

# 2023 TSRI ARC Summer High School Mentorship Program: Learning & Memory

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# What is learning?

- is 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

# Learning in an educational setting

## VISUAL

### LEARN BY SEEING

- Charts, Graphs
- Graphic organizers
- Lesson outlines
- Picture aids
- PowerPoints

## AUDITORY

### LEARN BY HEARING

- Read-alouds
- Listening centers
- Verbal instructions
- Discussions
- Repeat to a friend

## READ/ WRITE

### LEARN BY READING & WRITING

- Books & texts
- Dictionaries
- Note-taking

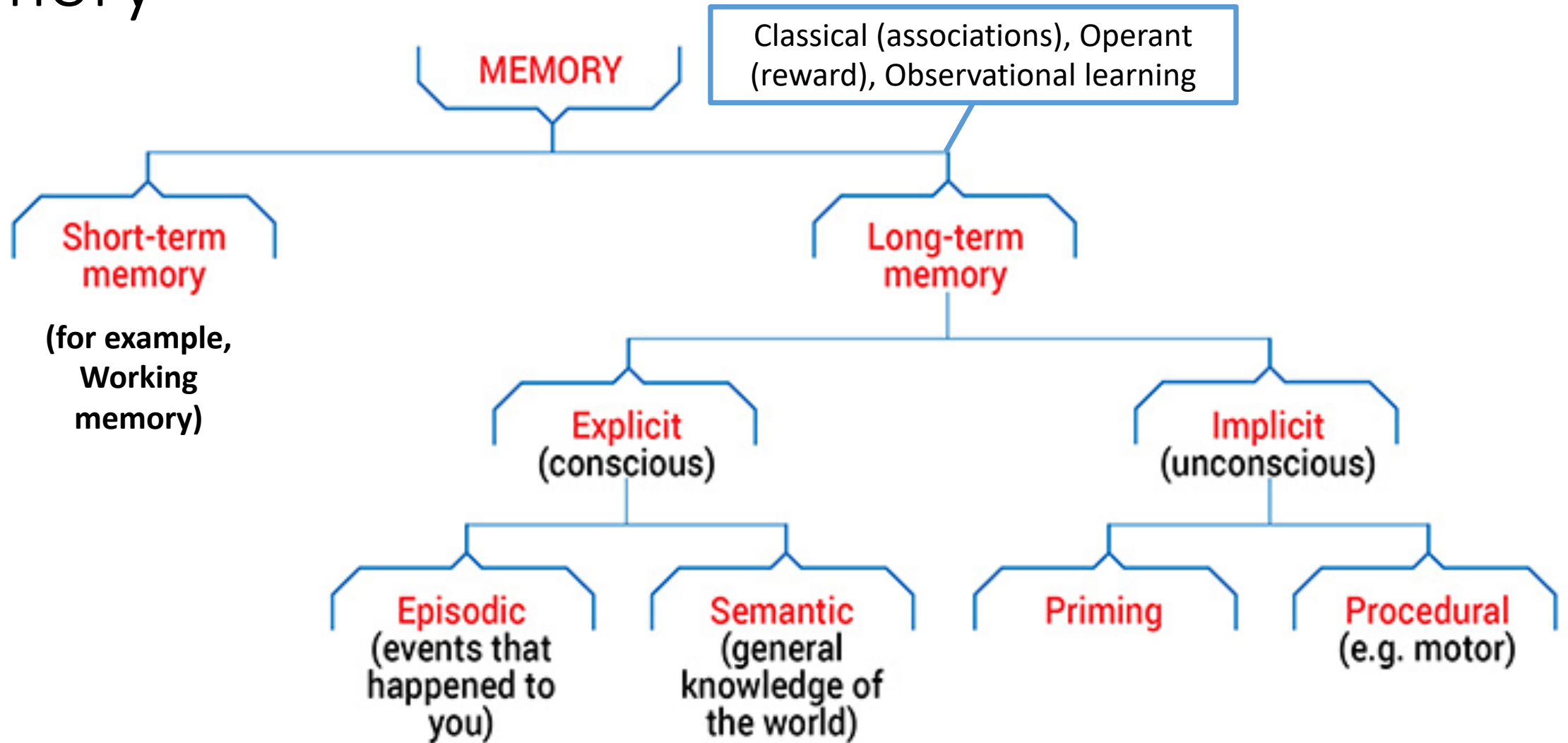
## KINESTHETIC

### LEARN BY DOING

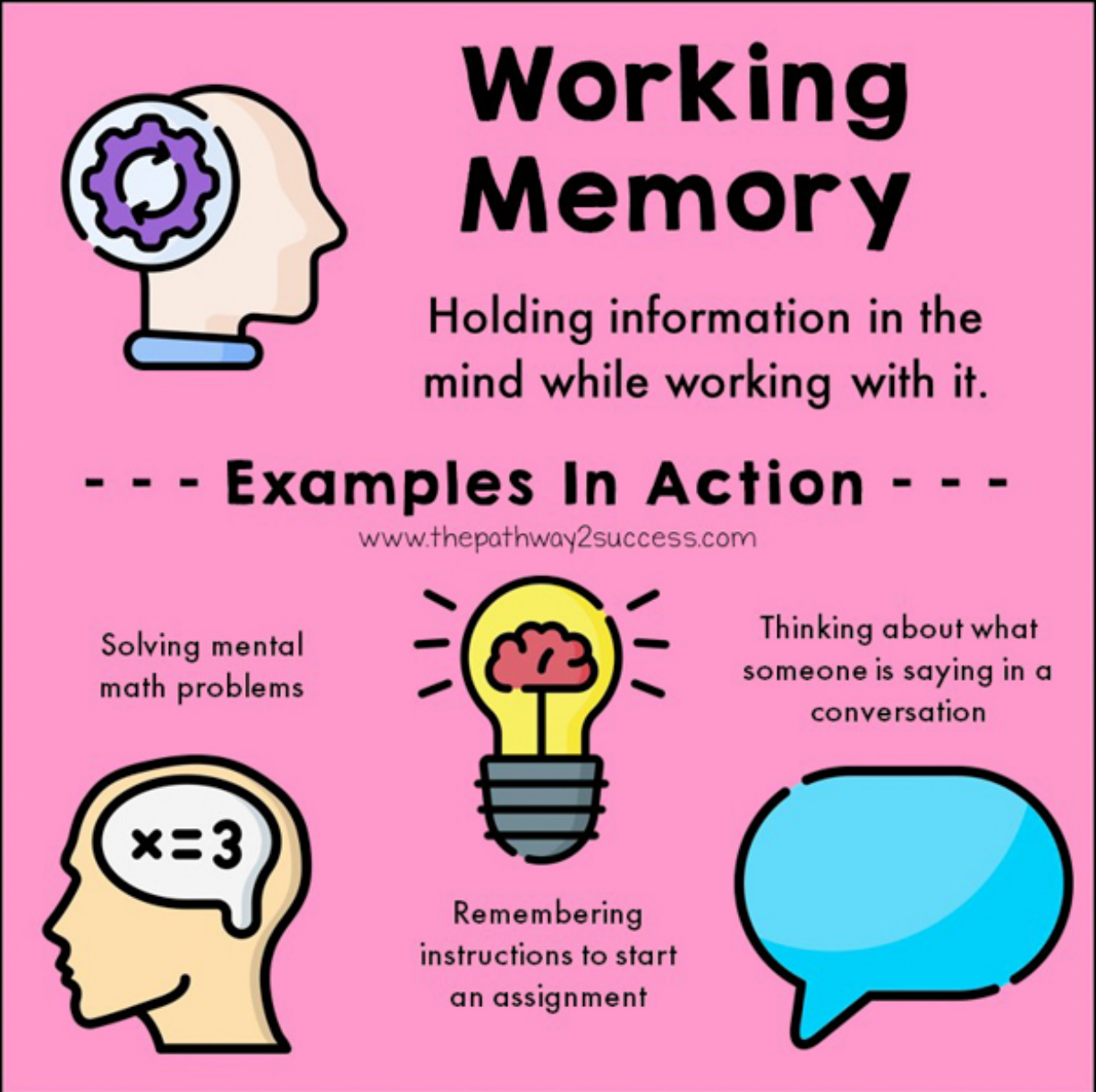
- Incorporate body movement
- Tactile- touch, feel
- Hands-on!

- A process that leads to change, which occurs as a result of experience and increases the potential for improved performance and future learning
- Lots of theories about people having different learning styles, but these are likely just the person's preferences and don't necessarily match the actual amount of learning taking place.

# Memory



# Working memory



**Working Memory**

Holding information in the mind while working with it.

- - - **Examples In Action** - - -

[www.thepathway2success.com](http://www.thepathway2success.com)

Solving mental math problems

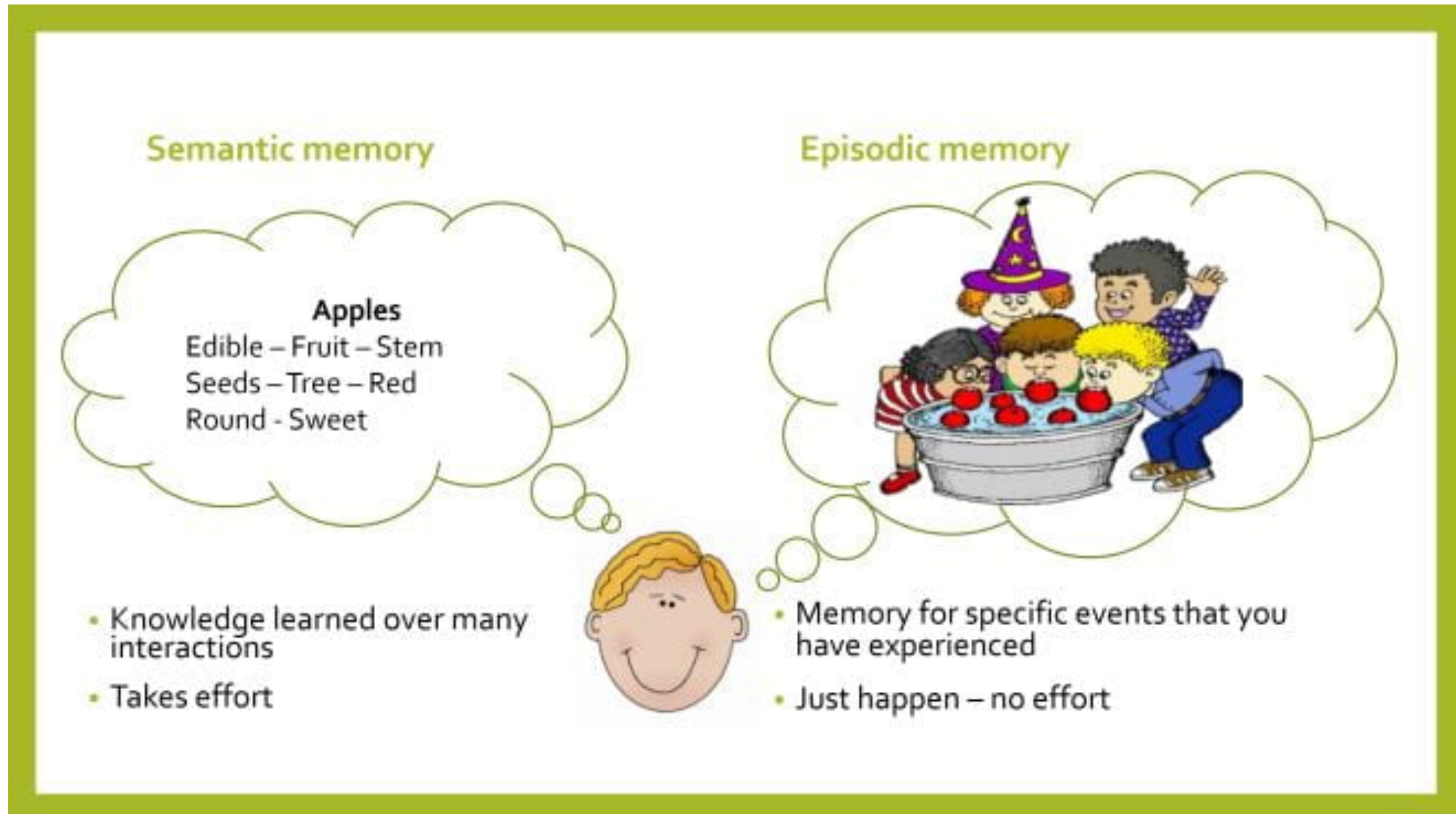
Thinking about what someone is saying in a conversation

Remembering instructions to start an assignment

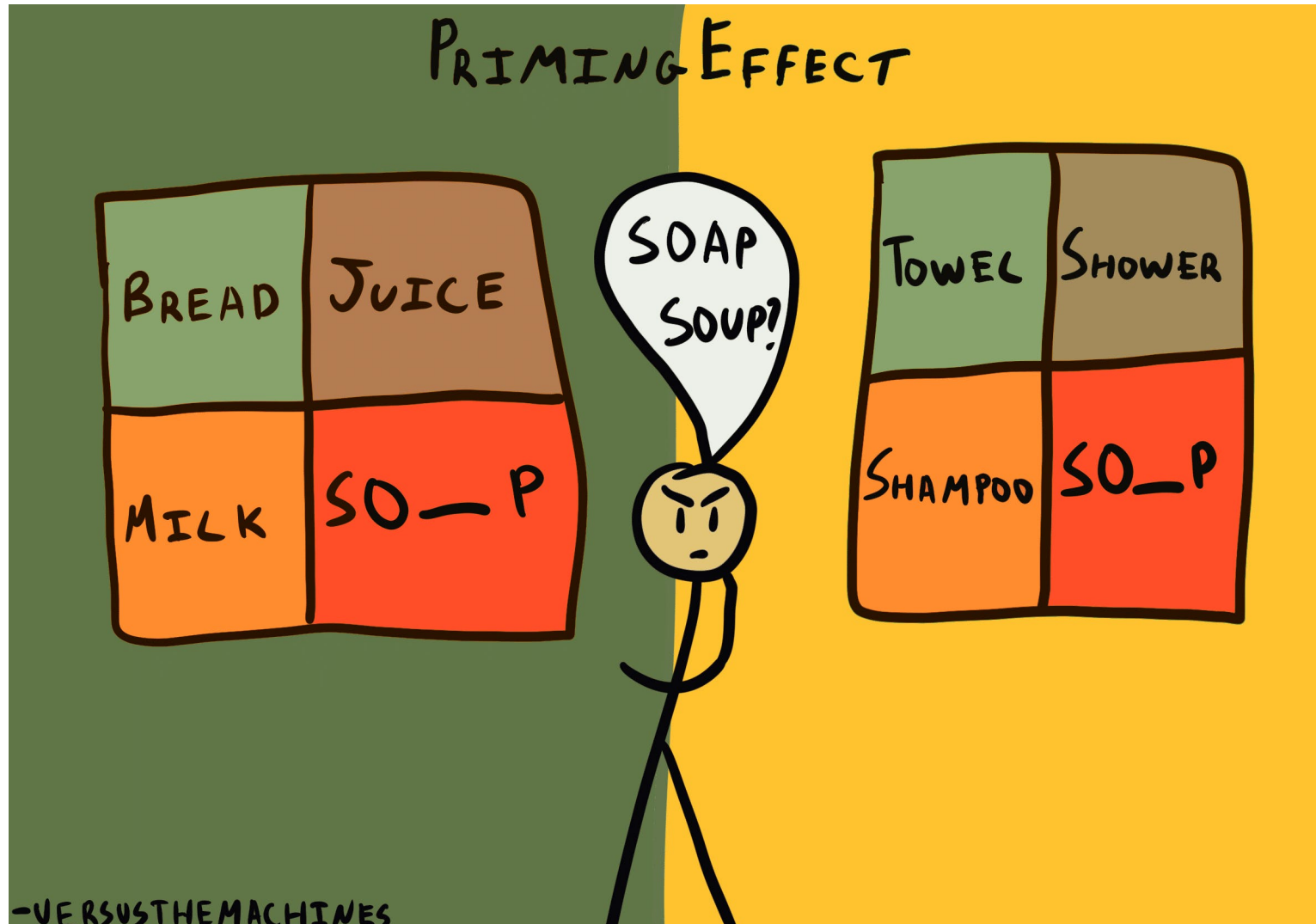
The infographic features a pink background with a black border. At the top left is an icon of a head with a gear inside. The title 'Working Memory' is in large, bold, black font. Below it is the definition 'Holding information in the mind while working with it.' A separator line of three dashes follows, with 'Examples In Action' in bold. The website URL is centered below. Three examples are shown: 'Solving mental math problems' with a head icon containing 'x=3', 'Thinking about what someone is saying in a conversation' with a lightbulb icon containing a brain, and 'Remembering instructions to start an assignment' with a speech bubble icon.

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

# Explicit (conscious) memory: Semantic and Episodic



# Implicit (unconscious) memory: Priming

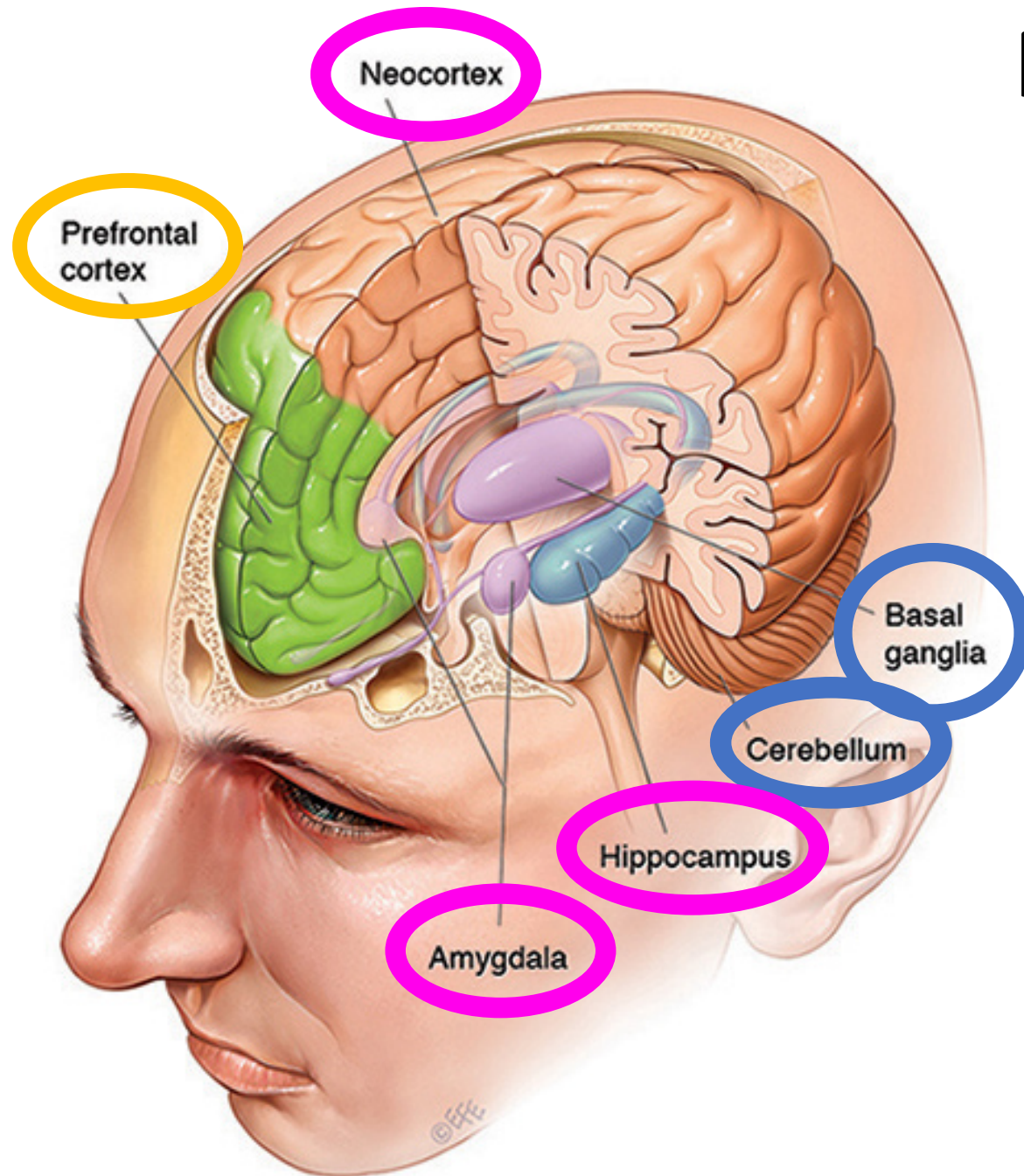




# Implicit (unconscious) memory: Procedural



# 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>

# Little Albert

Neutral Stimulus

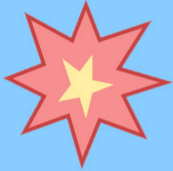


Neutral Response



Little Albert is not afraid of the rat

Unconditioned Stimulus



Unconditioned Response



Little Albert is afraid of loud bang



Little Albert is repeatedly shown the rat at the same time he hears a loud bang.

Conditioned Stimulus



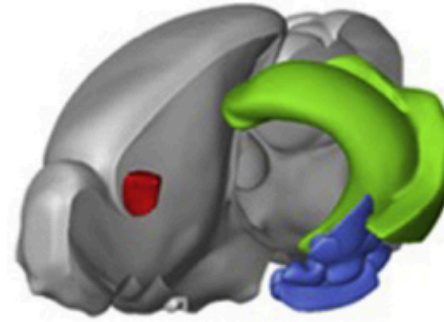
Conditioned Response



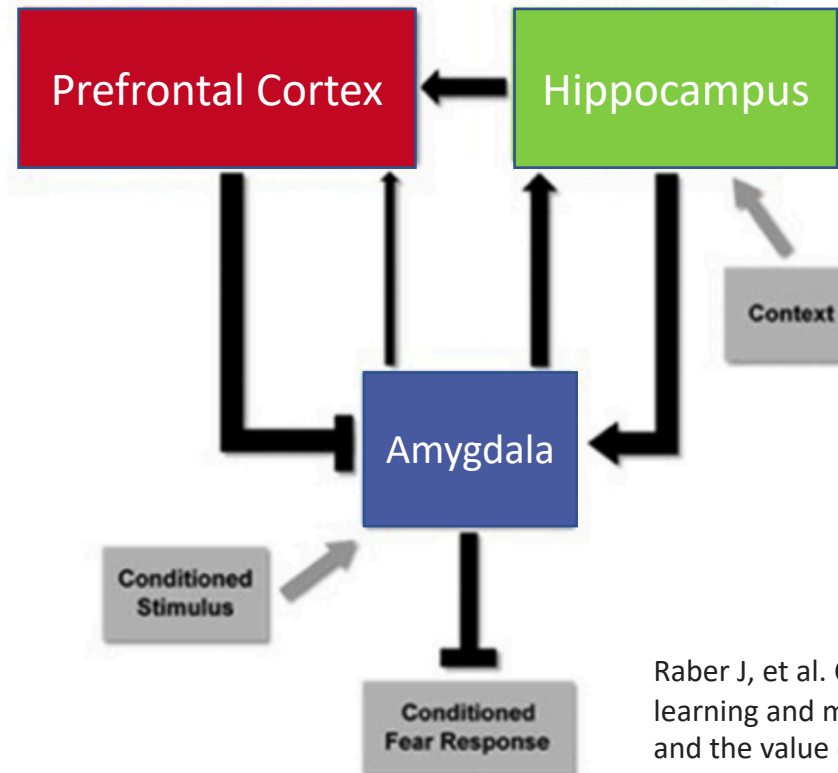
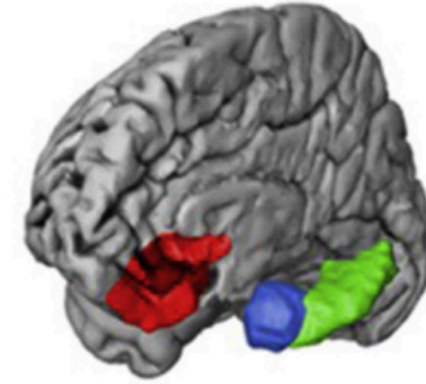
Little Albert is now afraid of the rat because he now connects the rat with the loud bang.

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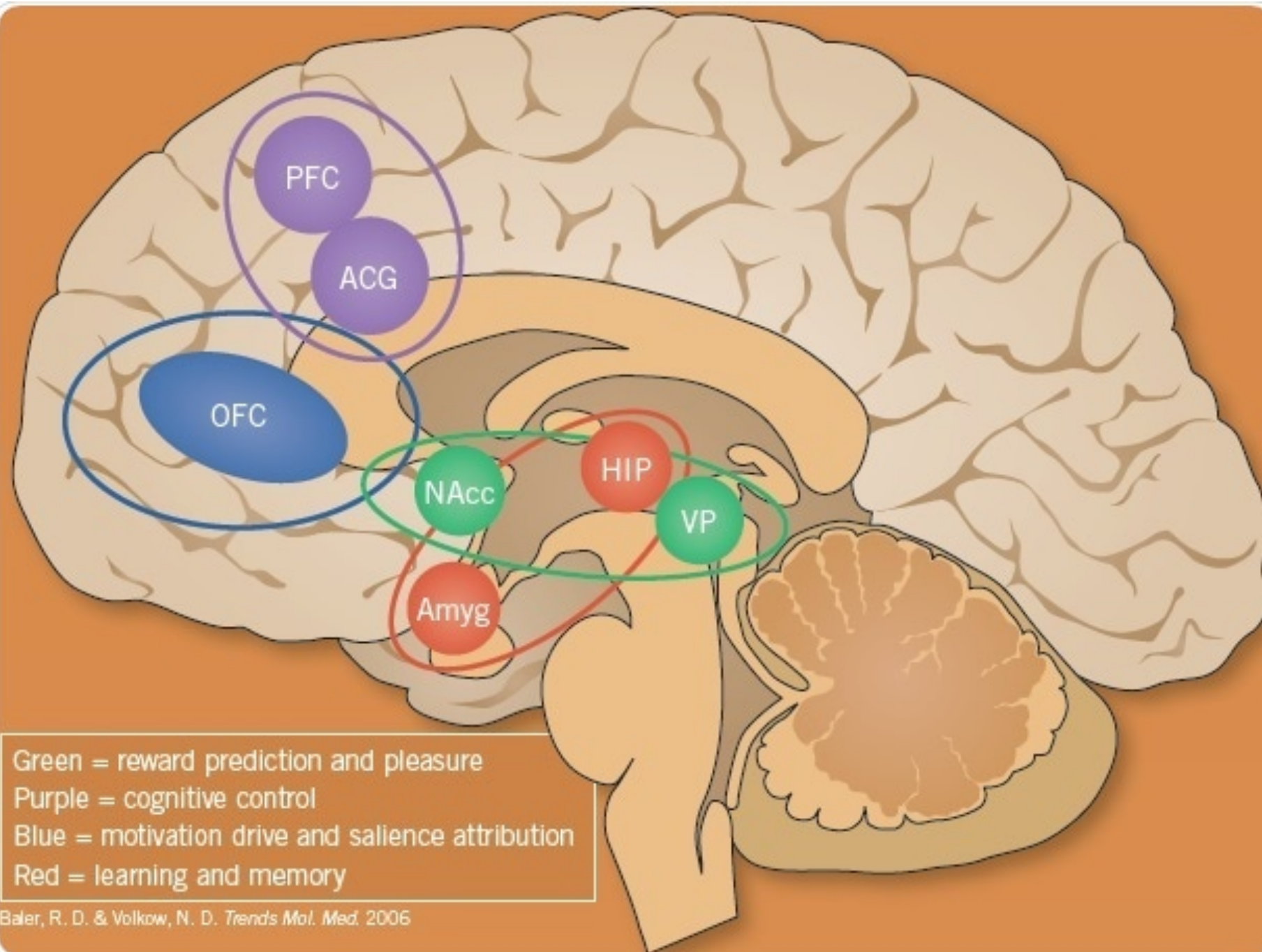
RODENT



HUMAN



Raber J, et al. Current understanding of fear learning and memory in humans and animal models and the value of a linguistic approach for analyzing fear learning and memory in humans. *Neurosci Biobehav Rev.* 2019 Oct;105:136-177



Overlap  
between  
addiction  
circuitry  
and  
learning &  
memory  
circuitry

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

# What is forgetting?

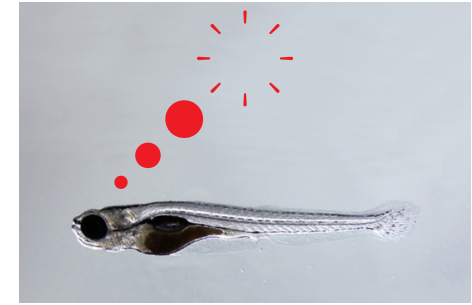
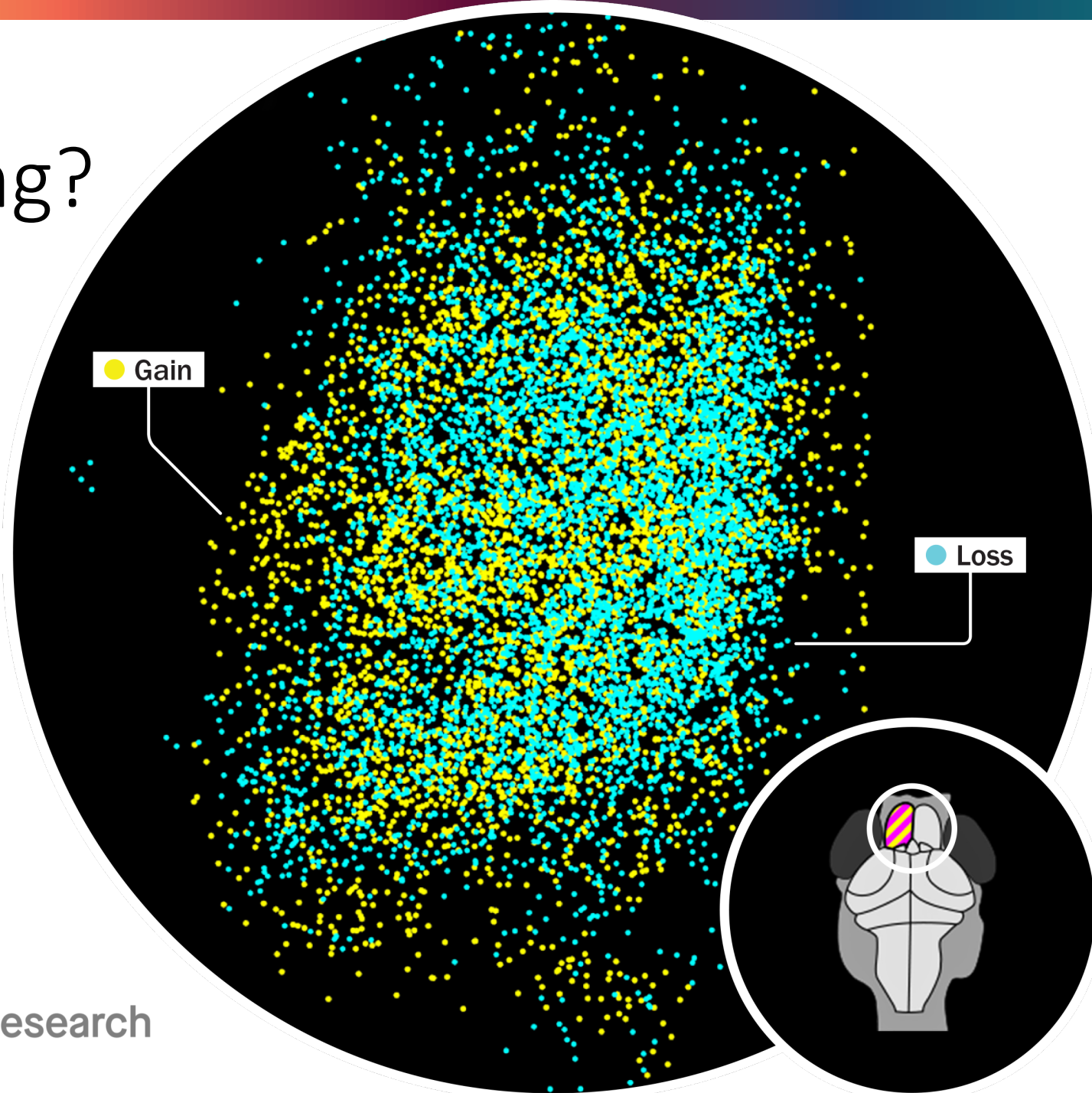
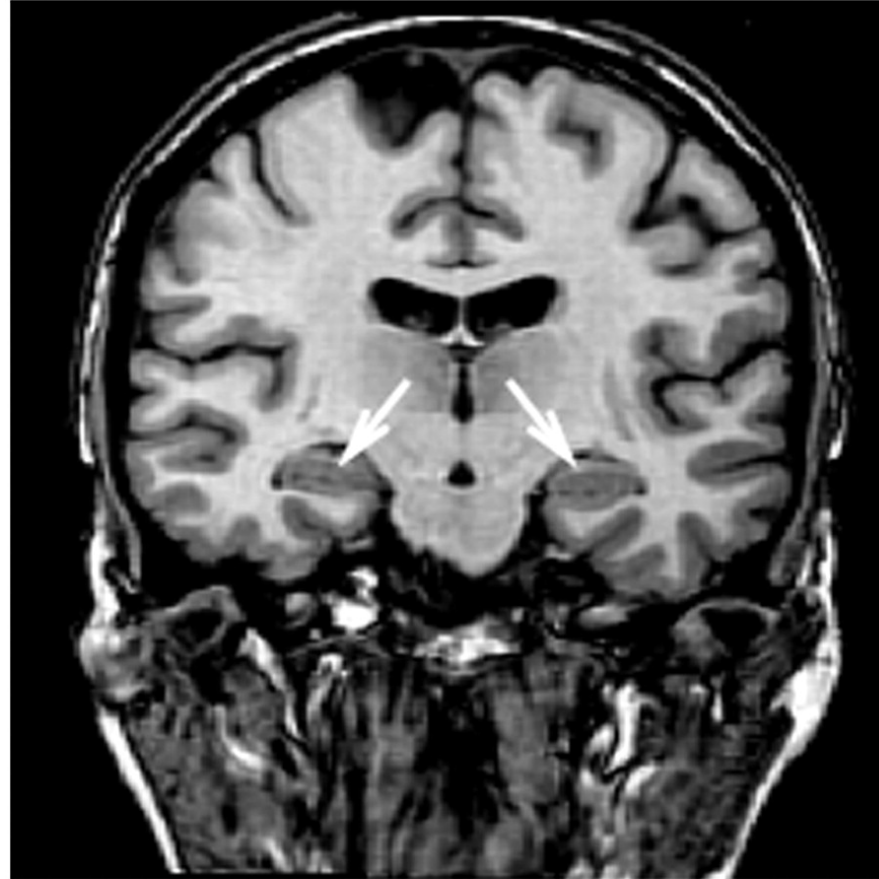


Image showing synaptic changes when a memory is made. Each yellow dot represents a new synaptic connection formed; each blue dot represents a connection lost.

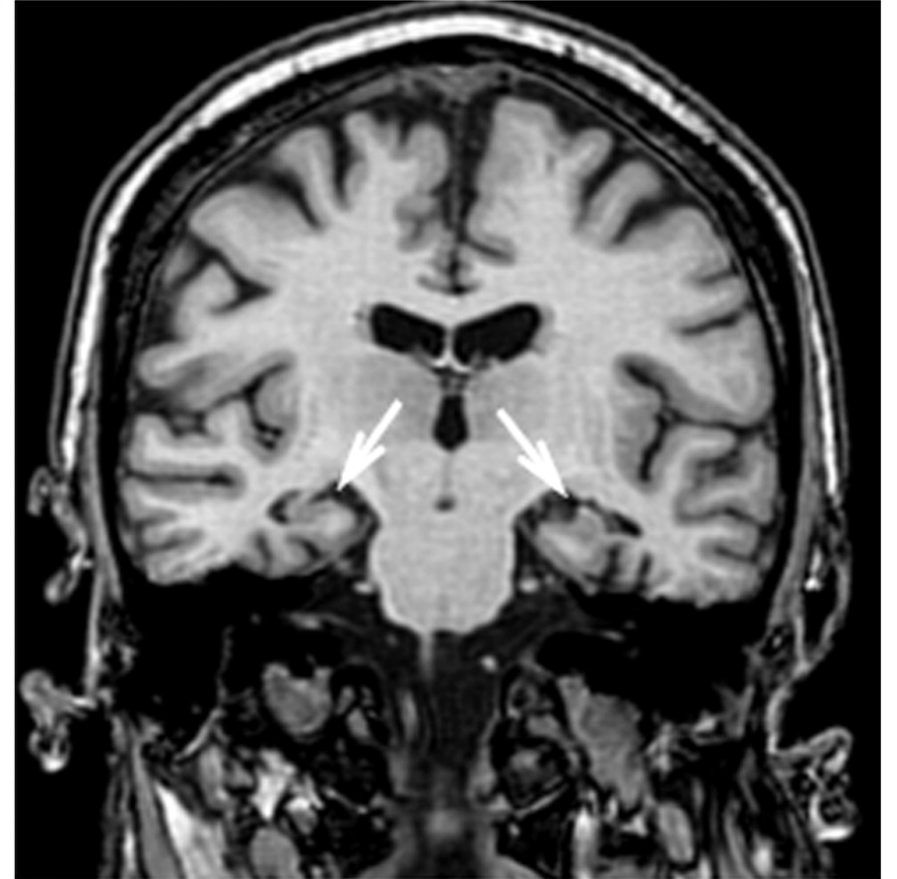
William Dempsey and Anna Nadtochiy

# Example of amnesia

People with amnesia (caused by illness, disease, or surgery) usually know who they are, but they may have trouble learning new information and forming new memories.

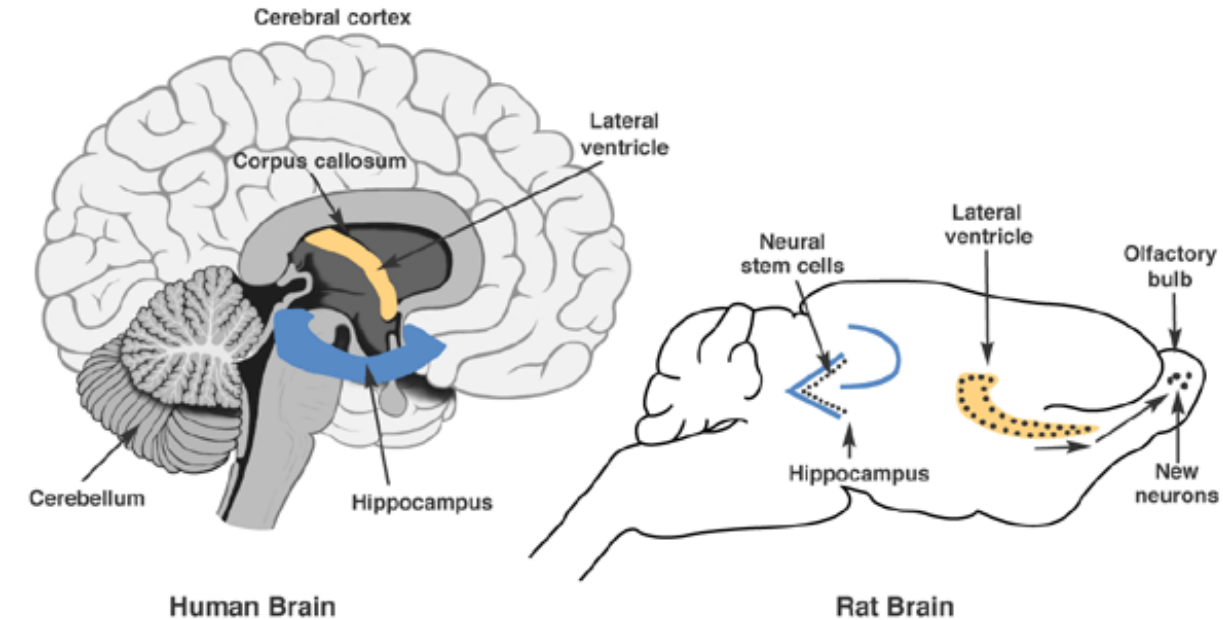


**Healthy brain**

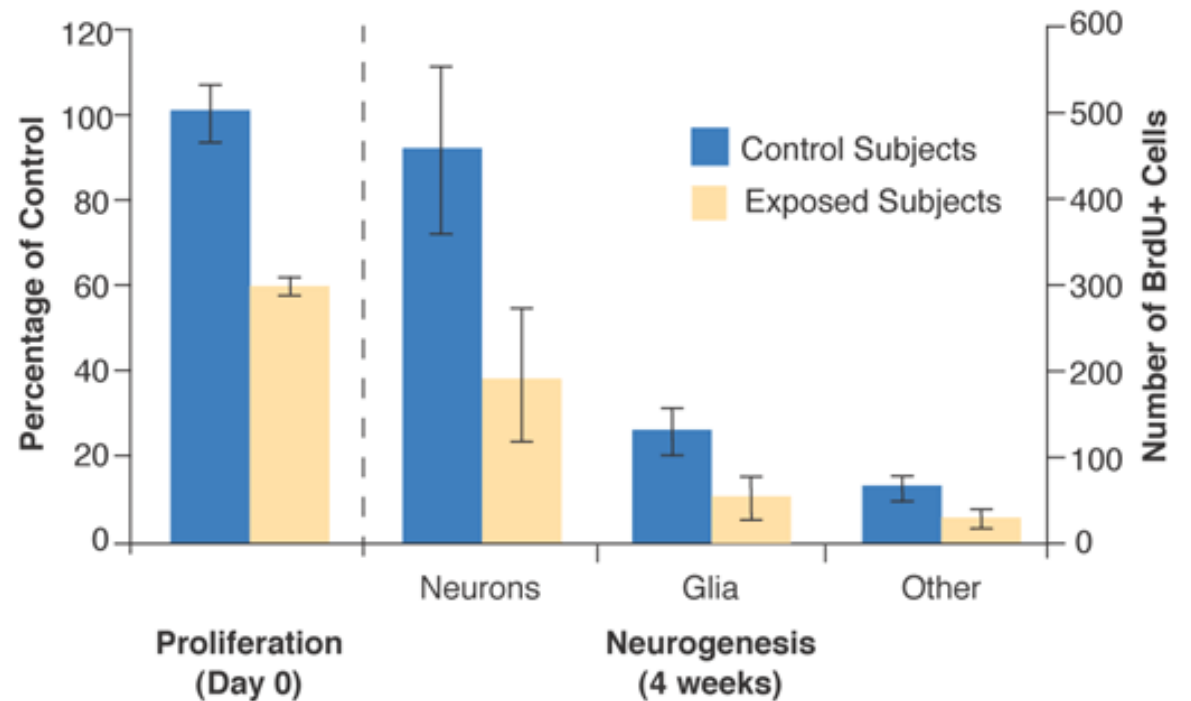


**Amnesic brain**

# Example of neuroplasticity: Adult neurogenesis



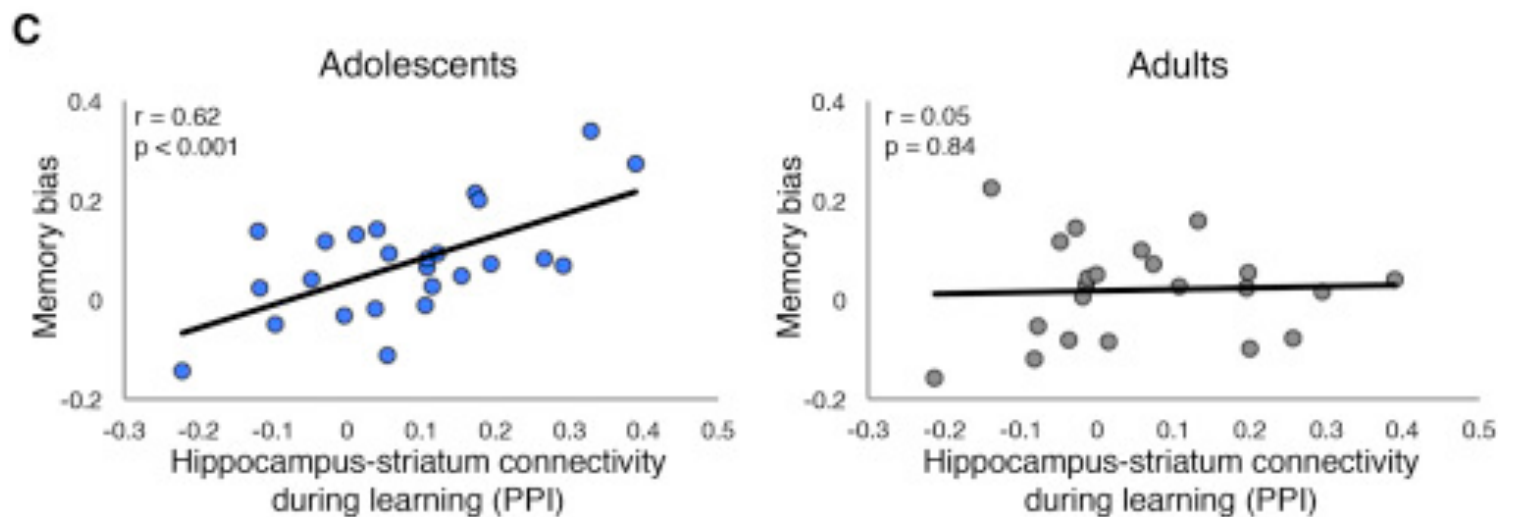
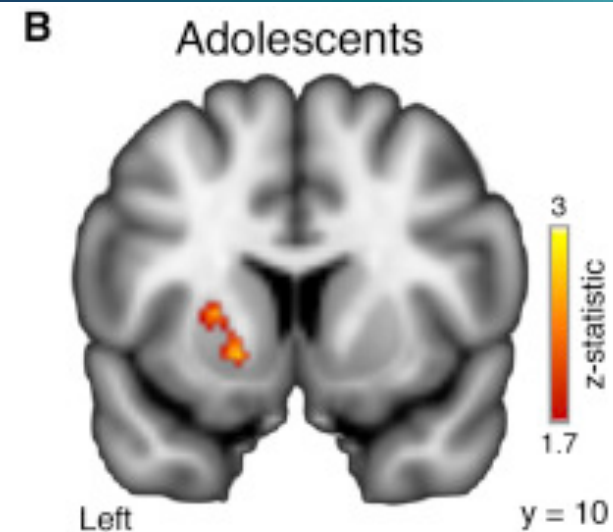
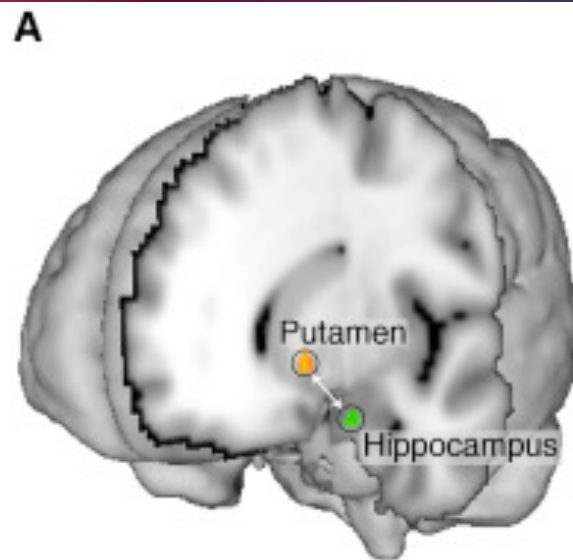
Decreased by alcohol!



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

# 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



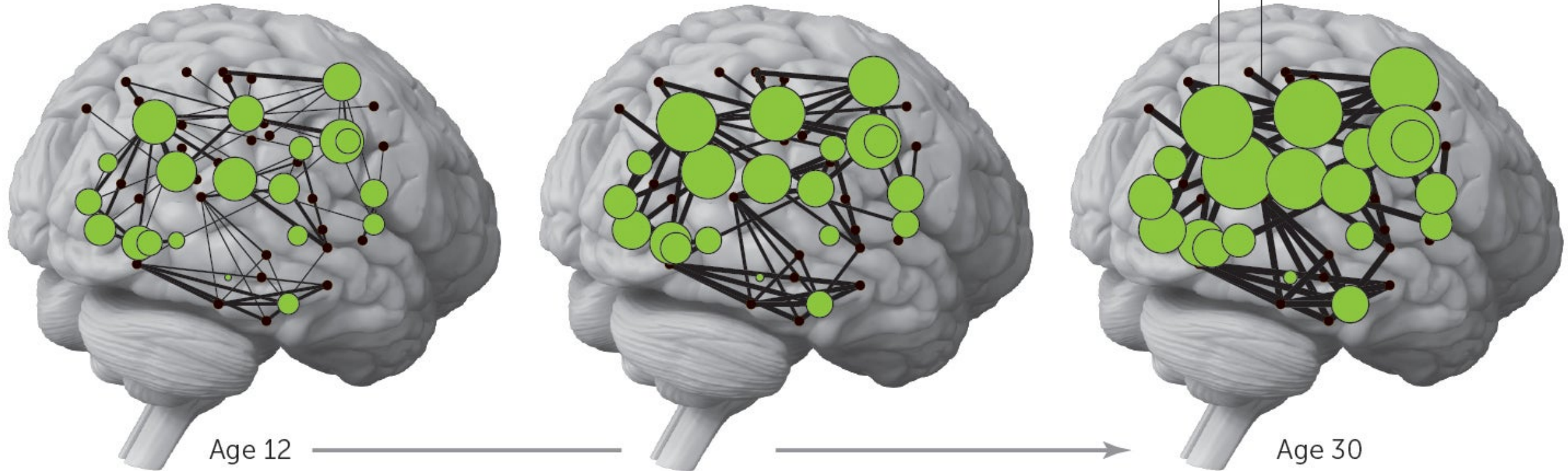
Davidow JY, Foerde K, Galván A, Shohamy D. An Upside to Reward Sensitivity: The Hippocampus Supports Enhanced Reinforcement Learning in Adolescence. *Neuron*. 2016 Oct 5;92(1):93-99. doi: 10.1016/j.neuron.2016.08.031. PMID: 27710793.



## 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.

Increasing Communications among Brain Regions over Time



# 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

# Some possible project topics to think about if you are still not sure

- How do people recover from amnesia?
- Why is forgetting a good thing?
- Pick a learning/memory difference (dyslexia, dyscalculia, dysgraphia, hyperthymesia, etc) and ask what this is and what are its causes, neuroscience, treatments/strategies for living with this successfully?
- Is photographic memory real?
- Why do some scientists call addiction a disorder of learning and memory?