How practice changes us – with a view from the brain

Sacramento Insight Meditation

Rick Maddock July 31, 2025

Sutta on the Two Kinds of Thought -MN 19 (Sujato)

Bhikkhus, before my enlightenment, while I was still *unawakened*, it occurred to me: ‘**Suppose that I divide my thoughts into two classes**. Then I set on one side thoughts of sensual desire, thoughts of ill will, and thoughts of cruelty, and I set on the other side thoughts of *non-clinging*, thoughts of non-ill will, and thoughts of non-cruelty.

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then he reflects on the first kind of thinking, e.g. thoughts of cruelty

"As I abided…, diligent, ardent, and resolute, a thought of cruelty arose in me.
I understood thus: 'This **thought of cruelty** has arisen in me. This leads to my own **affliction**, to others' **affliction**, and to the **affliction** of both; it obstructs wisdom, causes difficulties, and leads away from Nibbāna.' When I considered thus…it subsided in me…

then the same with wholesome thoughts, he sees mindfully, they do not lead to affliction

Sutta on the Two Kinds of Thought -MN 19 (Sujato)

(continued…)

Whatever a *practitioner* frequently thinks about and considers becomes their heart's inclination. …

If they often think about and consider cruel thoughts … their mind inclines to cruel thoughts …

Whatever a practitioner frequently thinks about and considers becomes their heart's inclination. …

If they often think about and consider thoughts of good will … their mind inclines to thoughts of good will.

Basic principle of learning

from Donald Hebb, 1949

”Neurons that fire together wire together.”

(neuroplasticity)

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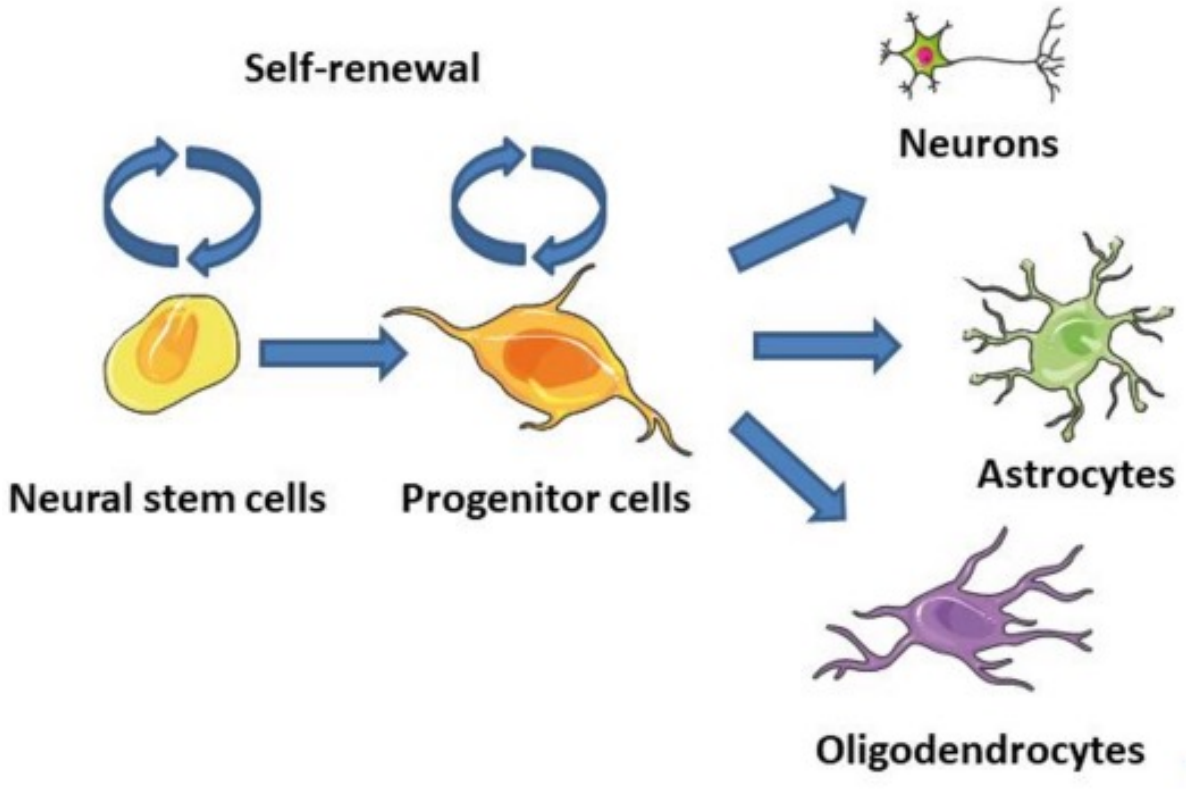
A young monk asked the old master, Yunmen,
“What is the fruit of a lifetime of practice?”

Yunmen replied, “An appropriate response.”

- Classic Zen text

Rate of generation of new brain cells



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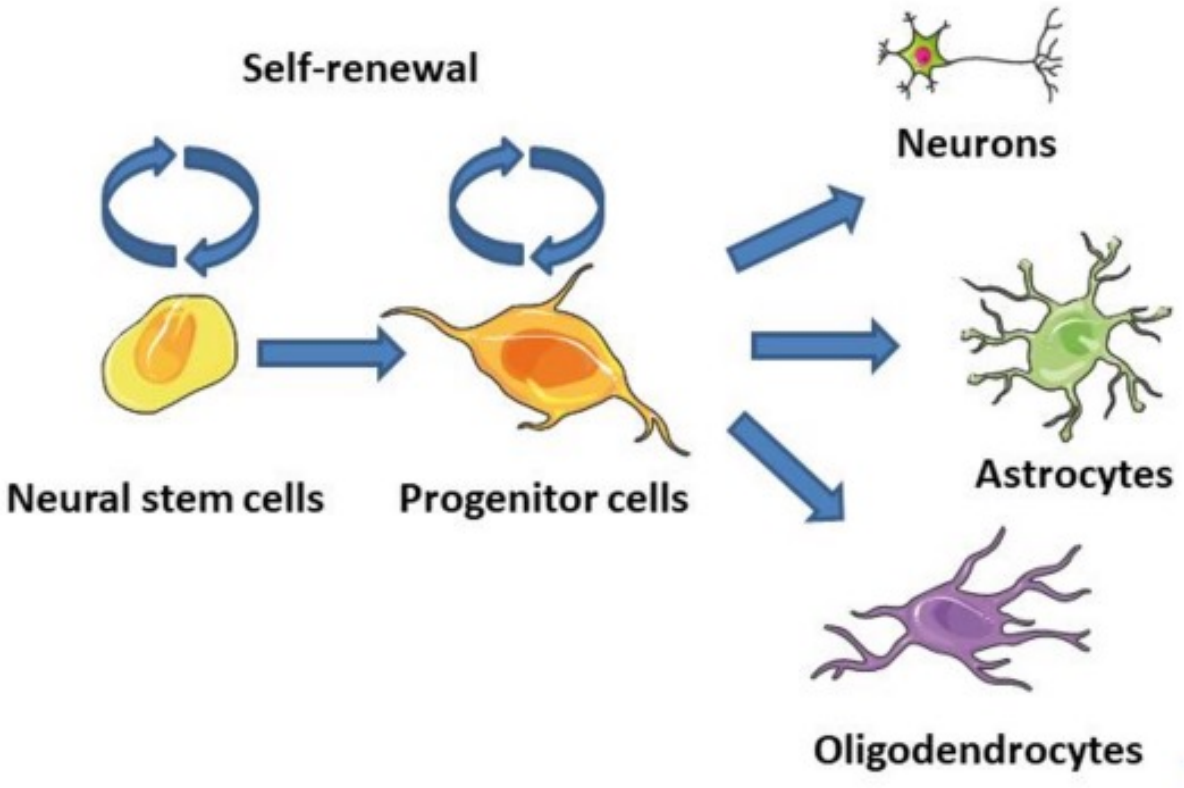
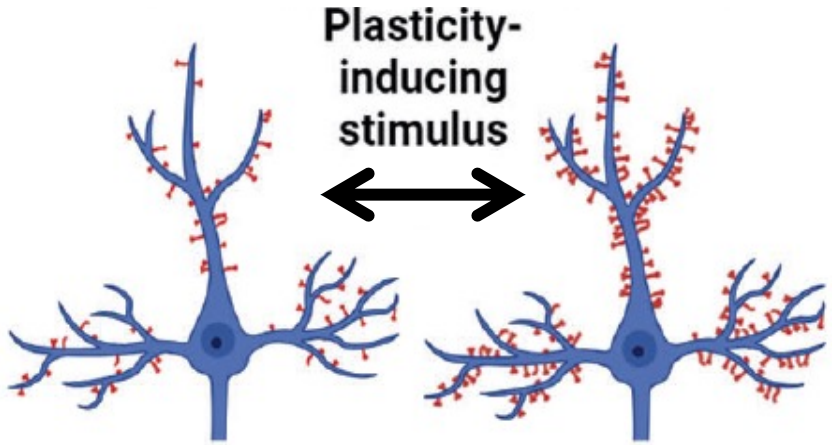
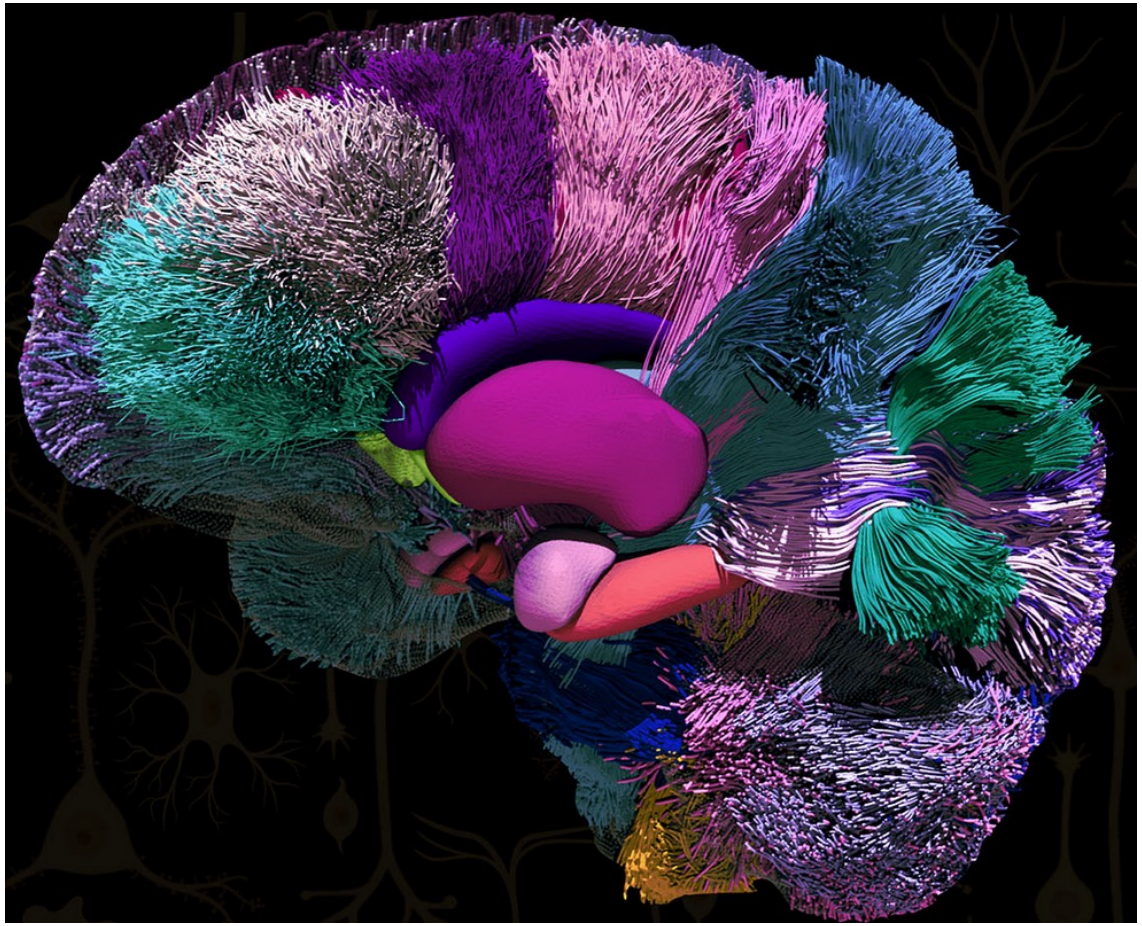


Degree of branching of individual neurons



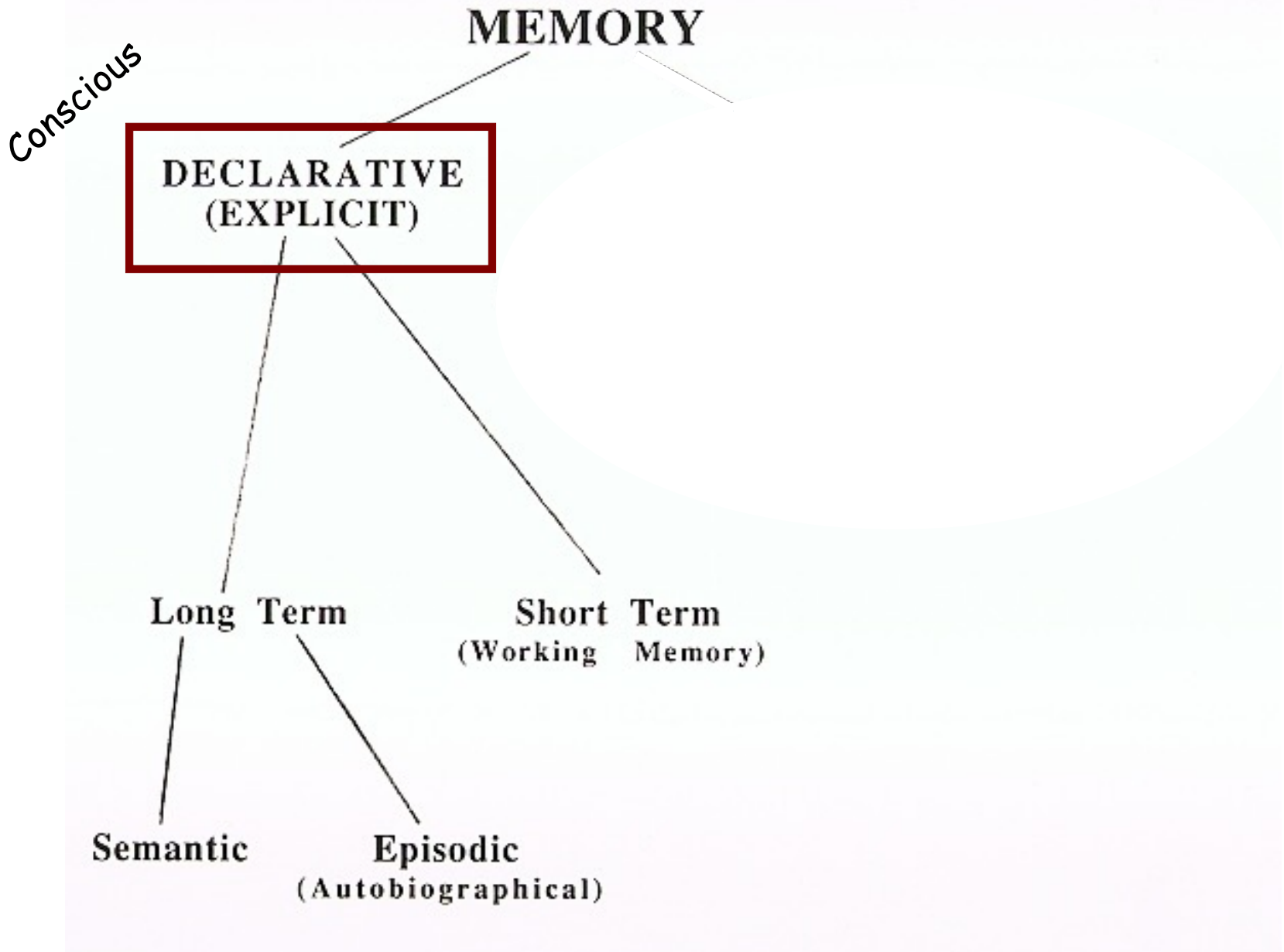
Both of these growth processes are diminished by stress



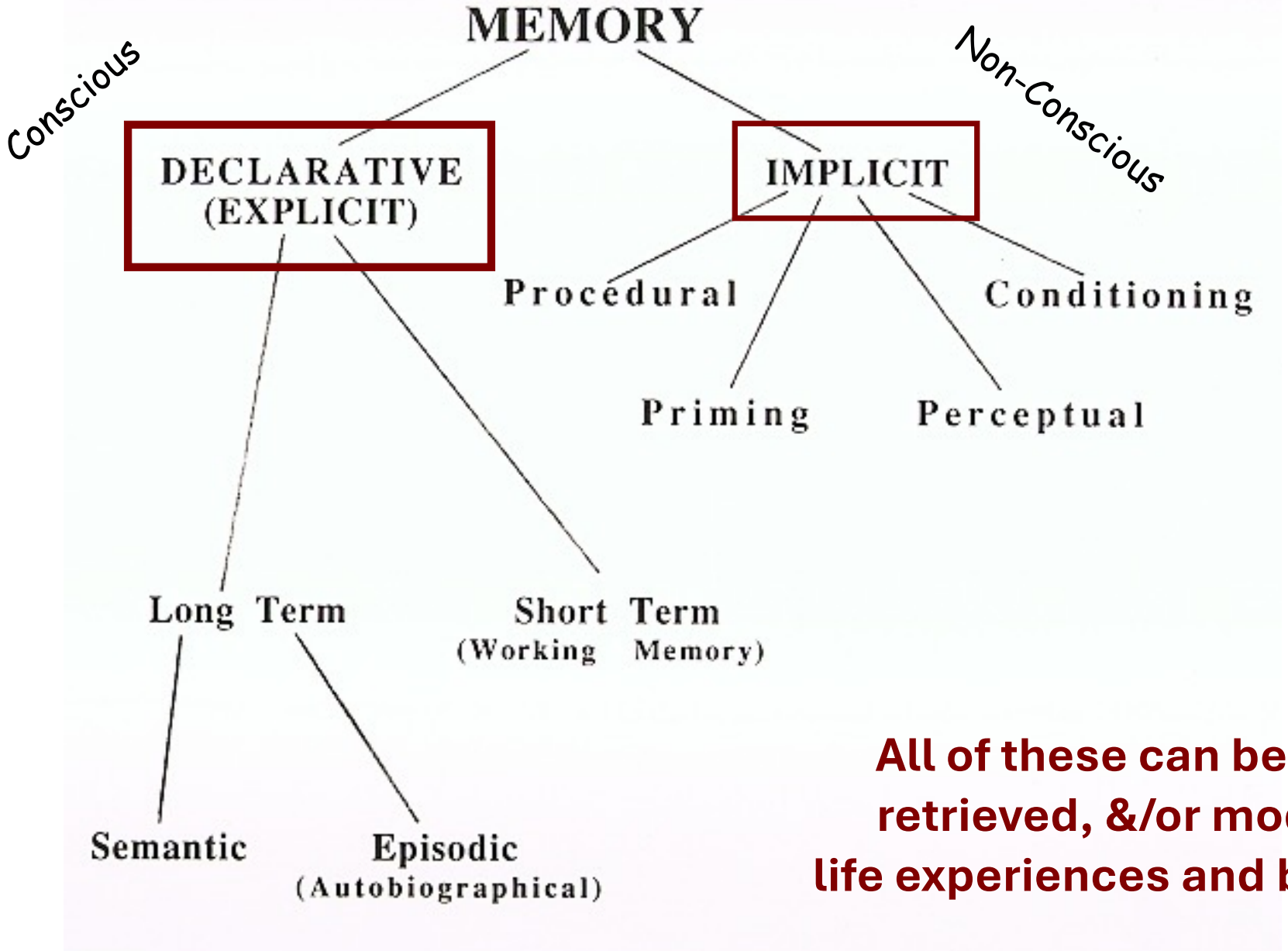
The brain includes many different modules with different circuit architectures, different types of neuroplasticity, and different forms of “memories”.

Helpful to think of the brain (and mind) as ***an ecosystem***.

Biologically Distinct Forms of Memory & Learning

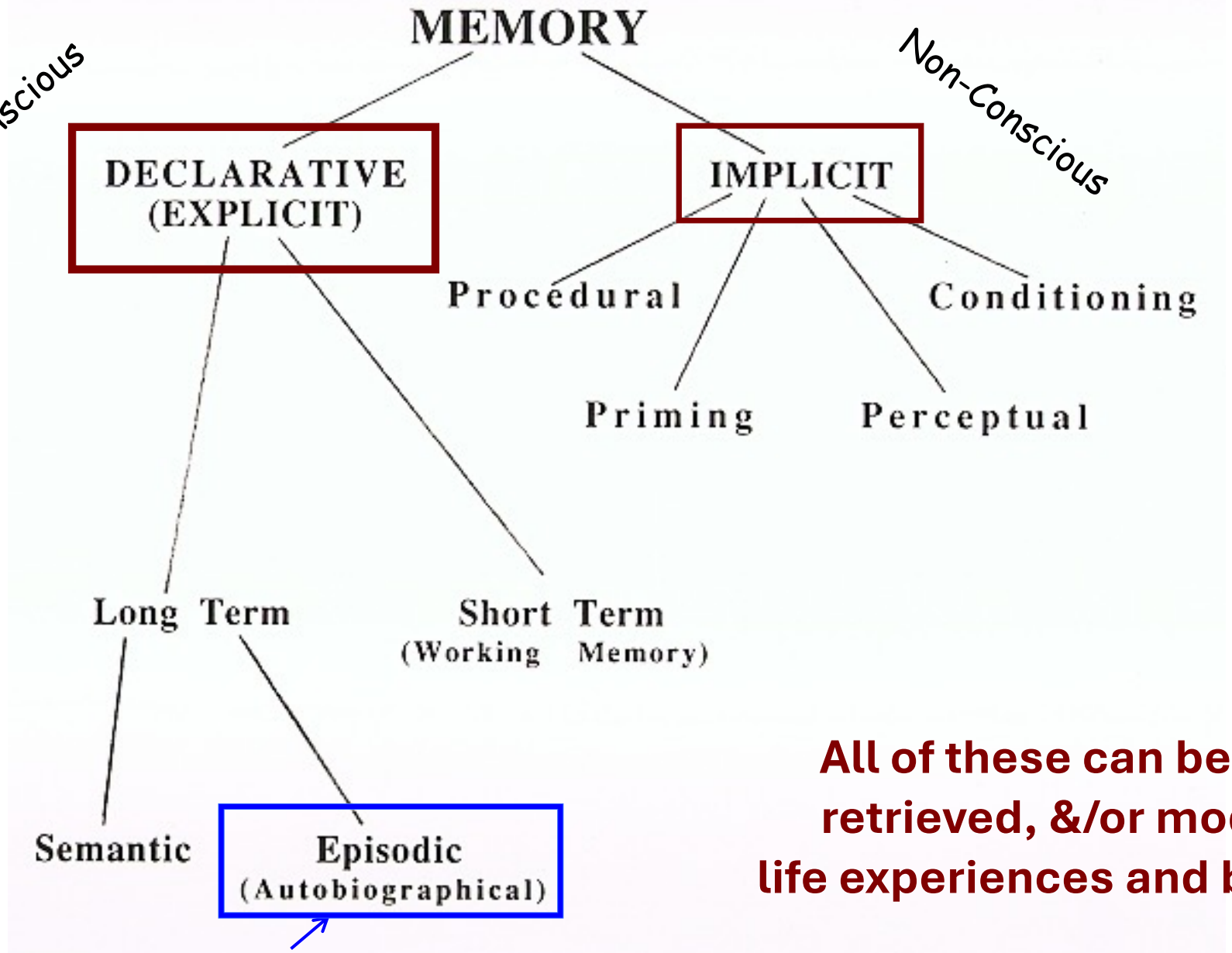


Biologically Distinct Forms of Memory & Learning



All of these can be formed, retrieved, &/or modified by life experiences and by practice.

Biologically Distinct Forms of Memory & Learning



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Episodic (Autobiographical) Memory

Memory for specific episodes of experience

For example:

What did you eat for breakfast today?

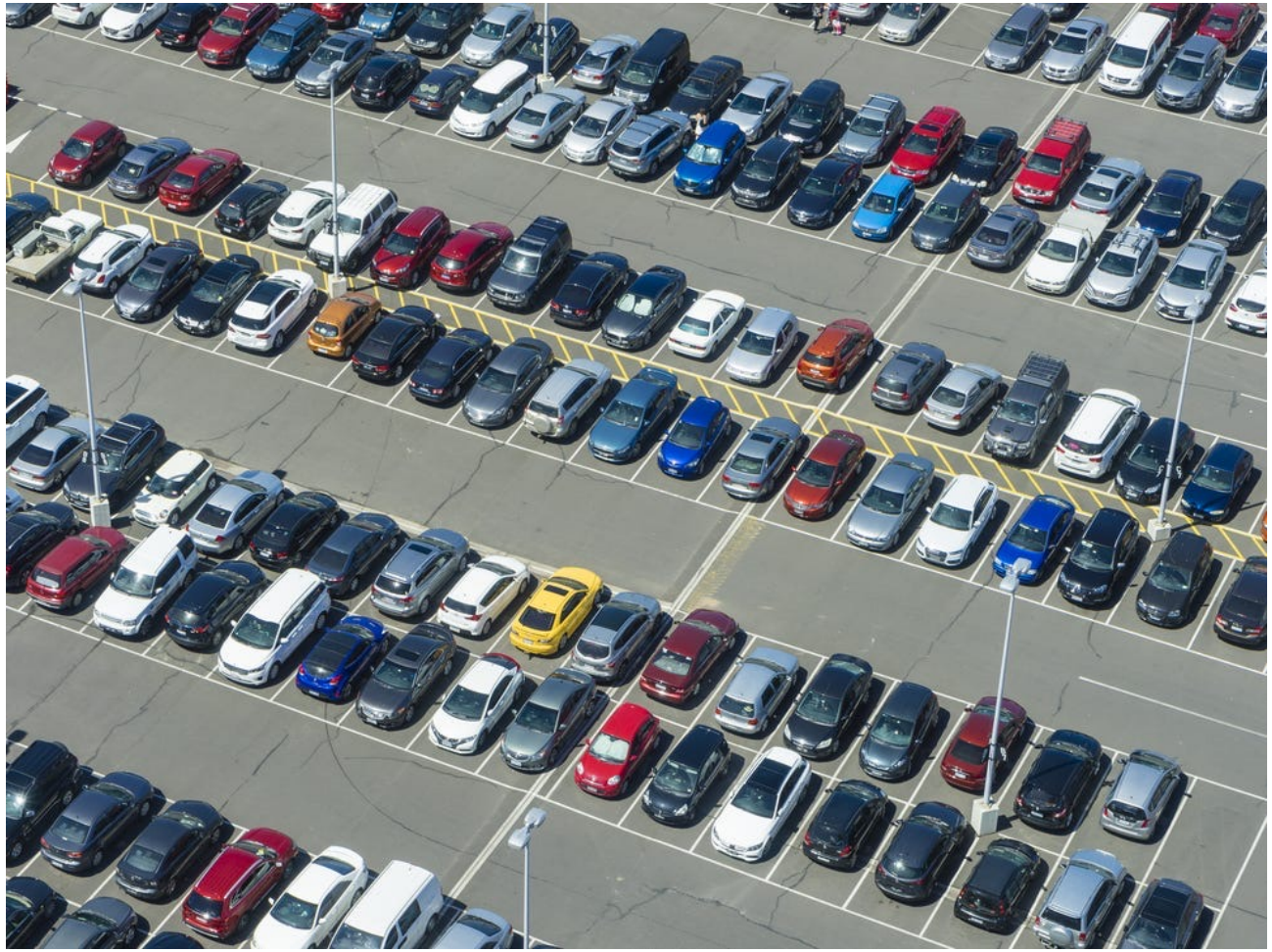
Where was your favorite vacation in the last 10 years?

Episodic memories are *"**situated**"* in an autobiographical context (including specific info about who, where, when, feeling tone, etc).

This differs from semantic memories.

Episodic Memories

Some are relatively short-lived and quickly forgotten



Like where you park your car each morning

We prioritize memories that are useful and meaningful to us

Flashbulb Memories

September 11, 2001

Some memories seem unusually clear

Like for September 11, 2001

One year later (Sept. 2002), 97% of Americans said they remembered “exactly” where they were and what they were doing the moment they heard about the attacks.

Why this sense of having such a clear memory of the event?

Arousal, Personal Relevance and Frequent Recollection

lead to feelings of “clear memory”

Some memories seem unusually clear

Like for September 11, 2001

One year later (Sept. 2002), 97% of Americans said they remembered “exactly” where they were and what they were doing the moment they heard about the attacks.

In one study, 148 undergrads recalled their experiences both **one week** and **again one year** after the attacks.

Memory clarity ≠ memory accuracy

Like for September 11, 2001

One year later (Sept. 2002), 97% of Americans said they remembered “exactly” where they were and what they were doing the moment they heard about the attacks.

In one study, 148 undergrads recalled their experiences both **one week** and **again one year** after the attacks.

Descriptions one year later agreed **only ~63%** with descriptions given 7 days after the attacks.

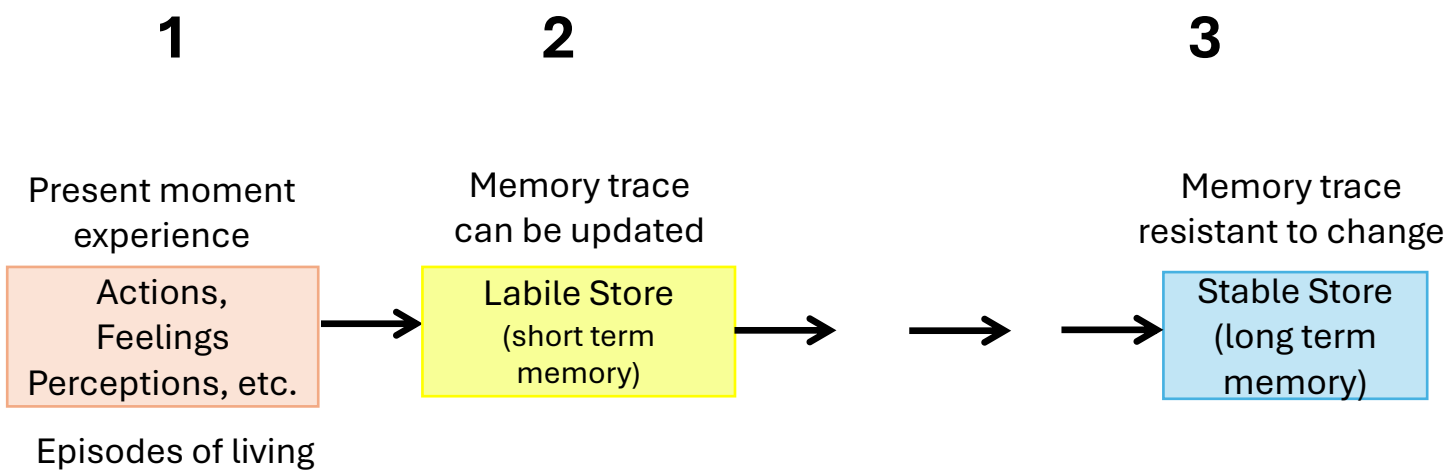
How do memories change over time and become **less accurate** than we believe them to be?

The answer lies in how memories are formed and reformed over time.

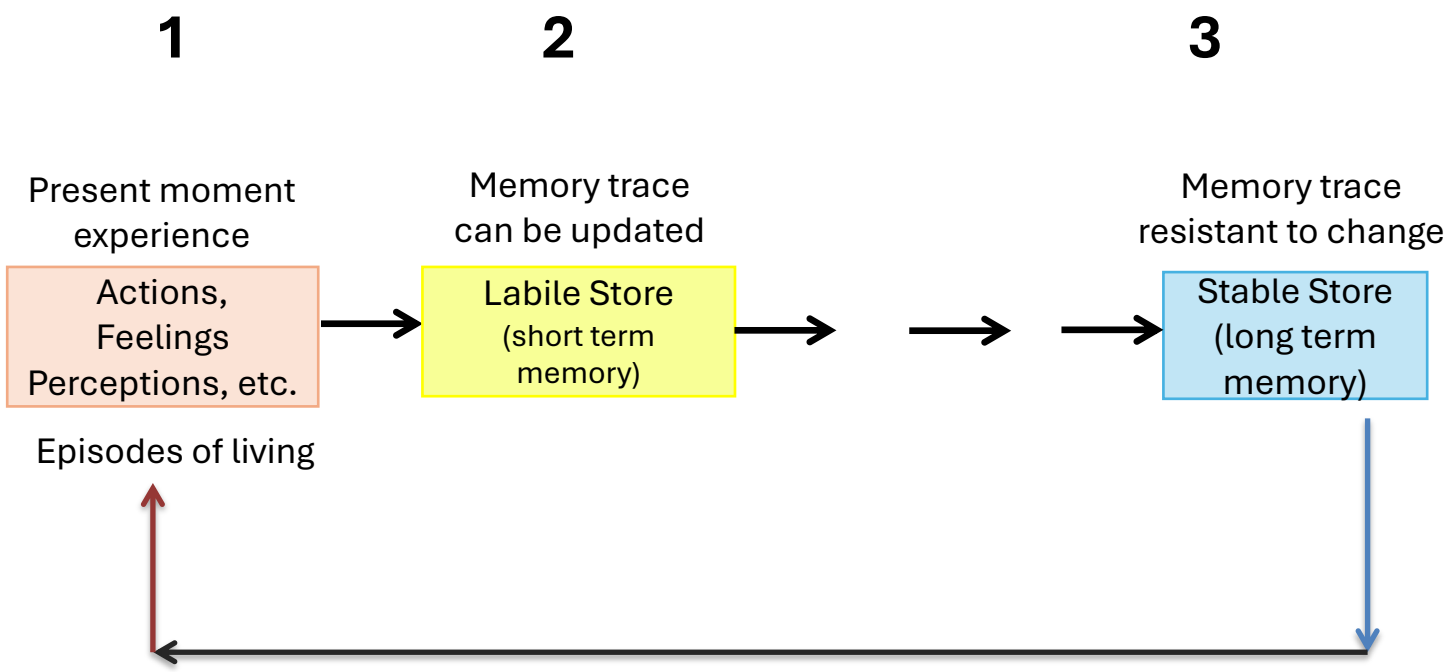
Three phases of episodic memory

1. "***Present moment***" experience.
2. A ***labile store***, where they can be updated, modified, clarified & consolidated.
3. A ***stable store***, where they can persist largely unchanged for long periods.

Three phases of episodic memory



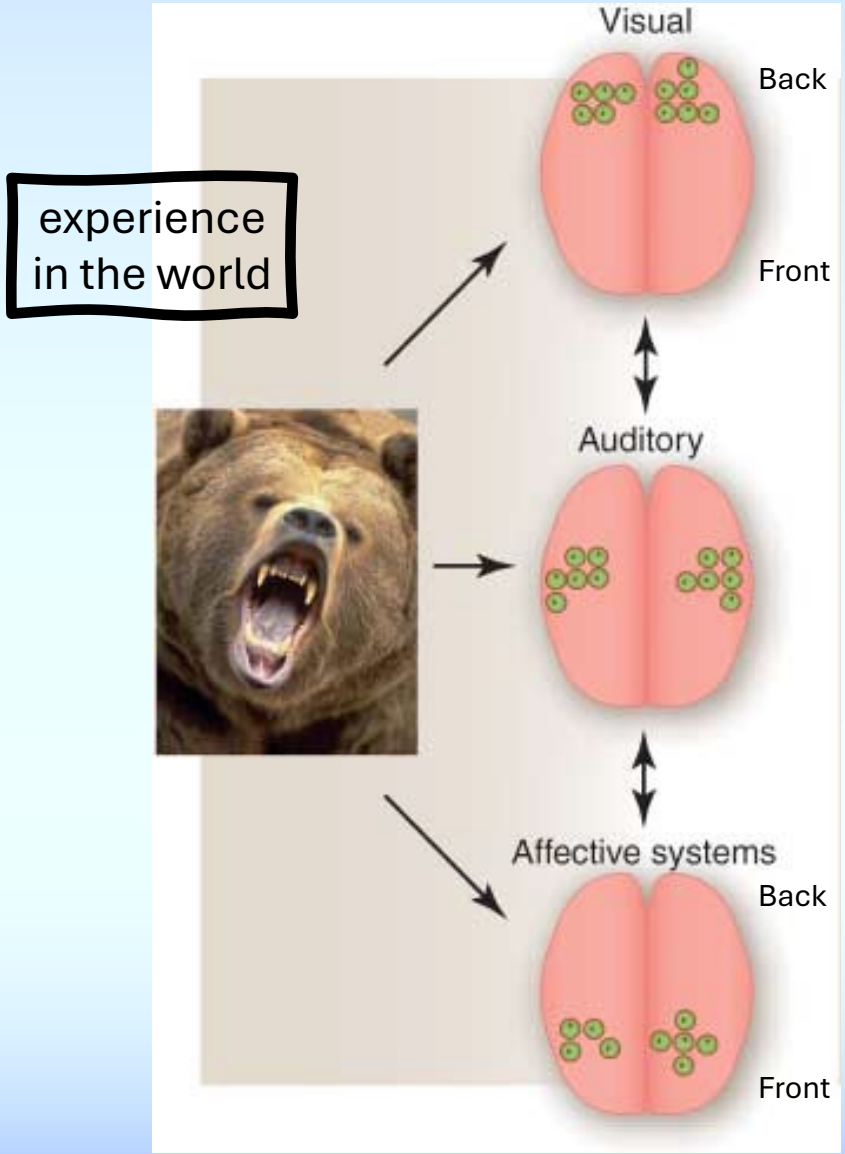
Three phases of episodic memory



When a stable memory is **reactivated**, it becomes part of **present moment** experience and re-enters the **labile phase again**

Example:
A boy sees a bear in the woods

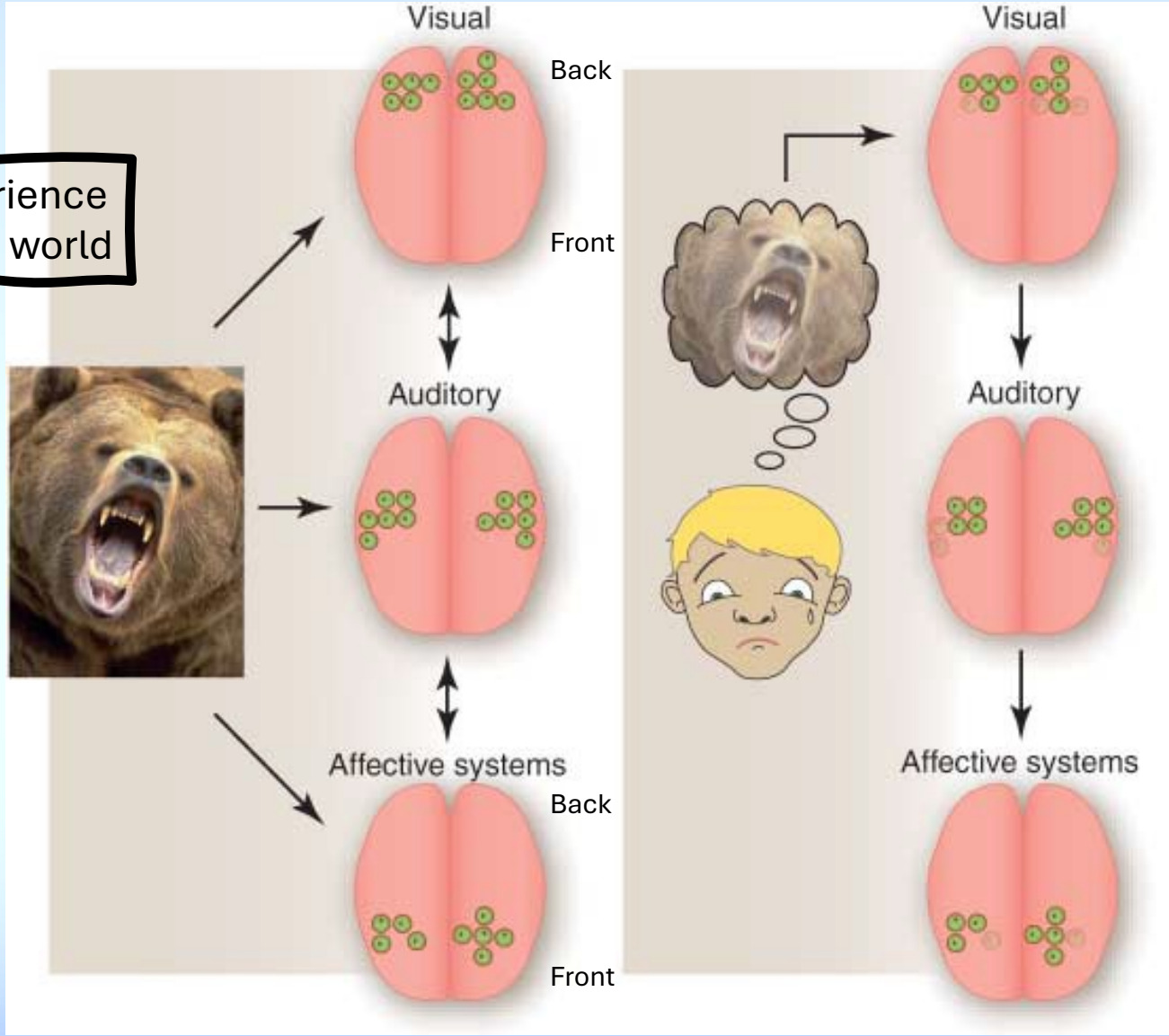
The "experience" is represented as a **pattern of activated cortical modules**.



Example:

A boy sees a bear in the woods

He can remember it later by reactivating a similar pattern of cortical modules



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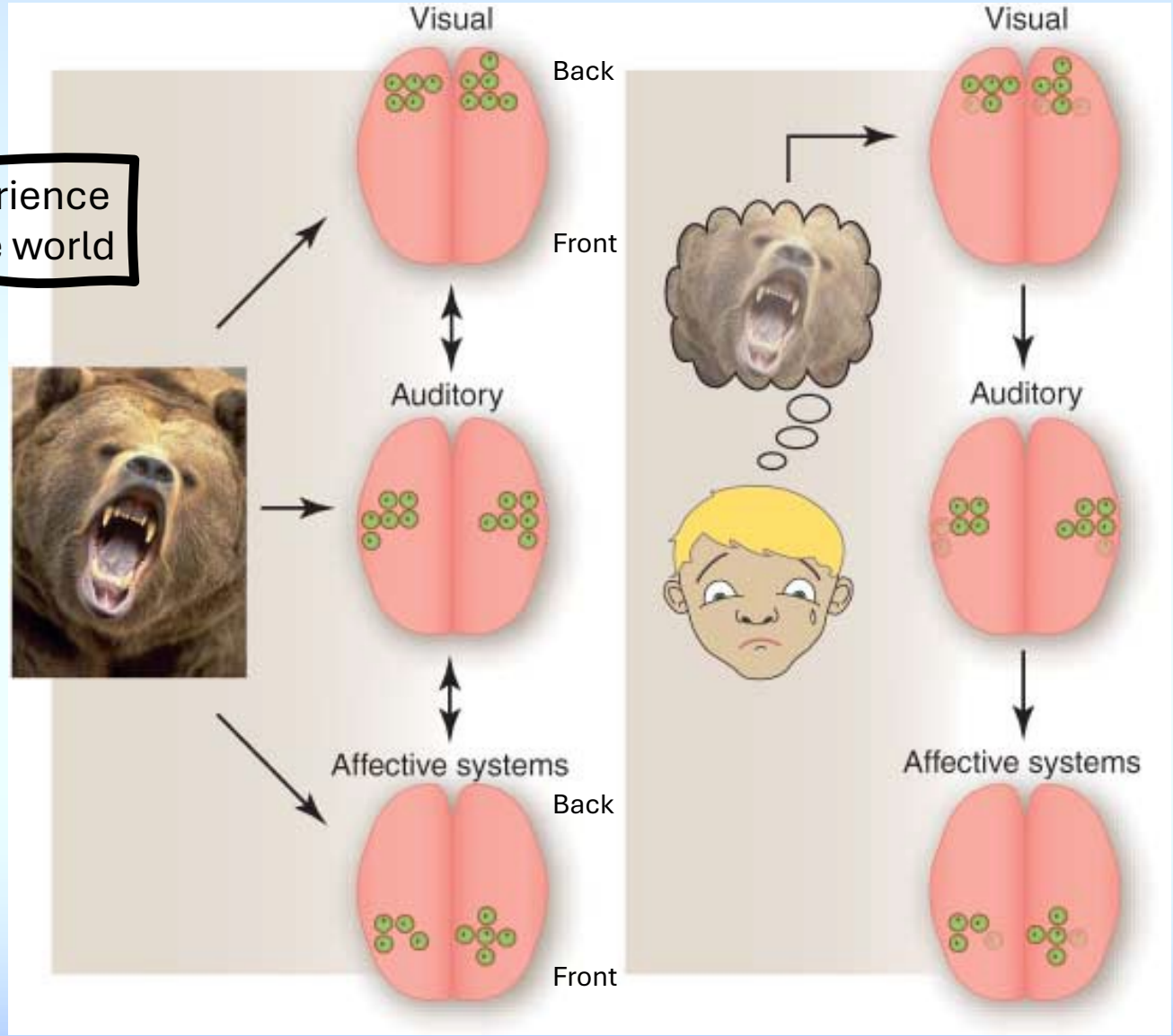

How does the brain generate a similar pattern from memory?

Example:
A boy sees a bear in the woods

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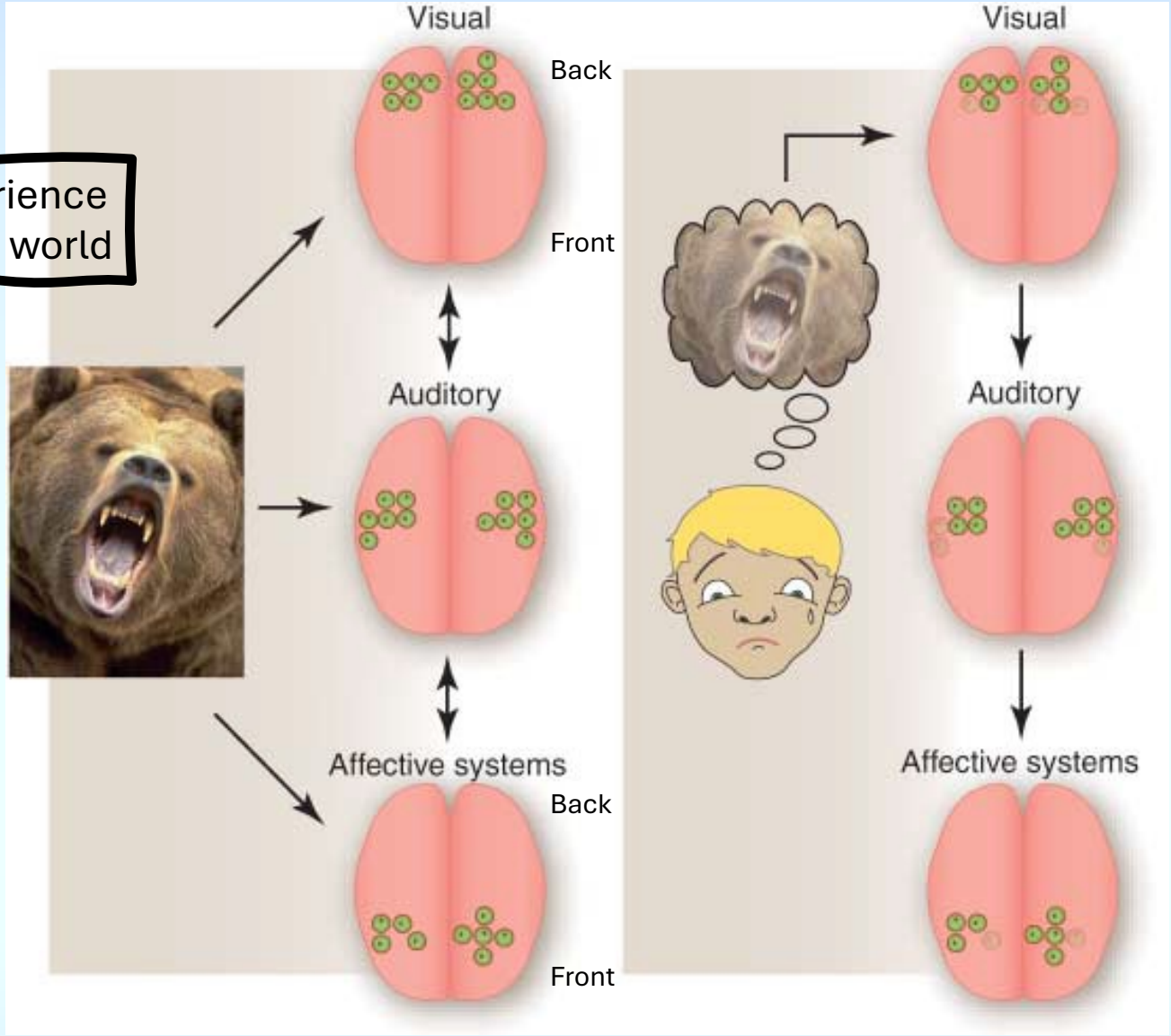

Fresh memory:
the hippocampus triggers a similar pattern of cortical activation

Hippocampus (HC) has essential role in encoding **NEW** memories for episodes of experience.

Hippocampus = HC

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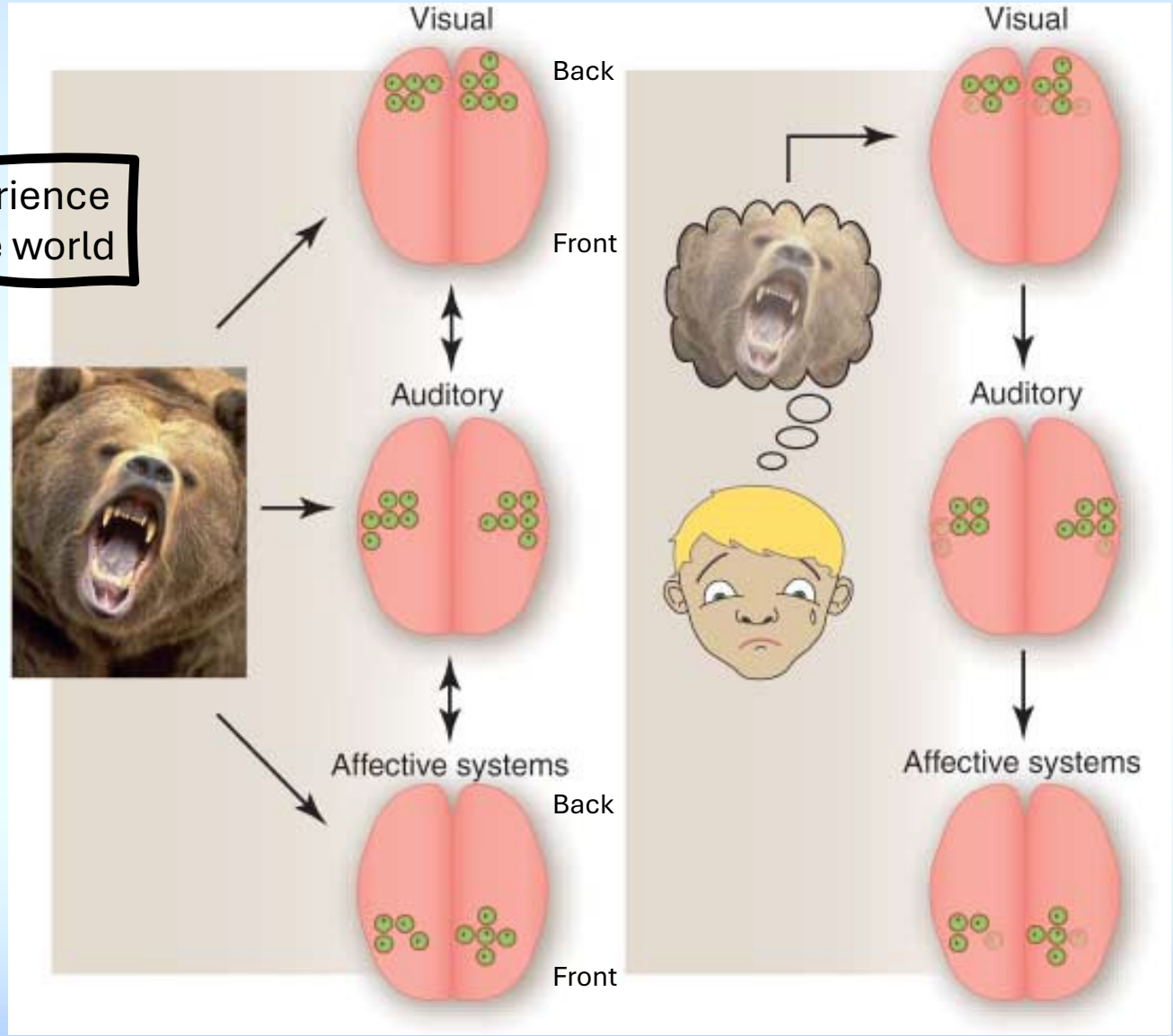
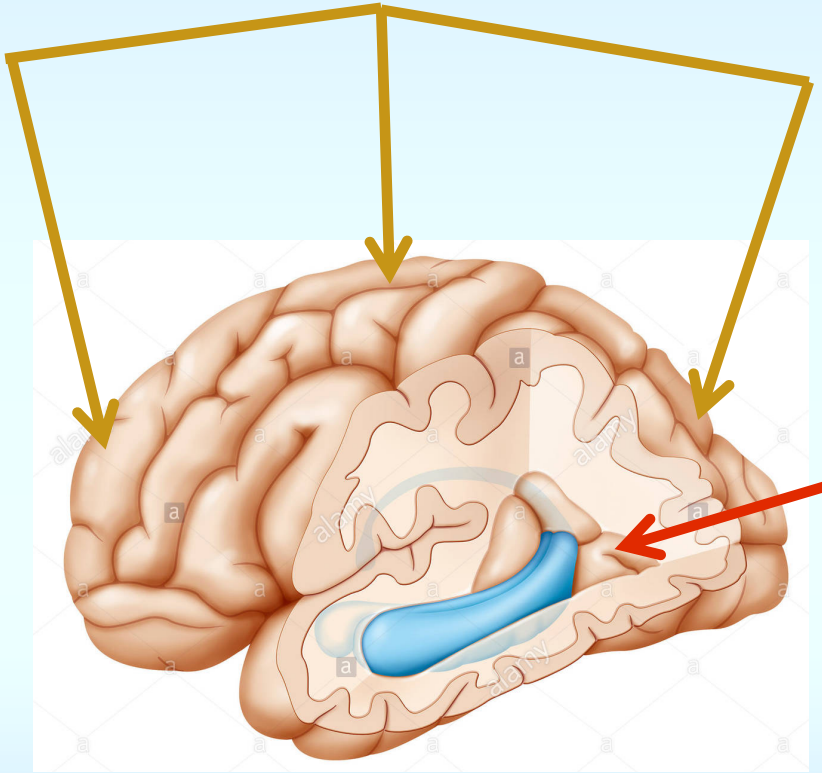


Old memory:
The pattern of activations is built-in to the cortex itself

Cortex encodes older memories



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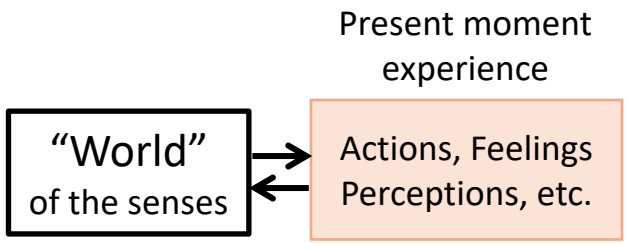
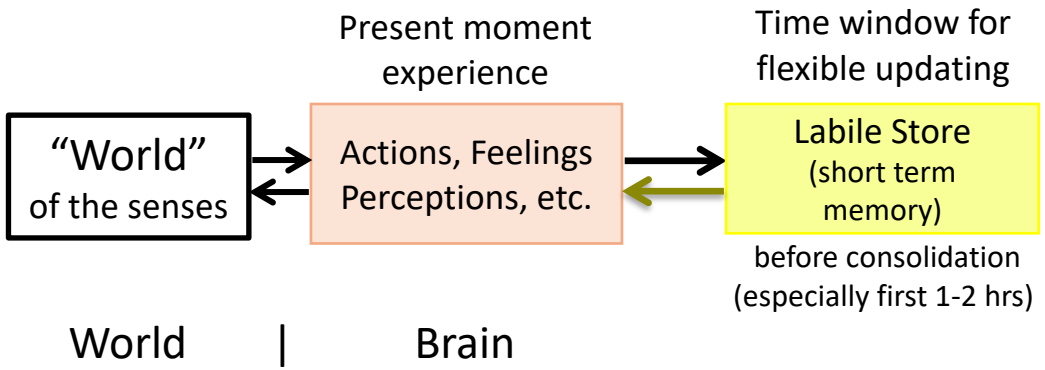
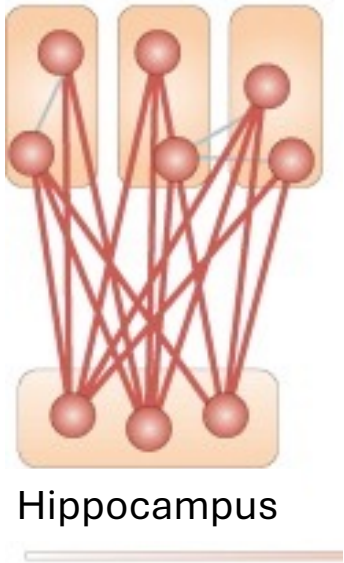


World | Brain

Ongoing experience corresponds to patterns of brain activation.

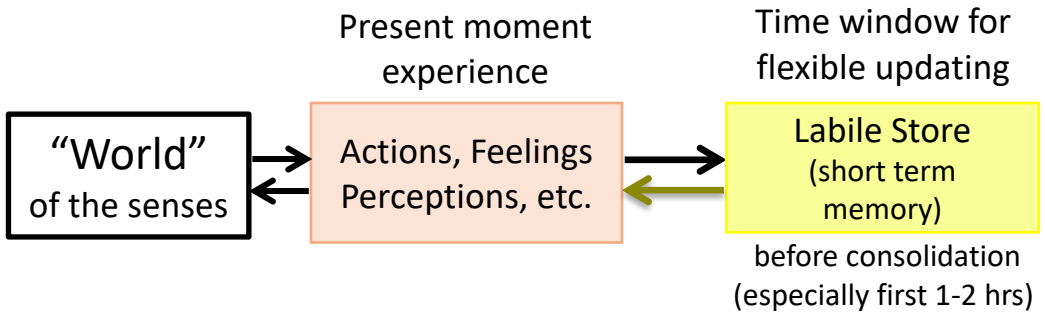
A model of episodic memory formation and modification



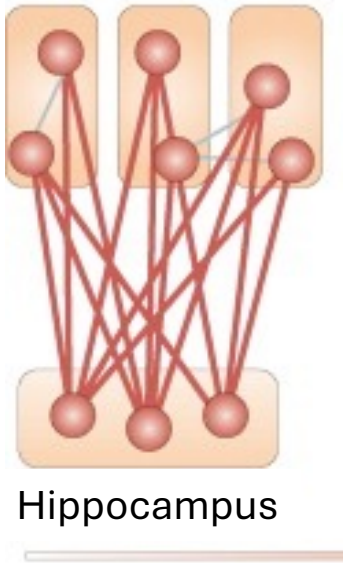


A model of episodic memory formation and modification

Episodic memories **start out as labile** and gradually stabilize through several steps that emphasize the "meaning" of an experience.



This is the "what just happened"phase for an unusual experience.



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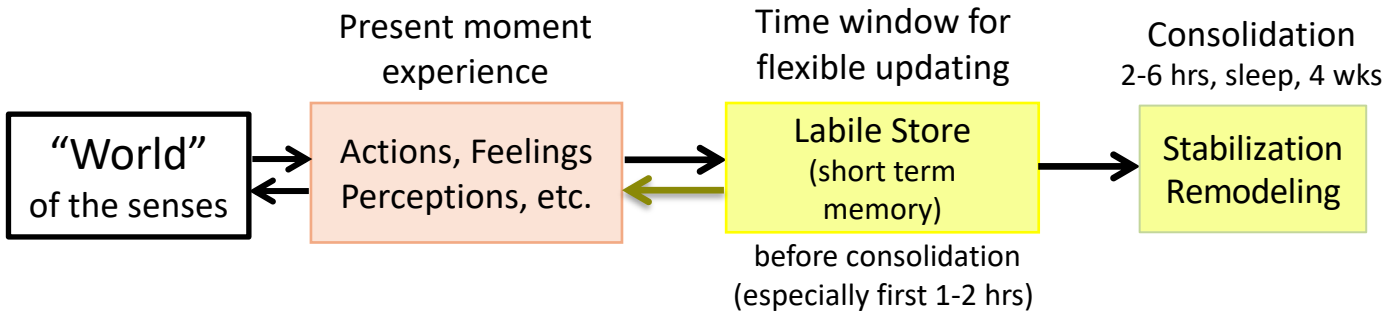

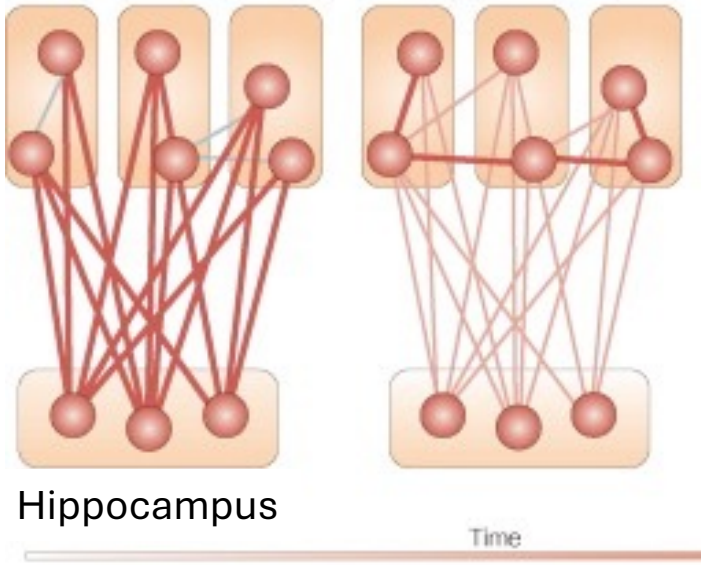

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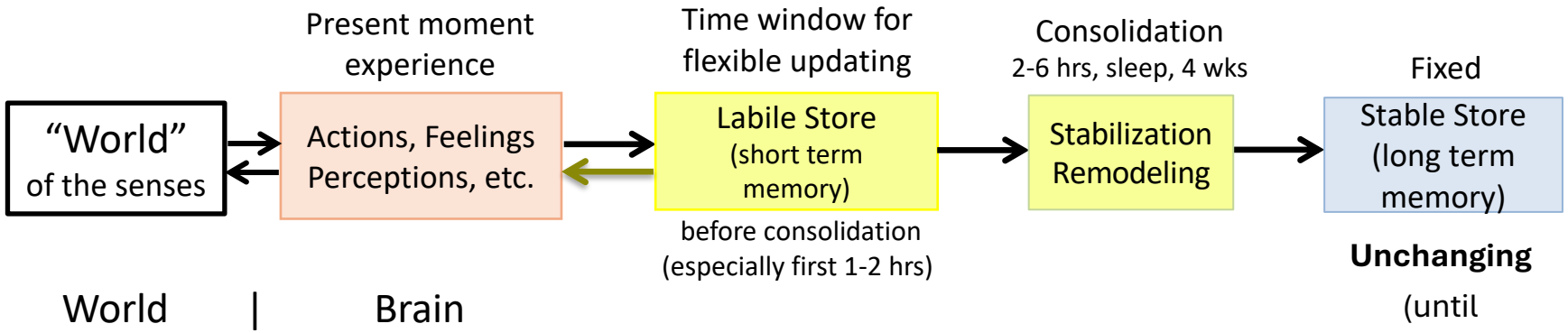
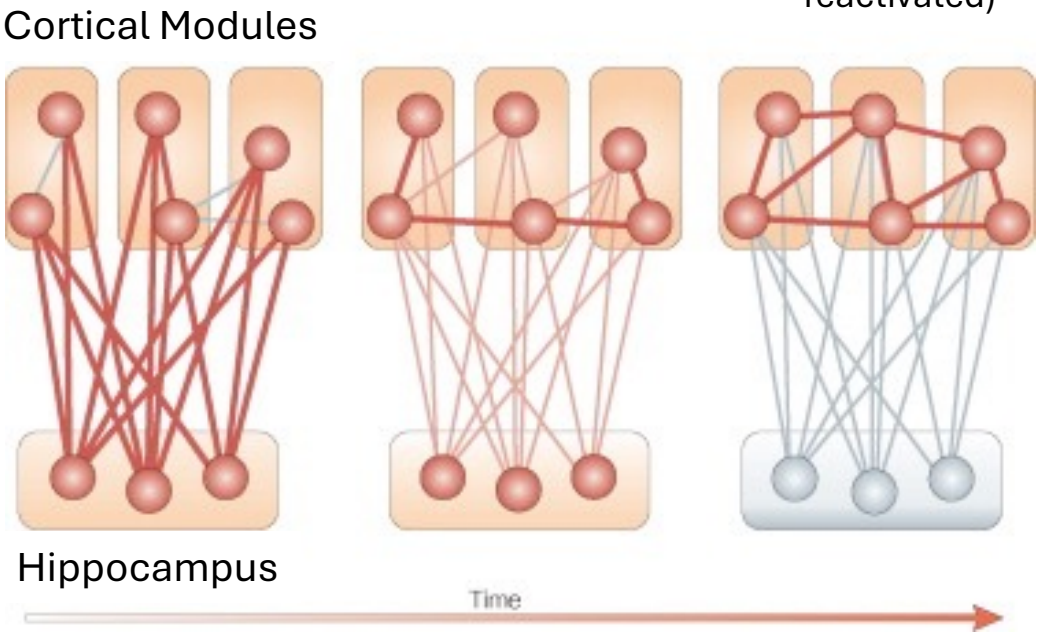




A model of episodic memory formation and modification

Episodic memories **start out as labile** and gradually stabilize through several steps that emphasize the "meaning" of an experience.
After about 4 weeks, memories assume a **fixed form** in long term memory.

Consolidation of new memories in the cortex is organized thematically ***in relationship to existing memories*** already stored in the cortex.

This is one reason for the bias toward “meaning” or “gist” in episodic memory.

Episodic Memory for a word list

“Please listen to this list of 15 words”

15 seconds after the last word is read,

“please write down all the words you can recall”

Words for the memory test

bed	nap	snore
rest	snooze	wake
awake	blanket	peace
tired	doze	yawn
dream	slumber	drowsy

Perform mental arithmetic for about 15 seconds...

Then write down all the words you can remember.

Words for the memory test

bed	nap	snore
rest	snooze	wake
awake	blanket	peace
tired	doze	yawn
dream	slumber	drowsy

About 50% of people “remember” hearing the word

“SLEEP”

even though it was NOT on the list

The word “sleep” is suggested by

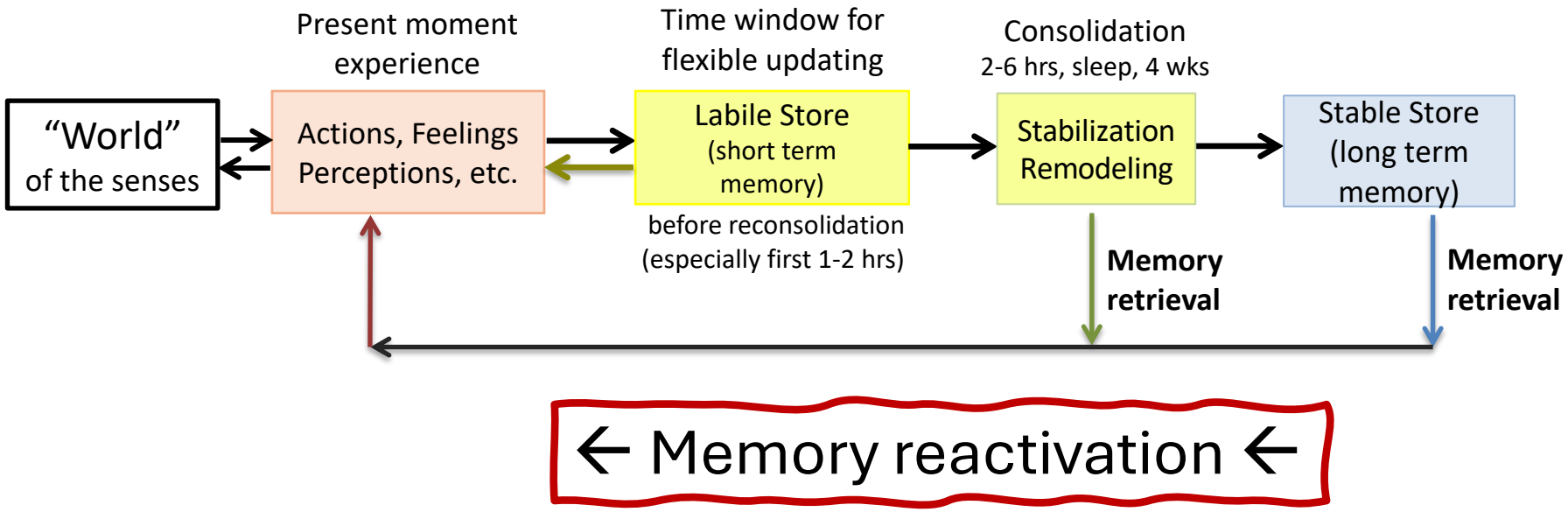
the “gist” or “meaning” of the word list.

Episodic memory *prioritizes the meaning* of an episode

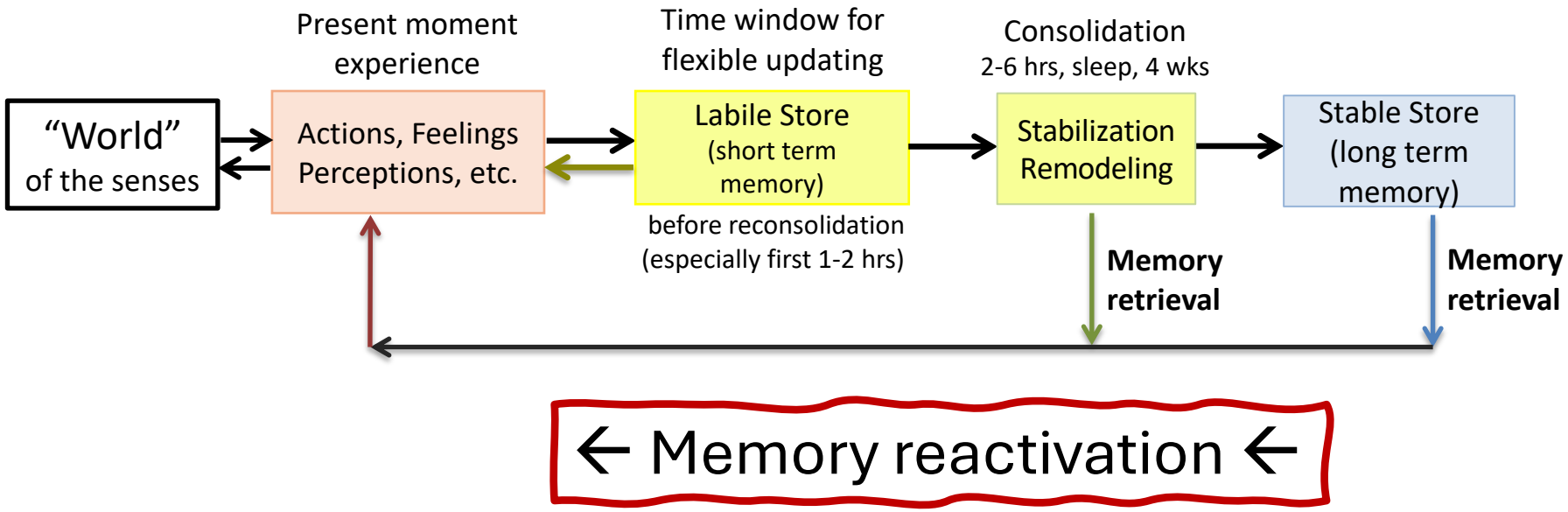
Episodic Memory

(and other forms of memory)

- Its evolved purpose is to ***meaningfully guide behavior***, NOT to accurately record the past.
- Changing the ***meaning*** changes the memory and changes how it influences behavior.



When a memory is "reactivated," it becomes part of a new present experience.
It becomes labile again and **will be consolidated again**.



When a memory is "reactivated," it becomes part of a new present experience. It becomes labile again and will be consolidated again.

If the ***meaning changes*** (e.g. due to mindfulness), the modified memory will partly or completely replace the old one.

This can only happen when the memory has been reactivated

This seems to happen for all types of memories, including the "inclinations of the mind."

AN 10.206 The Deed-Born Body

"Bhikkhus, I do not say that there is a termination of volitional kamma that have been done and accumulated so long as one has not experienced [their results]....”

Mindfulness of Mind

Sayadaw U Tejaniya's teachings emphasize the 3rd Foundation of Mindfulness

Satipatthana Sutta

(aka "The four foundations of mindfulness")

"He abides contemplating the body in the body (or feelings, or **mind states**, or dharmas)*,*

diligent, clearly knowing, and mindful,

***fit to be trained regarding longing and distress for the world**."*

Mindfulness of Mind

Relax

Mindfulness of Mind

Relax

Are you aware?

Mindfulness of Mind

Relax

Are you aware?

What is the primary object of awareness now?

Mindfulness of Mind

Relax

Are you aware?

What is the primary object of awareness now?

→ What is the attitude of the mind toward the object?

Mindfulness of Mind

Relax

Are you aware?

What is the primary object of awareness now?

→ What is the attitude of the mind toward the object?

Repeat

Mindfulness of Mind

Relax

Are you aware?

What is the primary object of awareness now?

→ What is the attitude of the mind toward the object?

Repeat

“Don’t look down on the defilements”

Observe whatever the mind is doing with respect.

AN 10.217 Volitional Sutta transl. B. Bodhi

"Bhikkhus, … I do not say that there is making an end of suffering **so long as one has not experienced the results** of volitional kamma that has been done and accumulated”

Meta-analysis, Fox et al. 2014

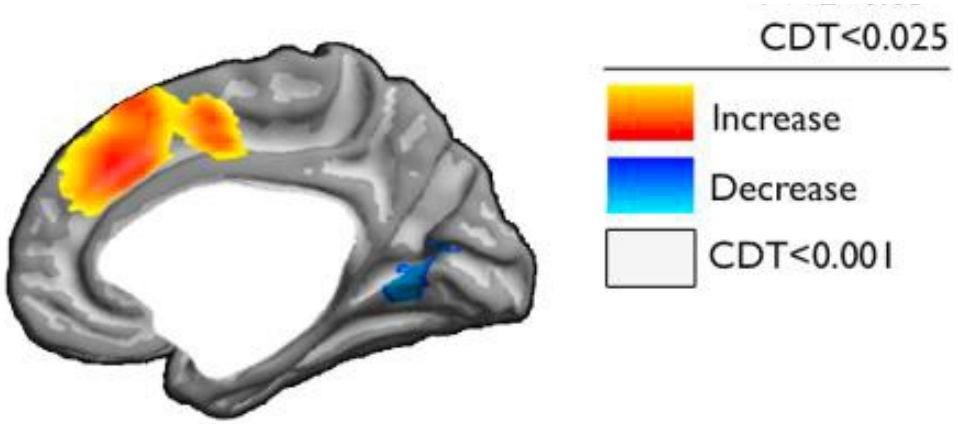
Area 24

Areas of increased brain gray matter associated with meditation practice

Area 24 (dorsal Anterior Cingulate Cortex)

Meta-analysis, Fox et al. 2014

Area 24



Valk et al. 2016, superb study design

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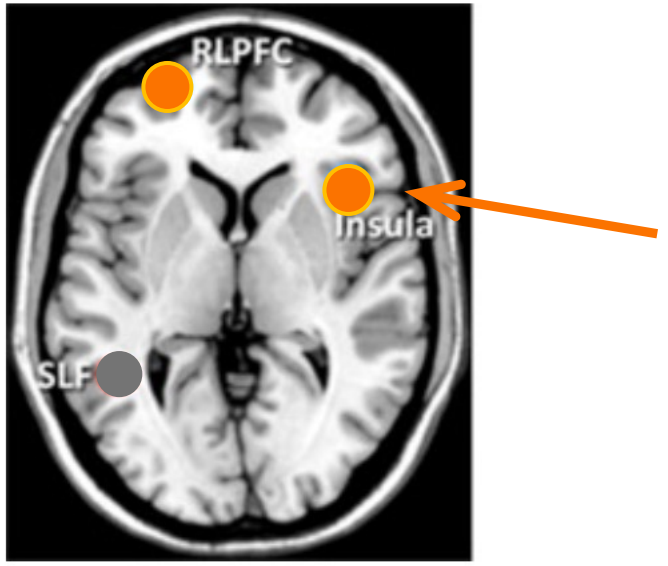


Meta-analyses, Fox et al. 2014

Right Insula also larger in Valk et al. study

Area 13

Areas of increased brain gray matter associated with meditation practice

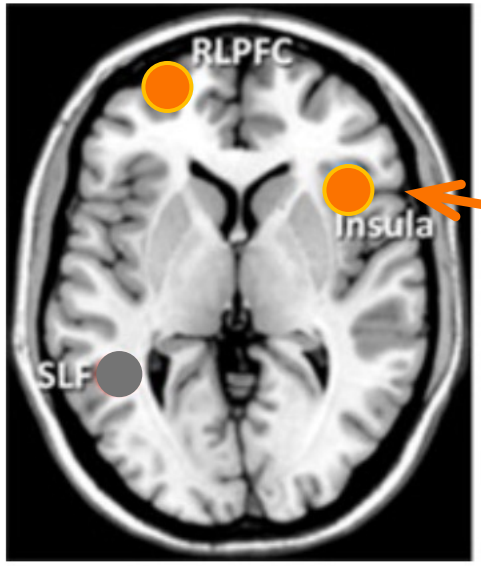
Area 24 (dorsal Anterior Cingulate Cortex)

and Area 13 (right Anterior Insula)

Area 24

Meta-analysis, Fox et al. 2014

What are the functions of these two areas that grow larger with meditation practice?



Area 13

Meta-analyses, Fox et al. 2014
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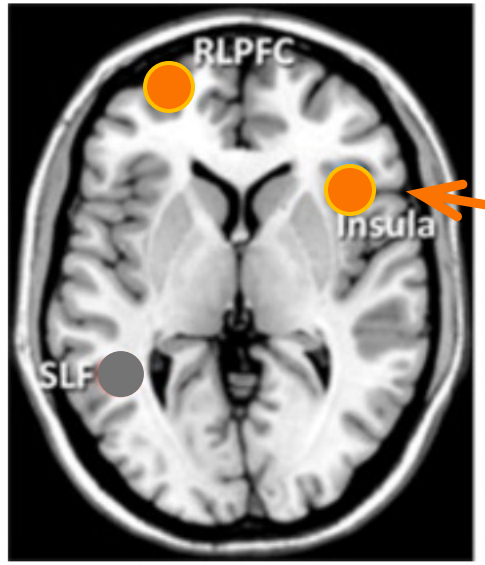
Area 24, Anterior Cingulate Cortex – many functions, including "suggesting" shifts in the focus of awareness based on current priorities, and focusing the mind for coping with challenging situations.

Area 13, Right Anterior Insula– many functions, including including self awareness, experiencing feelings in the body, and empathizing with the feelings of others

Area 24

Meta-analysis, Fox et al. 2014

Meditation Practice
increases
gray matter
in these two areas



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Meta-analyses, Fox et al. 2014

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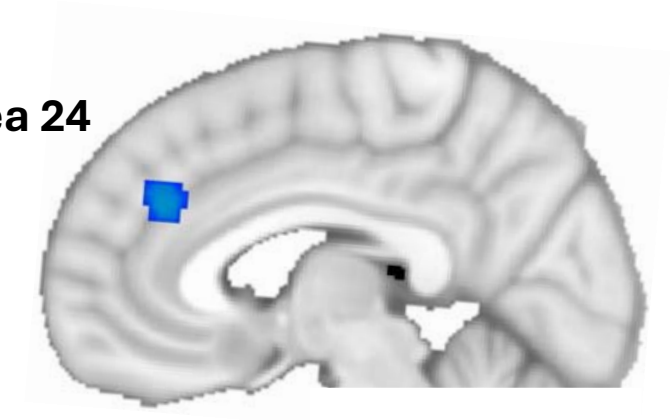
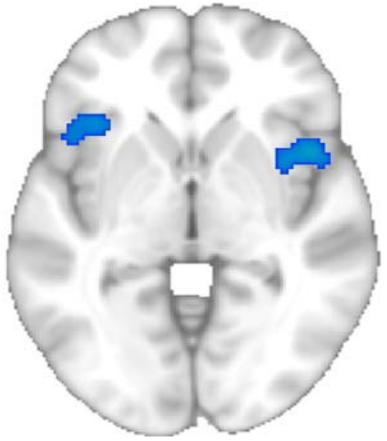


Meta-analysis, Goodkind et al. 2015

Psychiatric Disorders
have decreased
gray matter
in these two areas



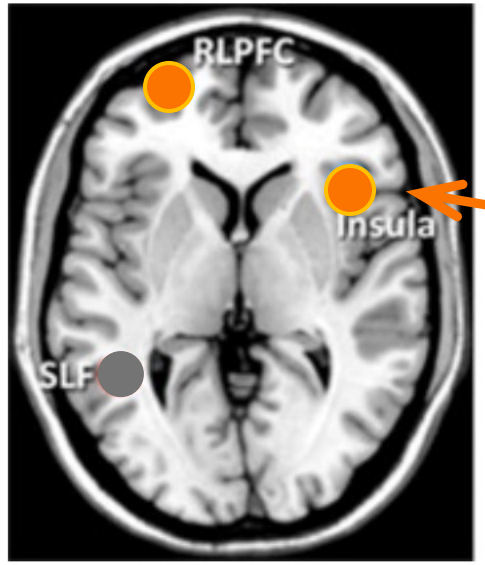
Area 13

Meta-analysis, Goodkind et al. 2015

Area 24

Meta-analysis, Fox et al. 2014

Meditation Practice increases gray matter in these two areas



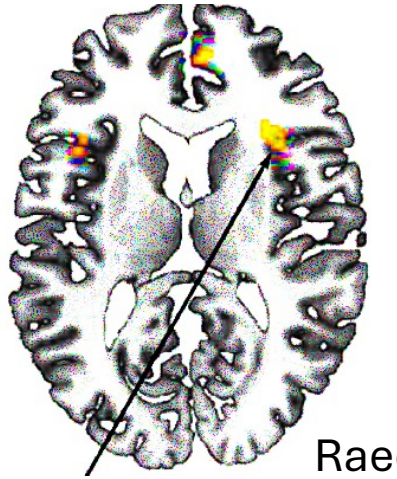
Area 13

Meta-analyses, Fox et al. 2014

Right Insula also larger in Valk et al. study

Raecke et al. 2013 & Meta-analysis, Cauda 2014

Decreased gray matter in similar areas in Chronic Pain (Reversible)



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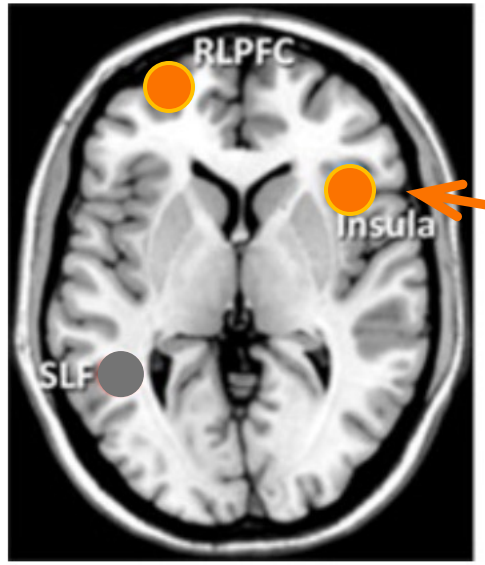

Area 13

Meta-analyses, Fox et al. 2014 & Pernet et al. 2021

Right Insula also larger in Valk et al. study

Mindfulness practice has an effect on the brain that is **the opposite of** how the brain is affected by **stress, pain, and suffering.**

Benefits of Satipatthana-style Mindfulness Practice

MN 10, transl: Sujato

Mendicants, the four kinds of mindfulness meditation
are the path to convergence *(are a direct path)*.

They are in order to **purify sentient beings**,

to **get past sorrow and crying**,

to **make an end of pain (dukkha) and sadness**,

to **discover the system**,

and to **realize extinguishment (nibanna)**.