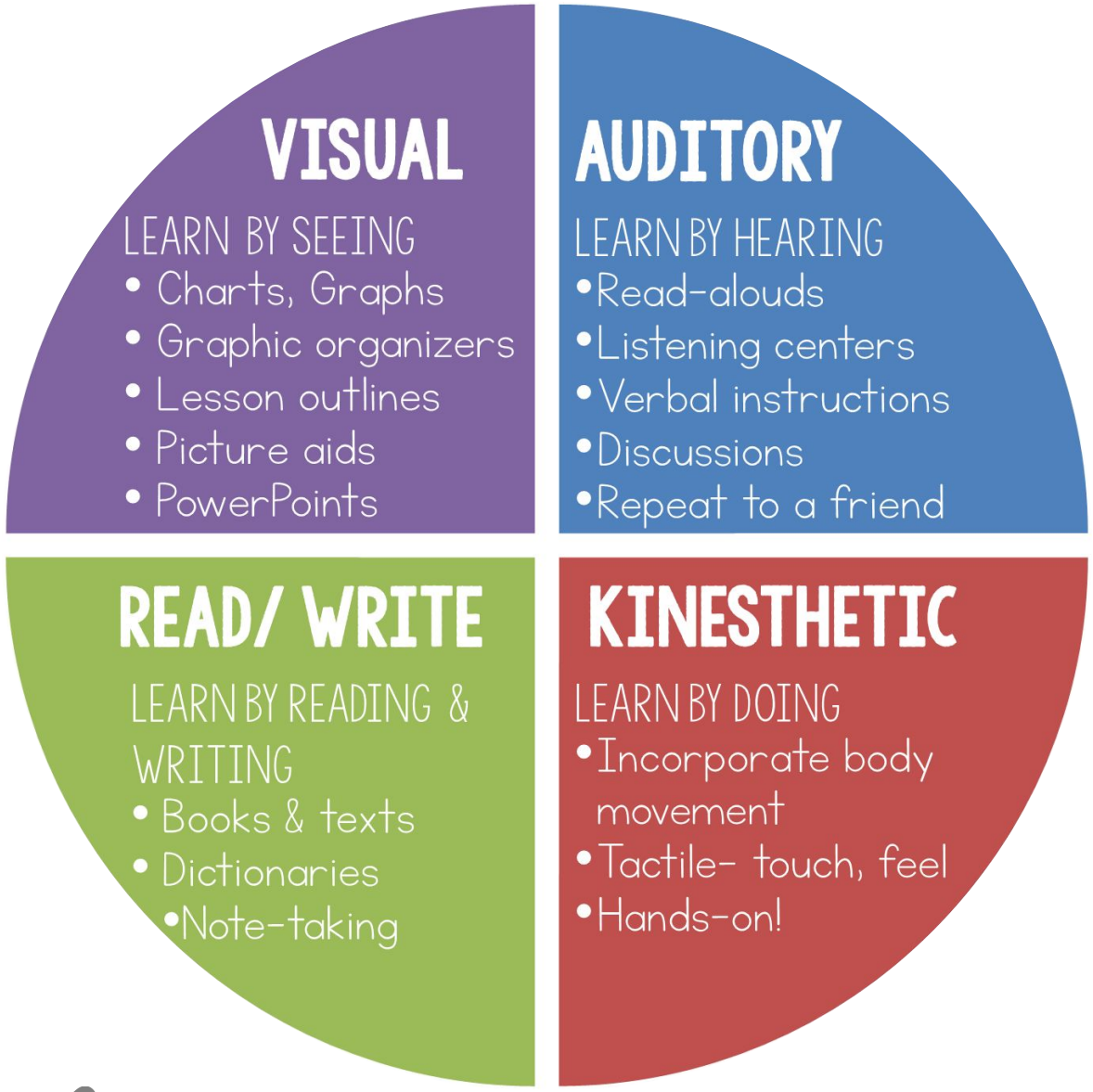
Learning occurs through observation and imitation of others

Examples:

- Learn new skills
- Learn to avoid negative consequences

https://www.verywellmind.com/learning-study-guide-2795698

Learning in an educational setting



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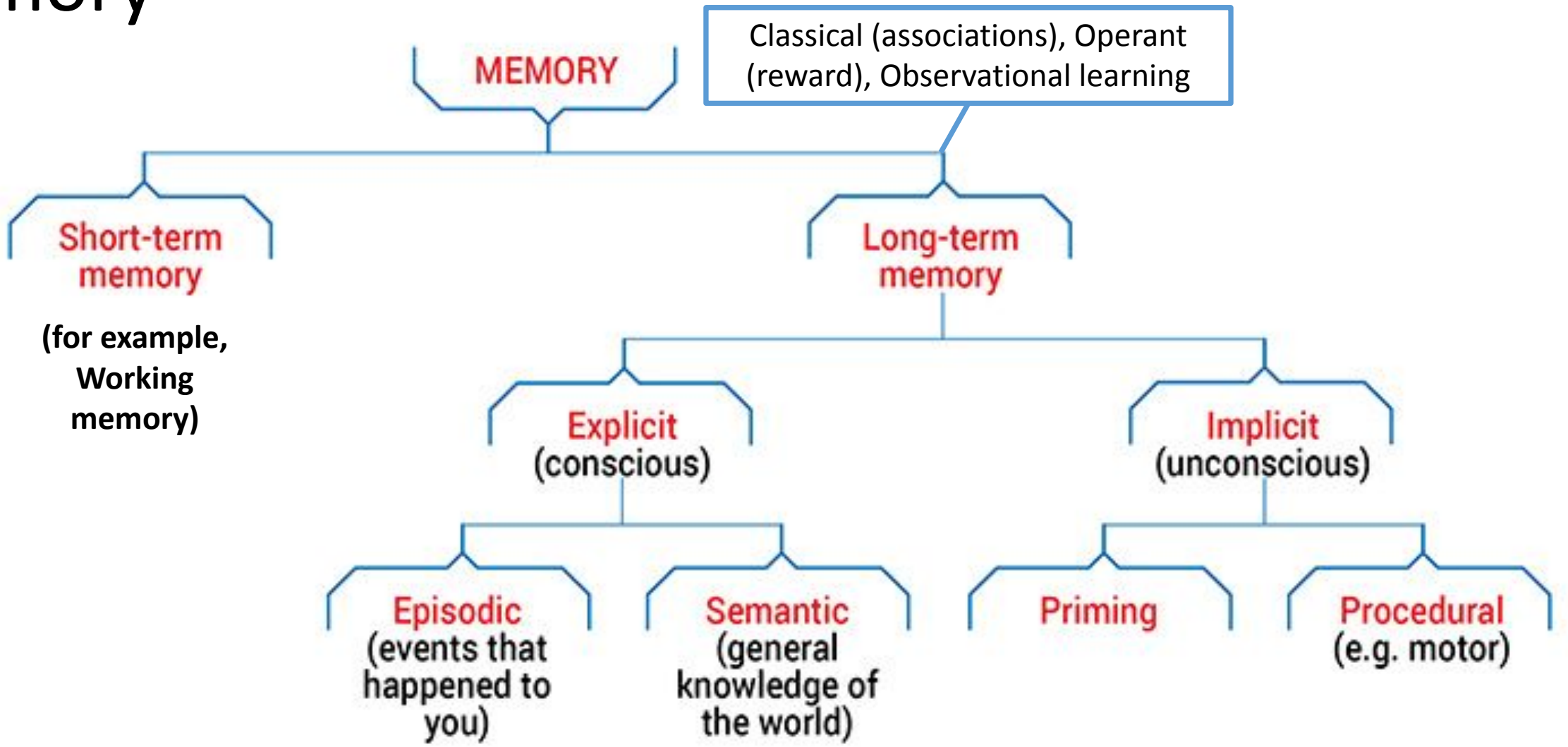
- Lots of theories about people having different learning styles, but these are probably just the person's preferences and don't necessarily match the actual amount of learning taking place.

Memory



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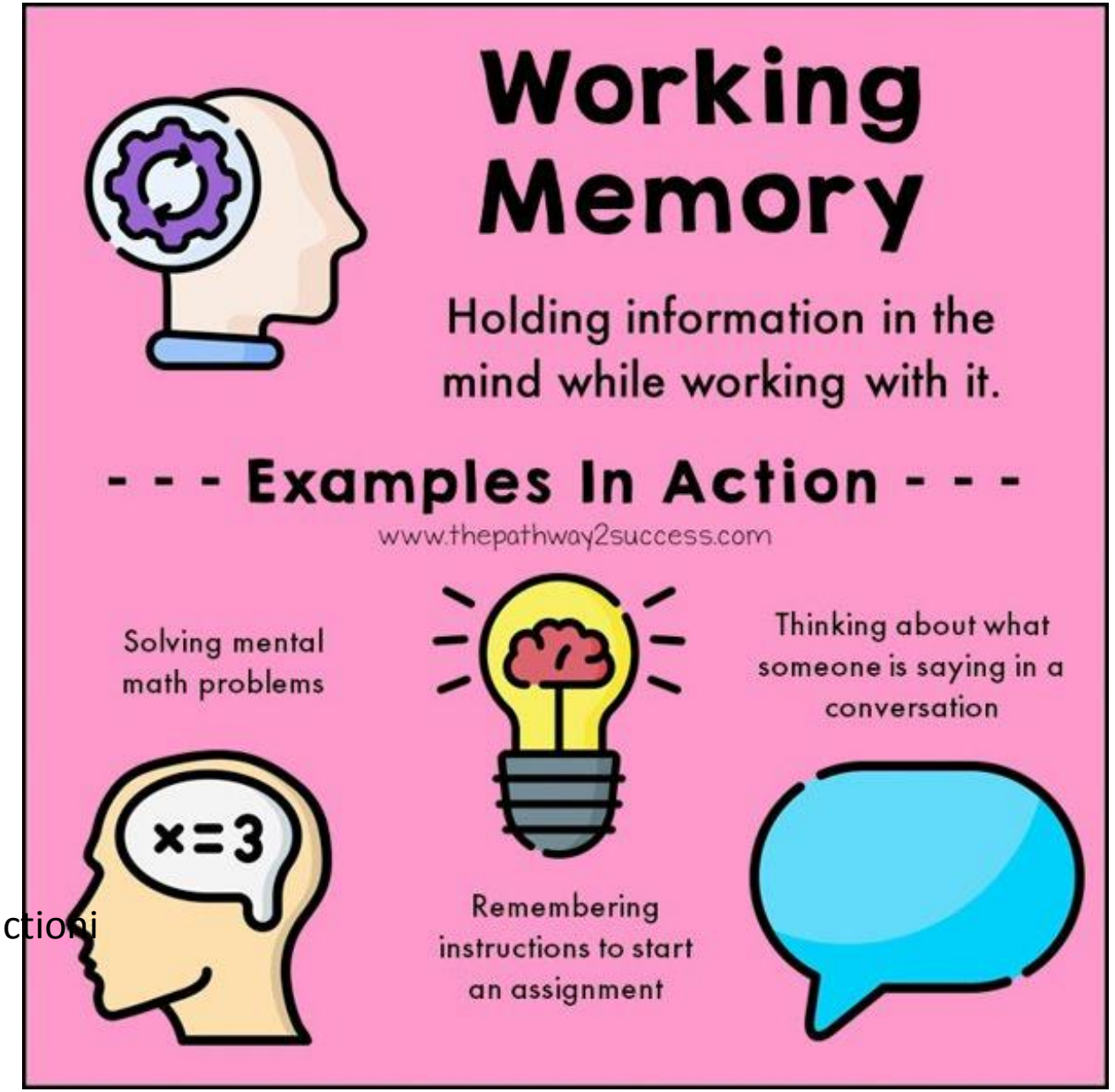
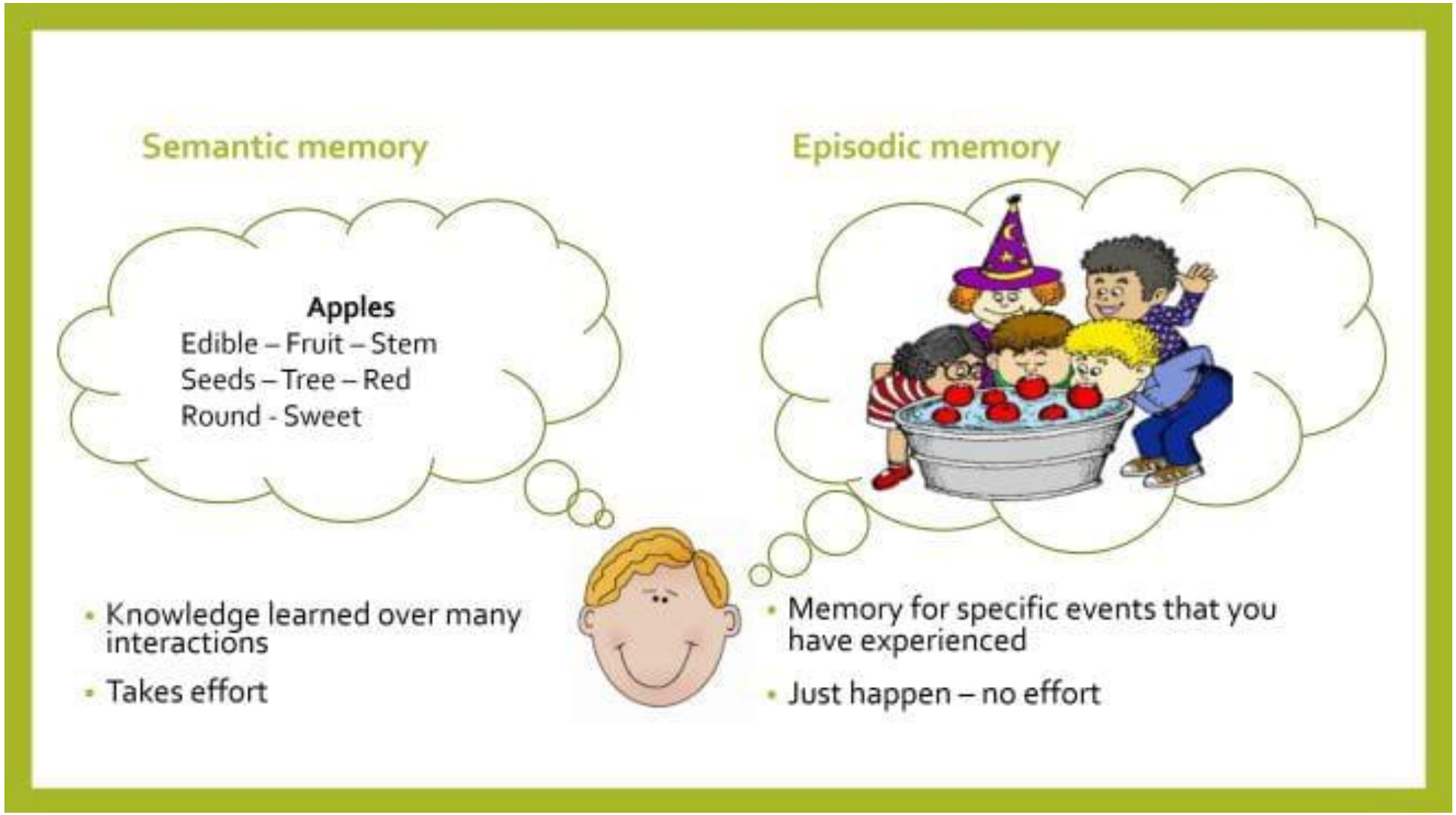
https://qbi.uq.edu.au/brain-basics/memory/types-memory

Working memory



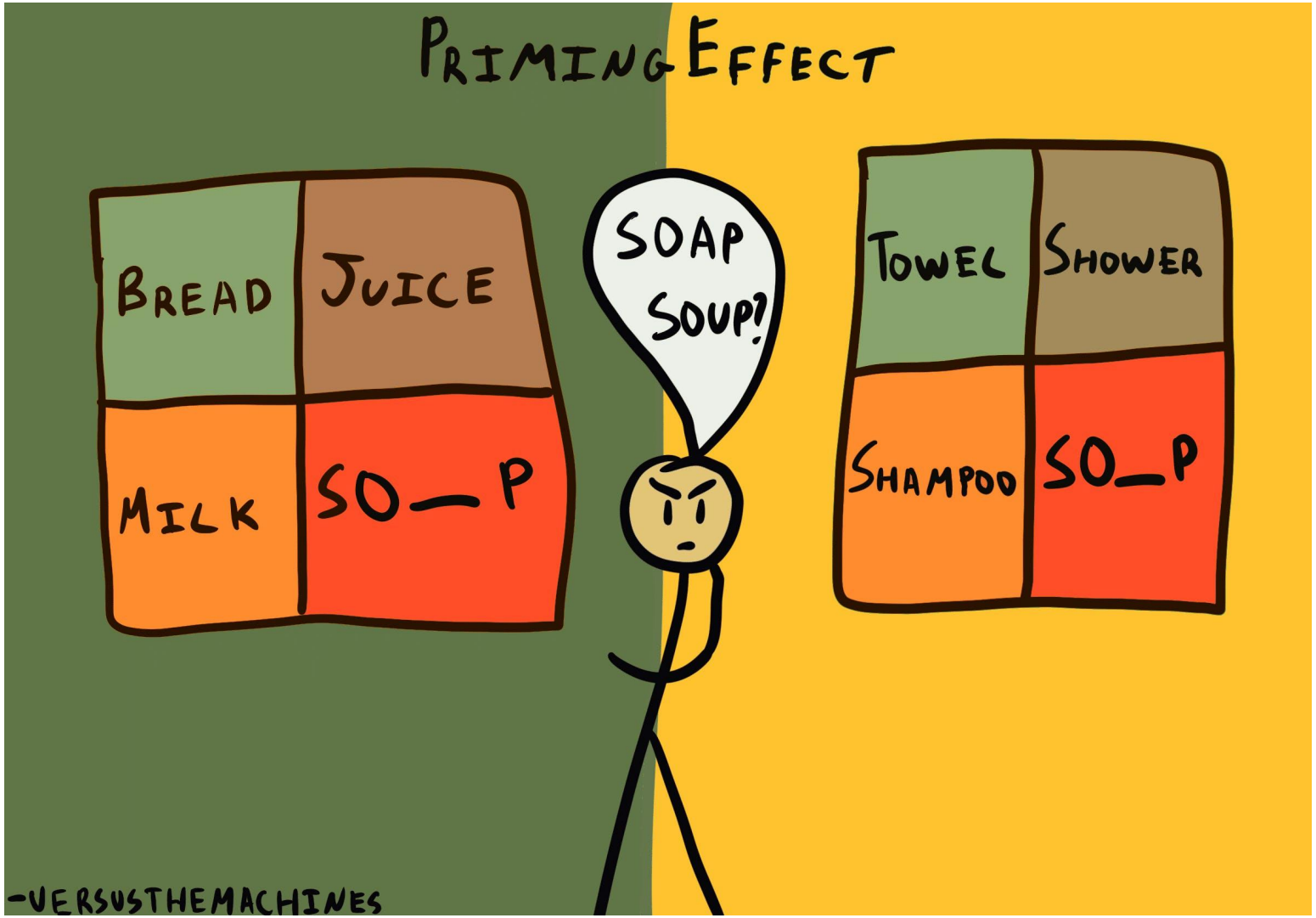
https://www.thepathway2success.com/10-executive-functioning-skills-the-ultimate-guide/

Explicit (conscious) memory: Semantic and Episodic



https://sites.psu.edu/intropsychf19grp8/2019/10/16/declarative-explicit-memories/

Implicit (unconscious) memory: Priming



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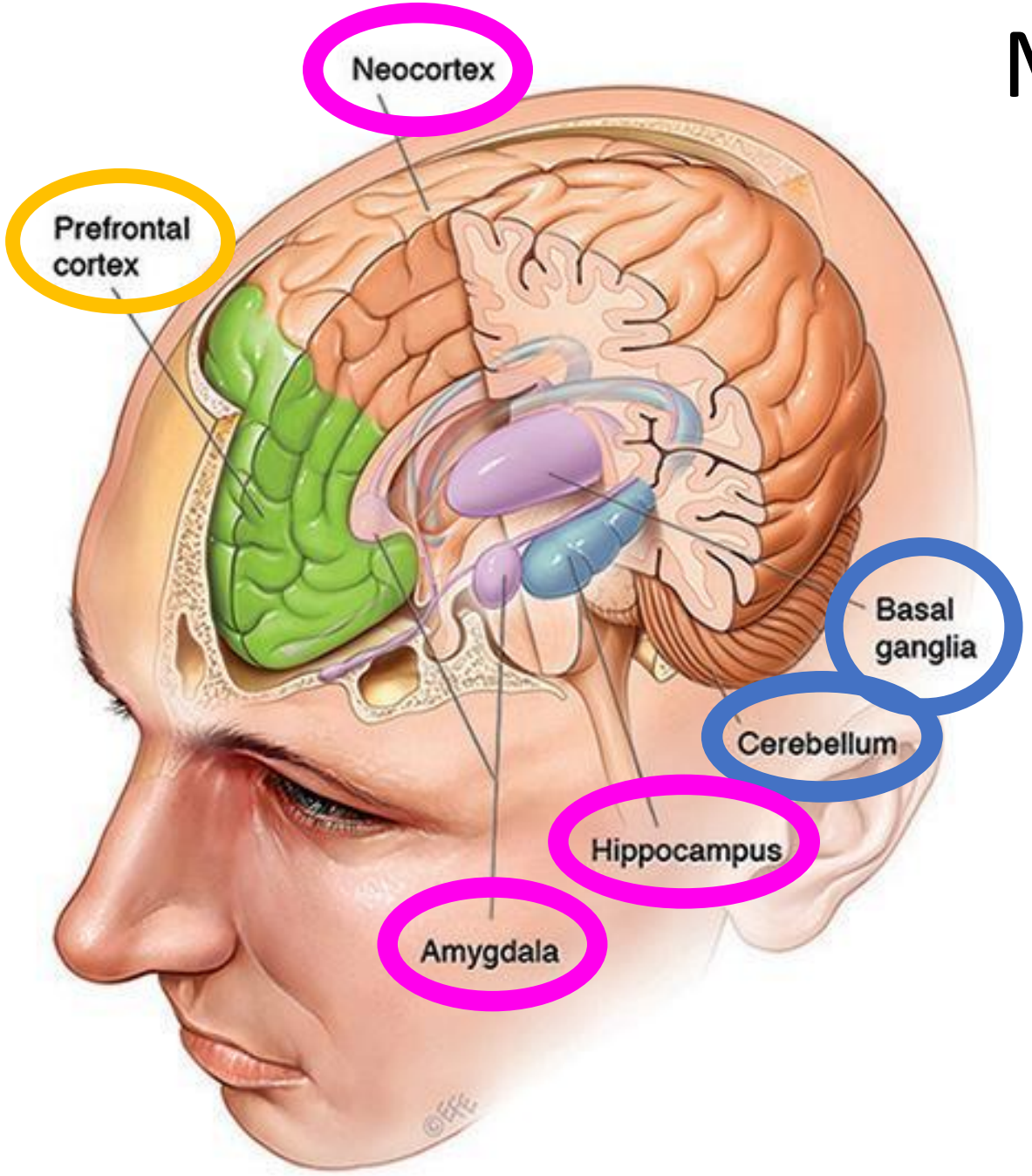
https://thedecisionlab.com/biases/priming

Implicit (unconscious) memory: Procedural

Memory & the brain



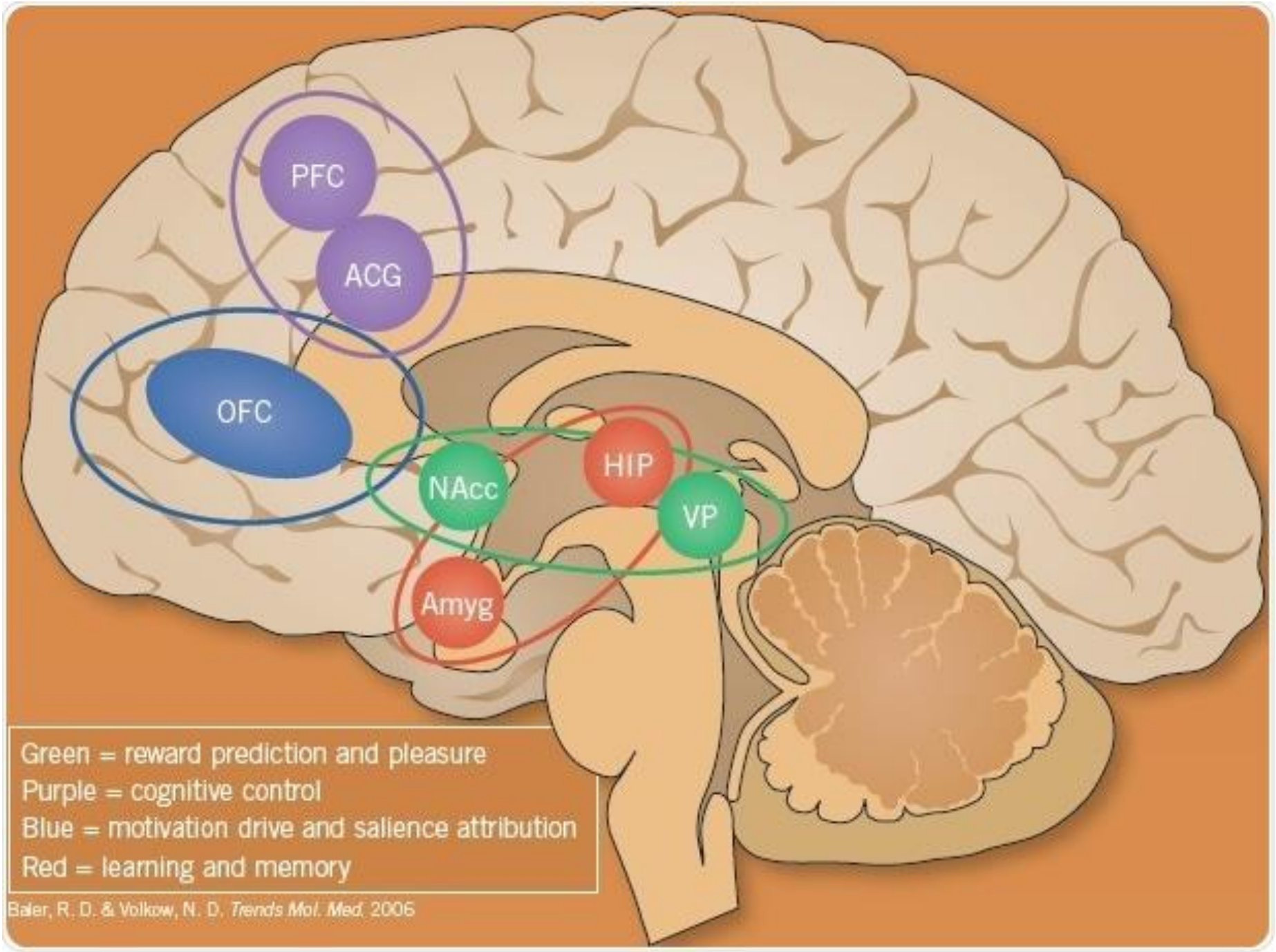
Working memory

Explicit memory

Implicit memory

This is more a general distinction: all these brain regions are connected!

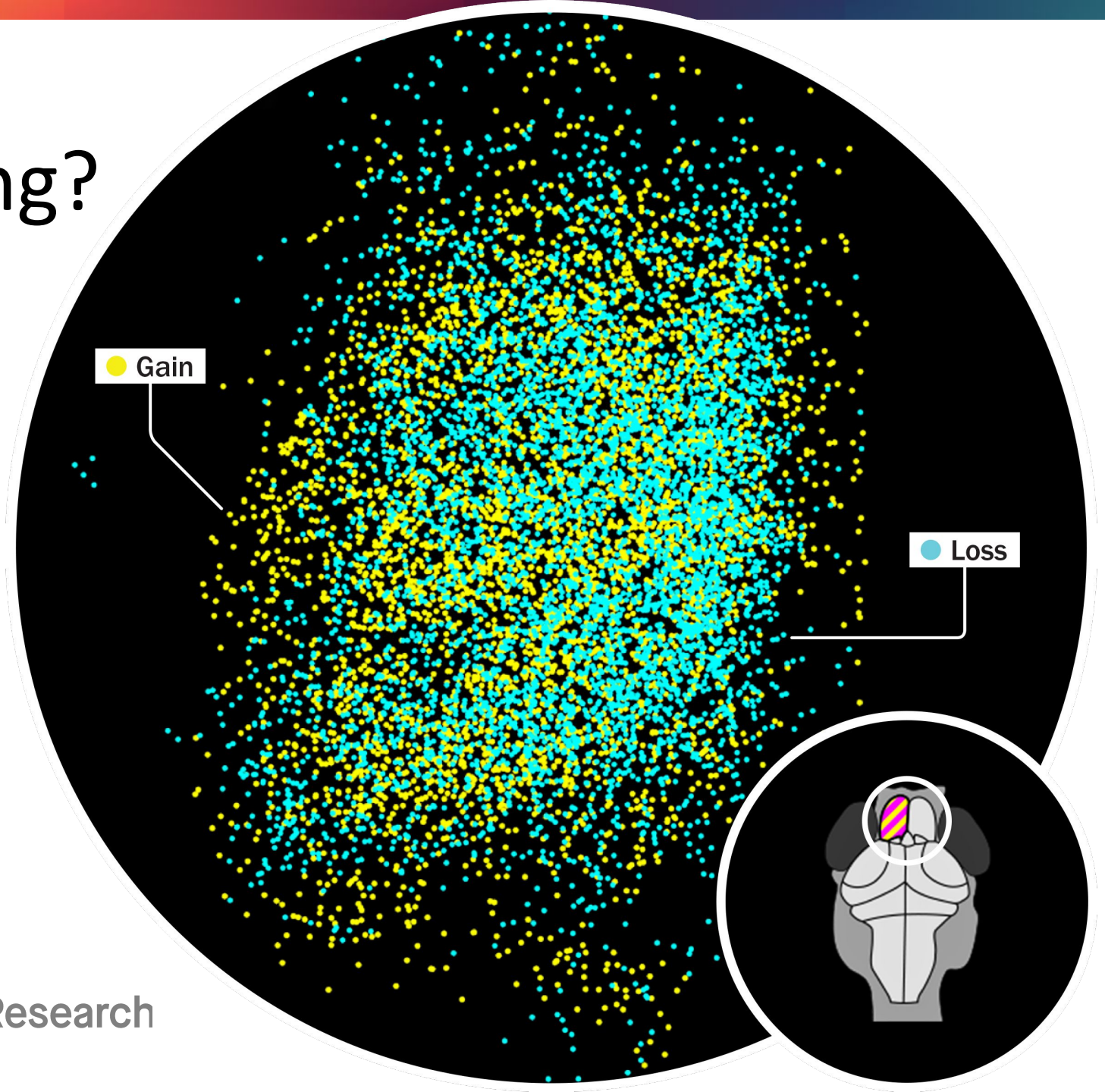
https://qbi.uq.edu.au/brain-basics/memory/where-are-memories-stored



Overlap between addiction circuitry and learning & memory circuitry

https://www.news-medical.net/whitepaper/20190311/The-Biological-Mechanisms-Behind-Addiction.aspx

What is forgetting?



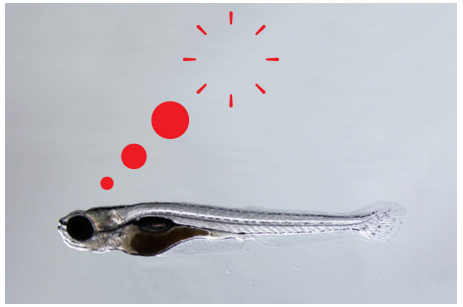


Image showing synaptic changes when a memory is made. Each yellow dot represents a new synaptic connection formed; each blue dot represents a connection lost.

William Dempsey and Anna Nadtochiy

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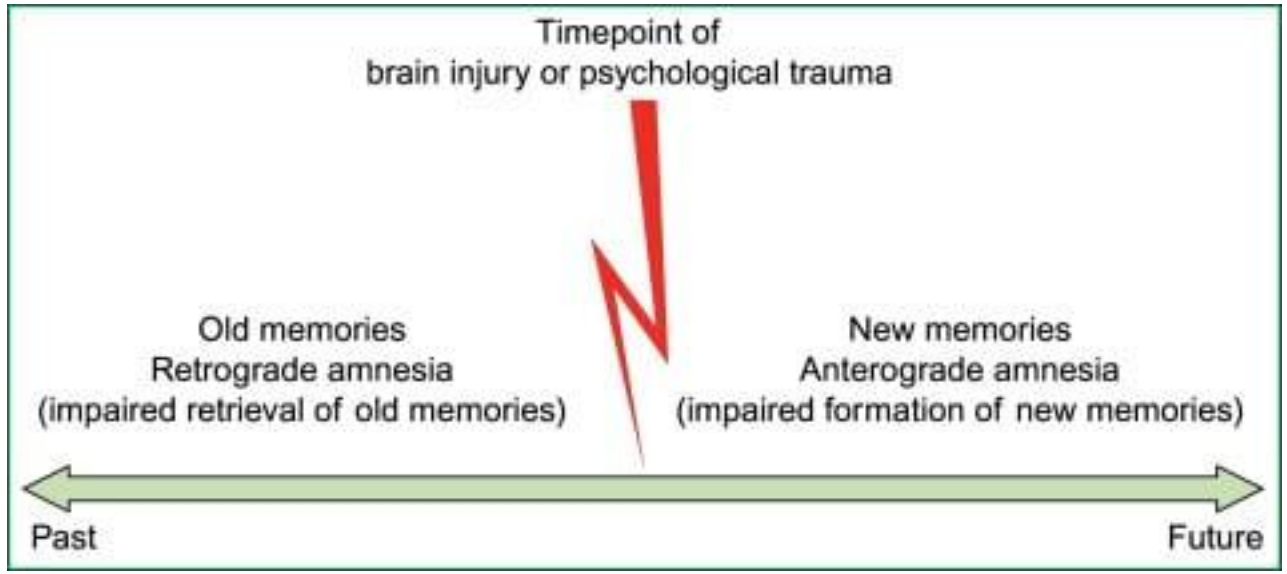
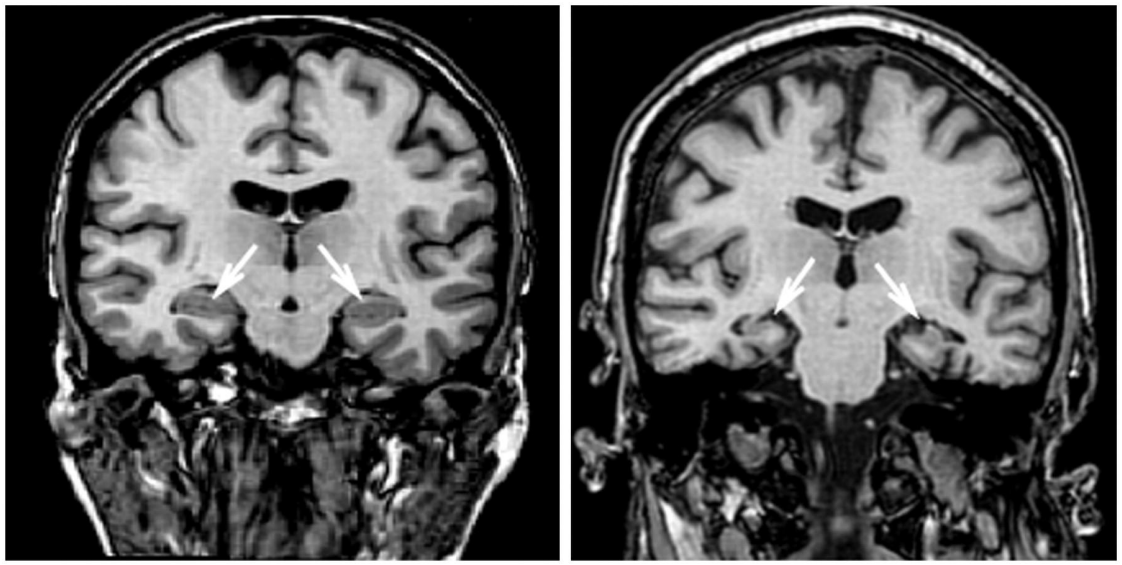
https://time.com/6171190/new-science-of-forgetting/

Amnesia

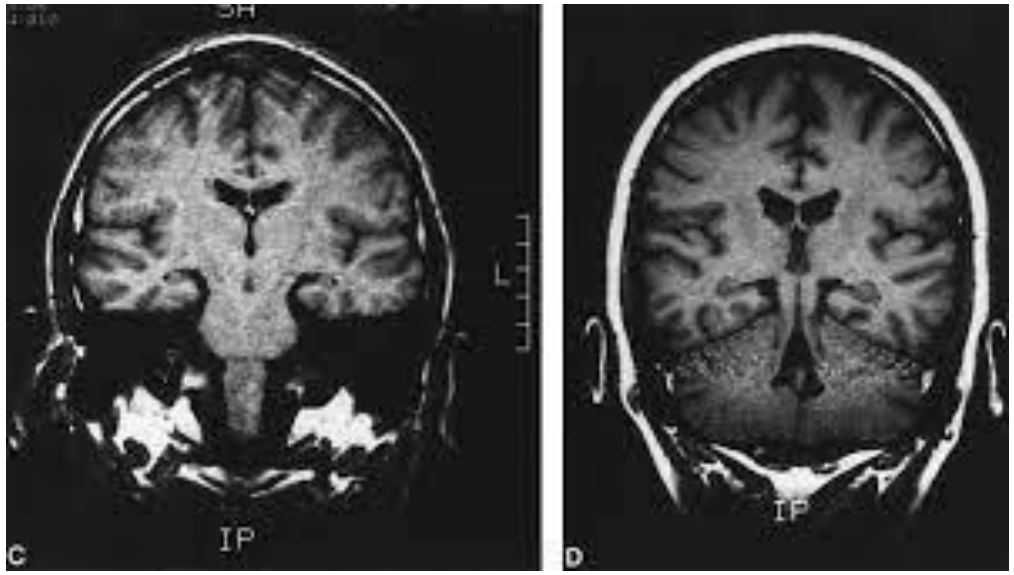


Medial temporal lobes



Healthy brain **Amnesic brain**

Hippocampus



Amnesic brain Healthy brain

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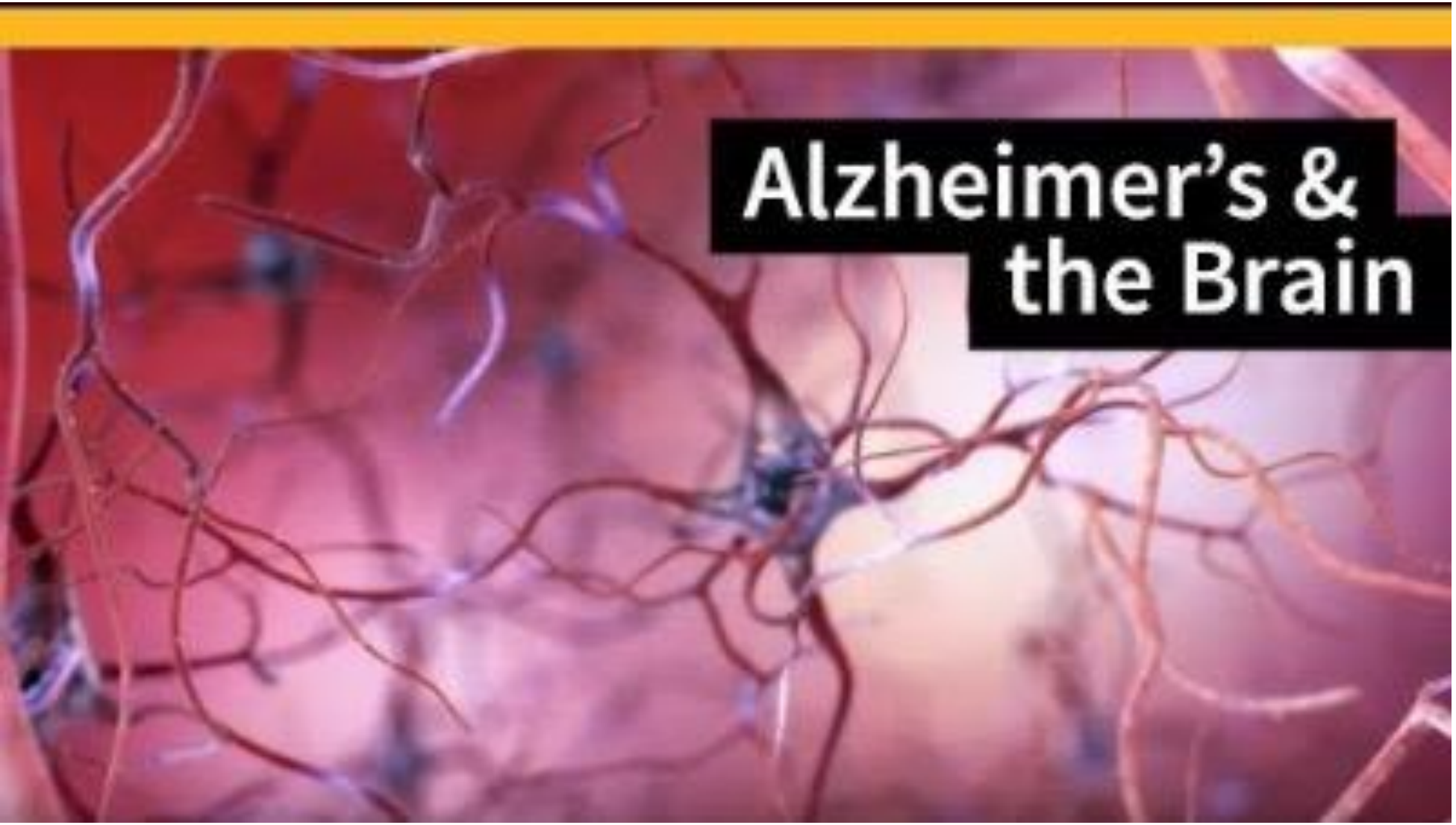
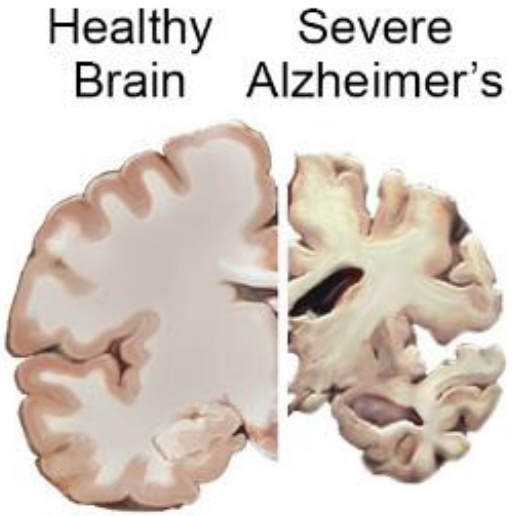
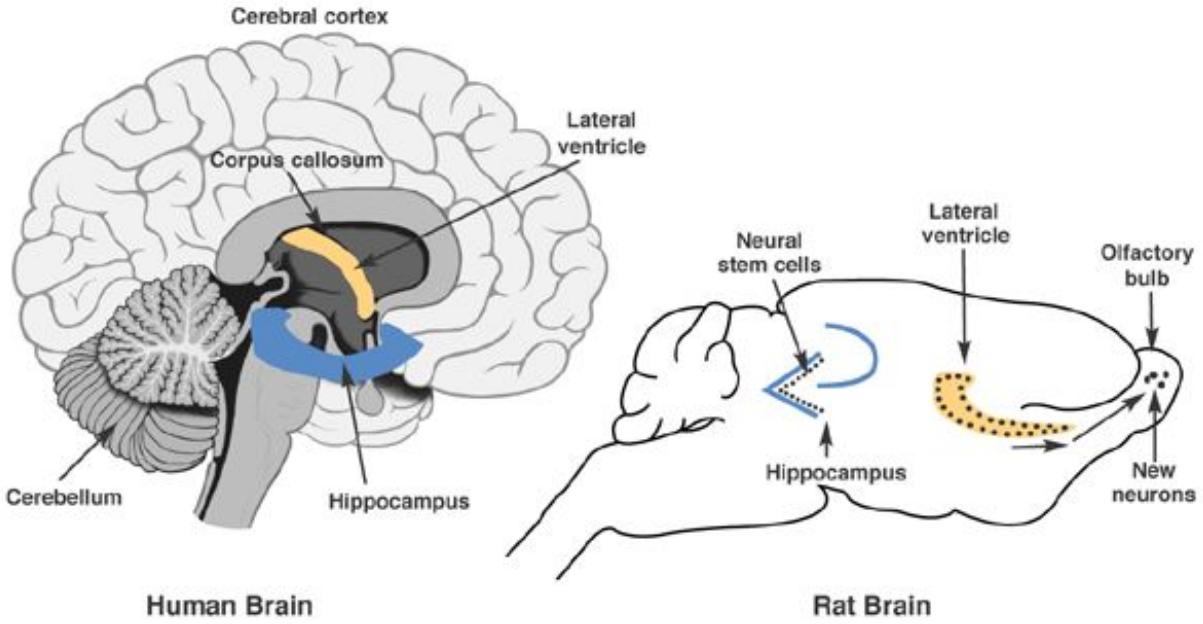
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1783611/#:~:text=(2000)%20and%20Moscovitch%20et%20al,produce%20a%20severe%20retrograde%20amnesia.

Alzheimer’s Disease

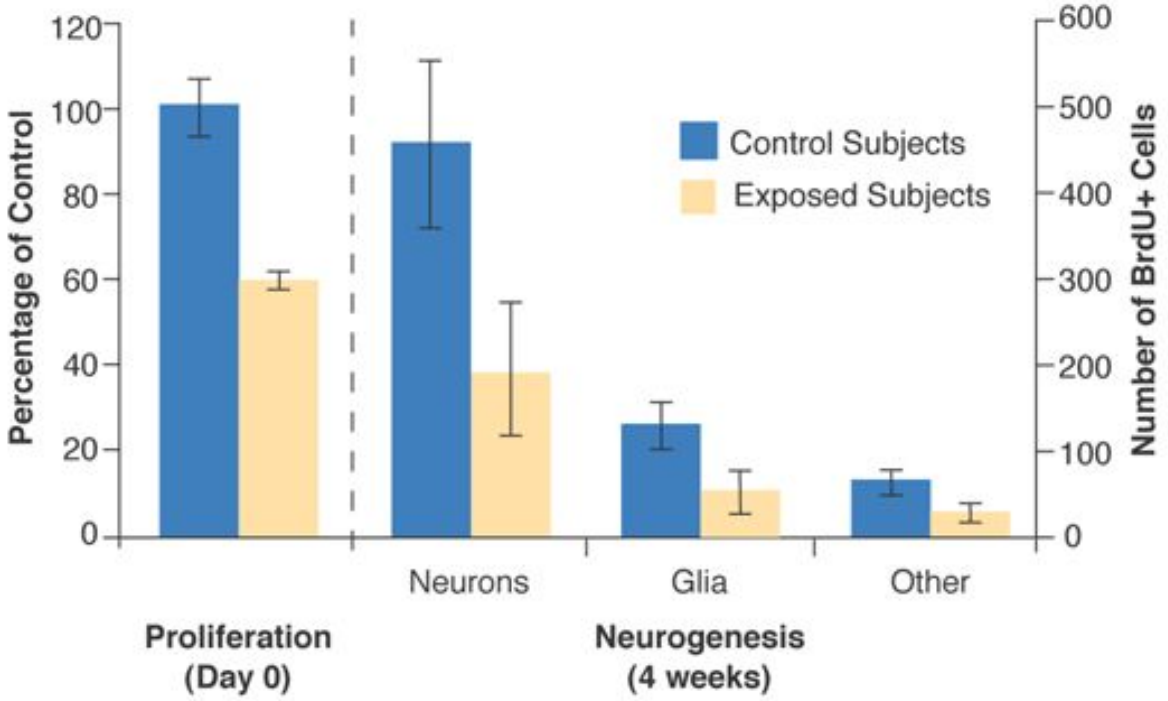




Example of neuroplasticity: Adult neurogenesis



Decreased by alcohol!



https://pubs.niaaa.nih.gov/publications/arh27-2/197-204.htm

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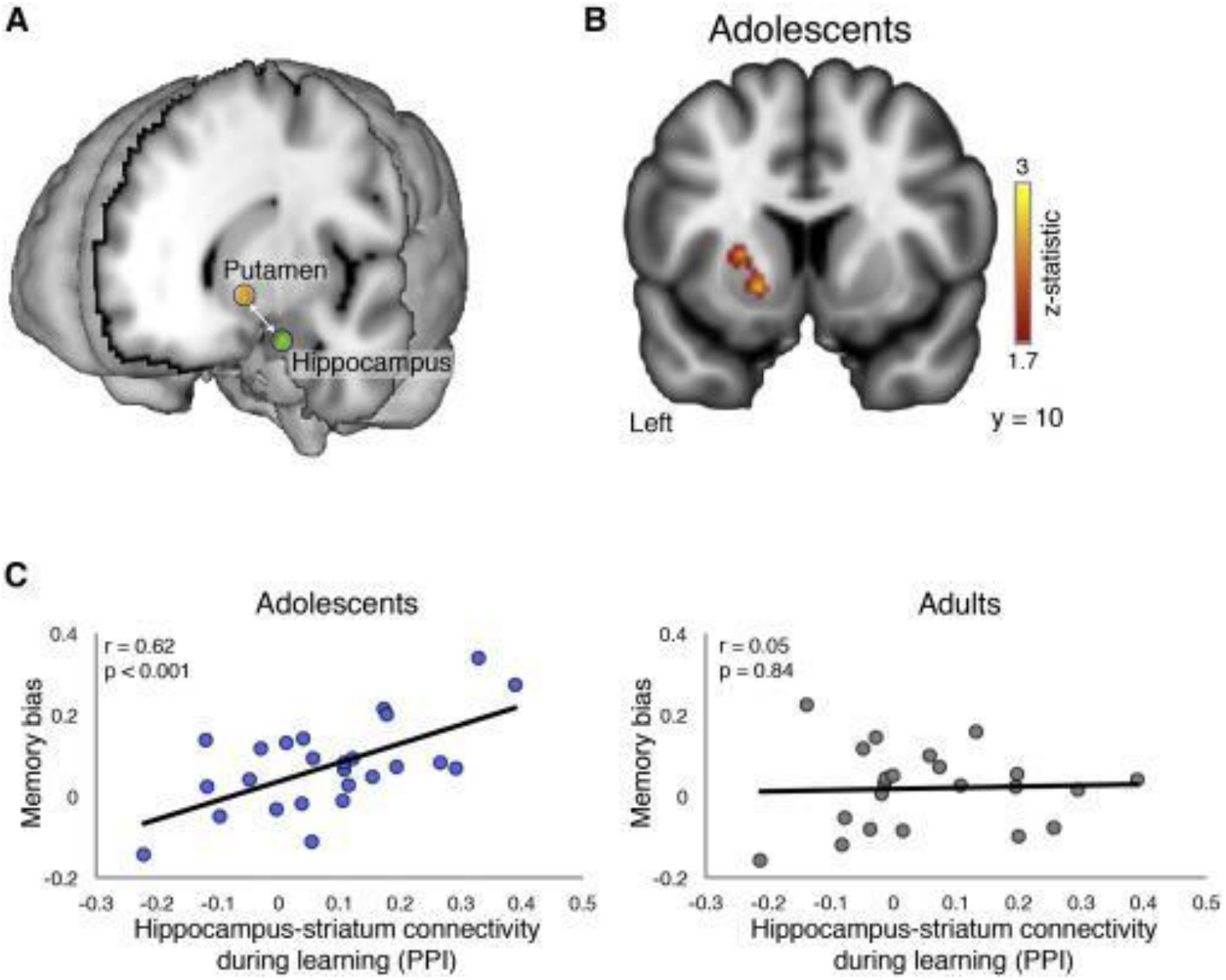
Example of a learning difference between adolescence & adulthood

The heightened sensitivity of striatal learning systems may put reward-seeking actions into overdrive but can also benefit learning from predictable, but variable, outcomes



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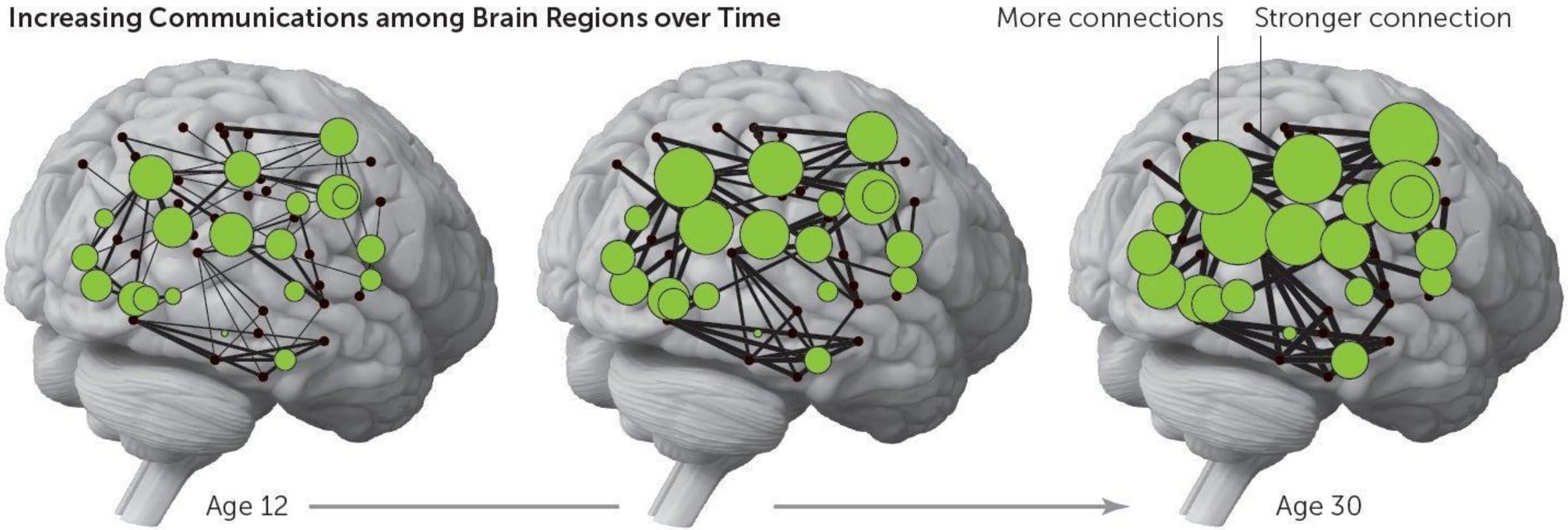
Davidow JY, Foerde K, Galván A, Shohamy D. An Upside to Reward Sensitivity: The Hippocampus Supports Enhanced Reinforcement Learning in Adolescence. Neuron. 2016 Oct 5;92(1):93-99. doi: 10.1016/j.neuron.2016.08.031. PMID: 27710793.

A NEW VIEW

Greater Networking Brings Maturity

Using graph theory, it was shown that from ages 12 to 30, connections between certain brain regions or neuron groups become stronger (*black lines that get thicker) &* certain regions and groups become more widely connected (*green circles that get larger*). These changes ultimately help the brain to specialize in everything from complex thinking to being socially adept.



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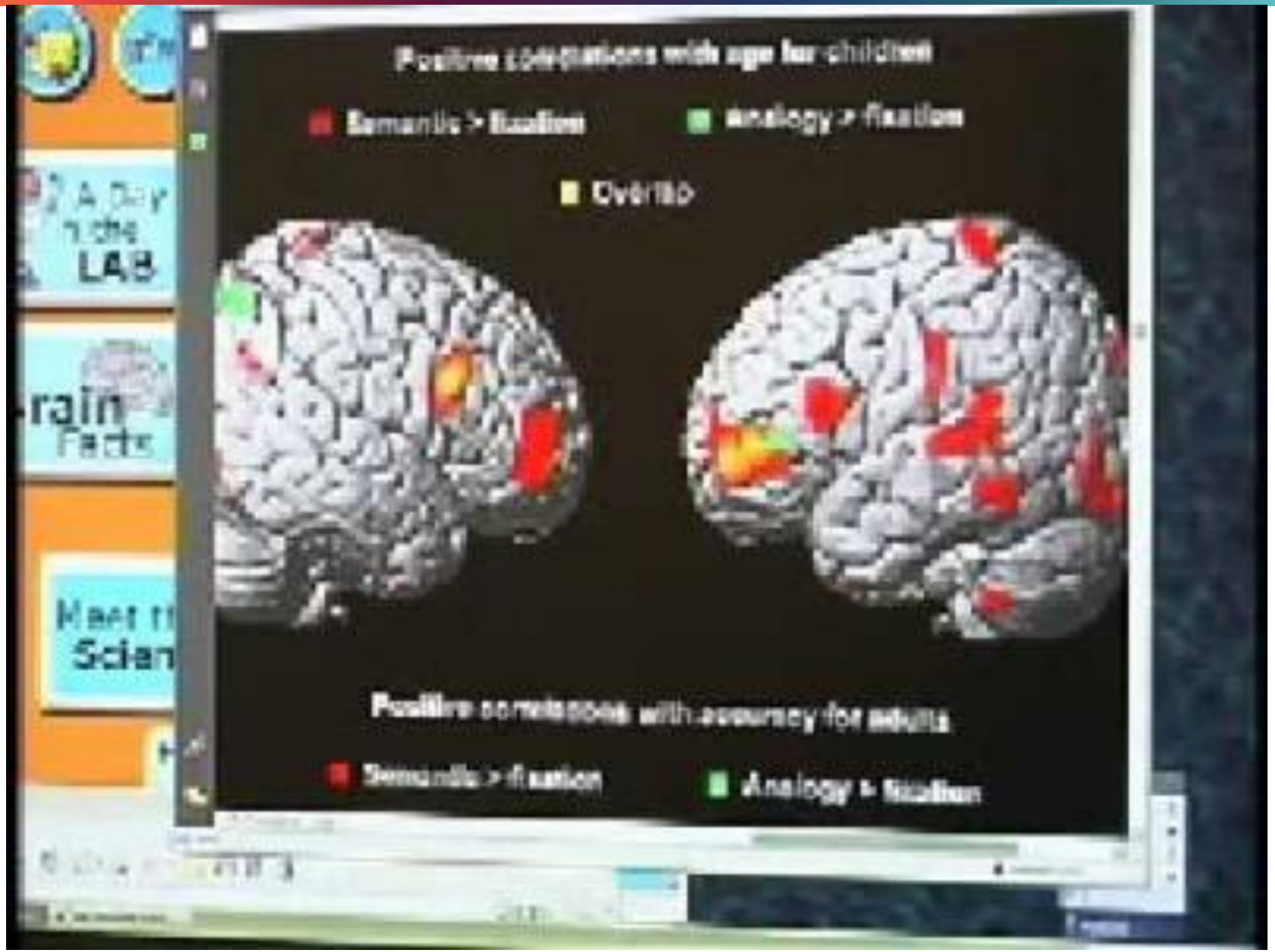
https://www.scientificamerican.com/article/the-amazing-teen-brain/


Positive correlations with age for children
Semantic > fixation
Analogy > fixation
Overlap
Positive correlations with accuracy for adults
Semantic > fixation
Analogy > fixation

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Take home messages

- We learn through interactions with our environment – and this allows us to adapt & live successful lives
- There are different kinds of memories that involve different (but connected) brain regions
- Notice that the brain regions involved in learning and memory overlap a lot with those involved in addiction
- Adolescence is an important time for learning and memory and brain development