University of Tartu speaking from 13:00 pm. to 15:00,

Effective Teaching & Learning:
Dramatic New Insights from Neuroscience

A growing body of research insight from neuroscience has revealed many surprises when it comes to teaching. For example, some forms of seemingly "rote" learning can engage students' sophisticated pattern recognition systems, which can be invaluable in making math or language easier to learn, particularly at more advanced levels. And there are further surprises—for example, just because students know how to solve a problem in math or have learned a skill in sports does *not* necessarily mean that they can—*or should*—be able to explain it. In fact, forcing some neurally diverse students to explain their reasoning when they can already demonstrate their understanding can actually kill their motivation for deeper learning.

In this talk, we will explore these and other counterintuitive insights from research that can allow you to make intelligent use of students' differing underlying approaches to learning. We will also explore the intimate connection between retrieval practice in math and the metaphors used in art, music, and poetry.

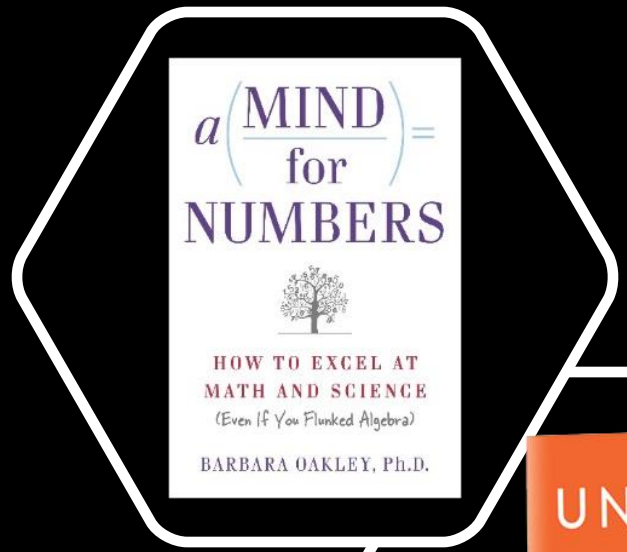
Effective Teaching & Learning: Dramatic New Insights from Neuroscience

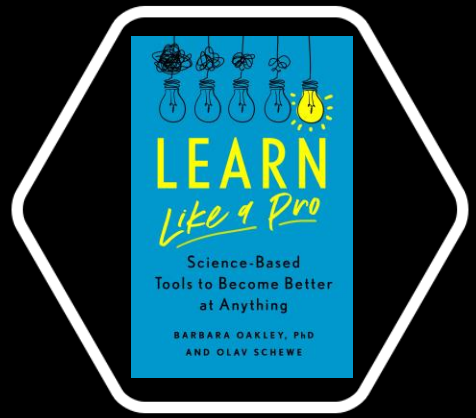
Barbara Oakley, PhD, PE

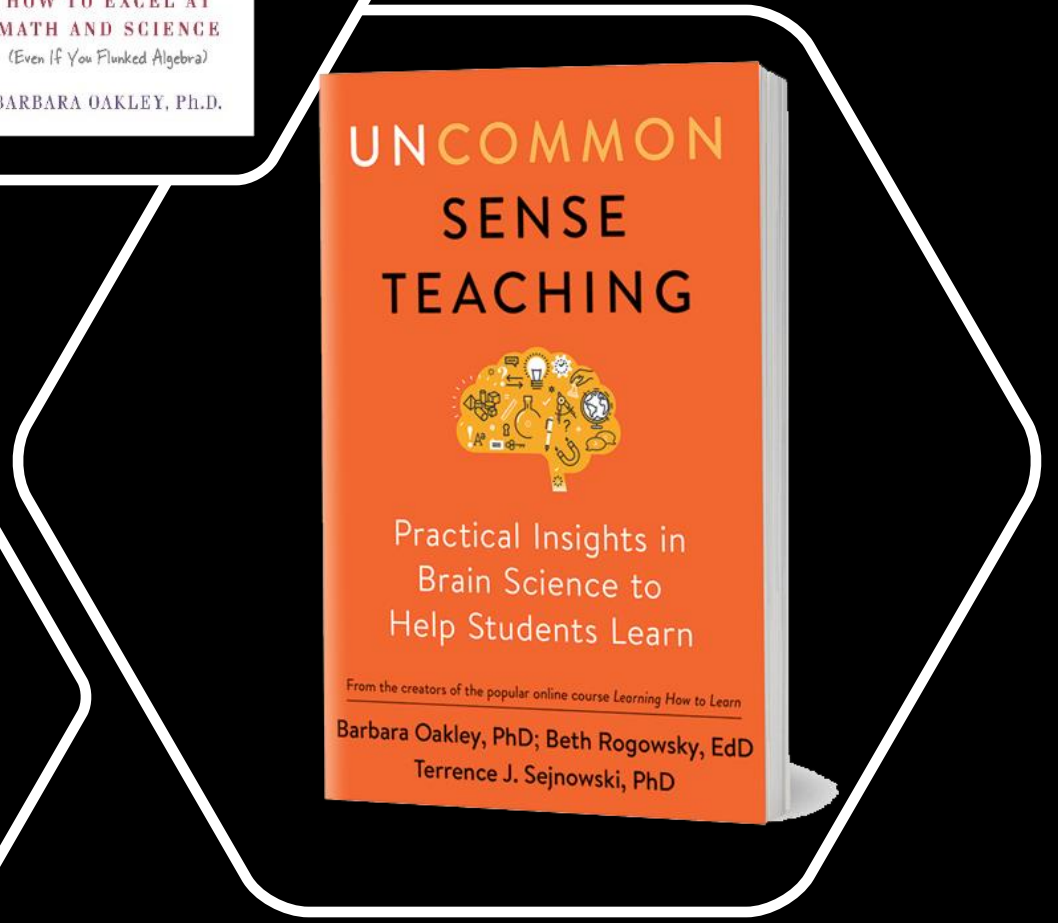
Distinguished Professor of Engineering

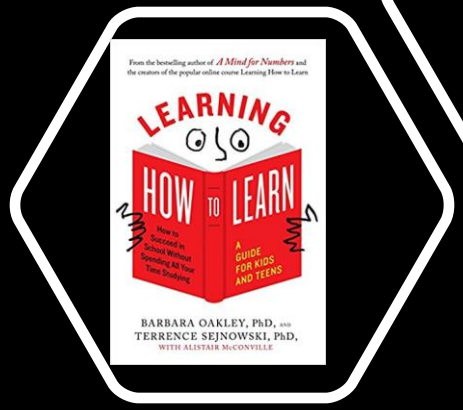
Oakland University

Rochester, Michigan







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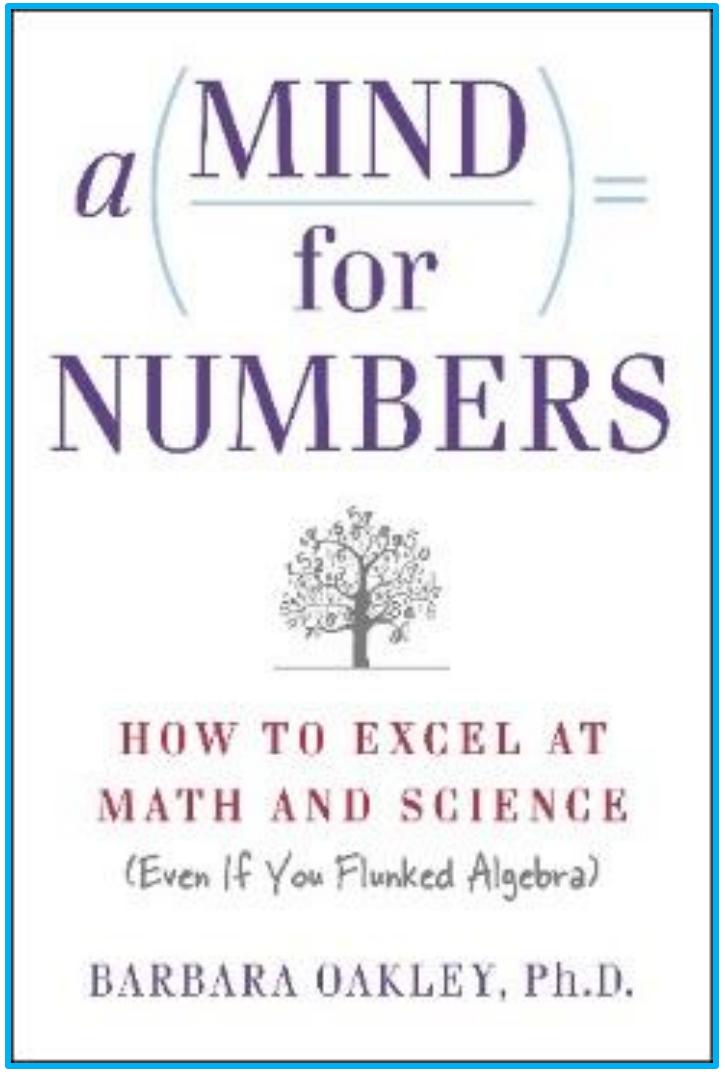
Philip Oakley

Supplemental schooling our two daughters in math from ages 3 to 15.

KUMON

Smartick



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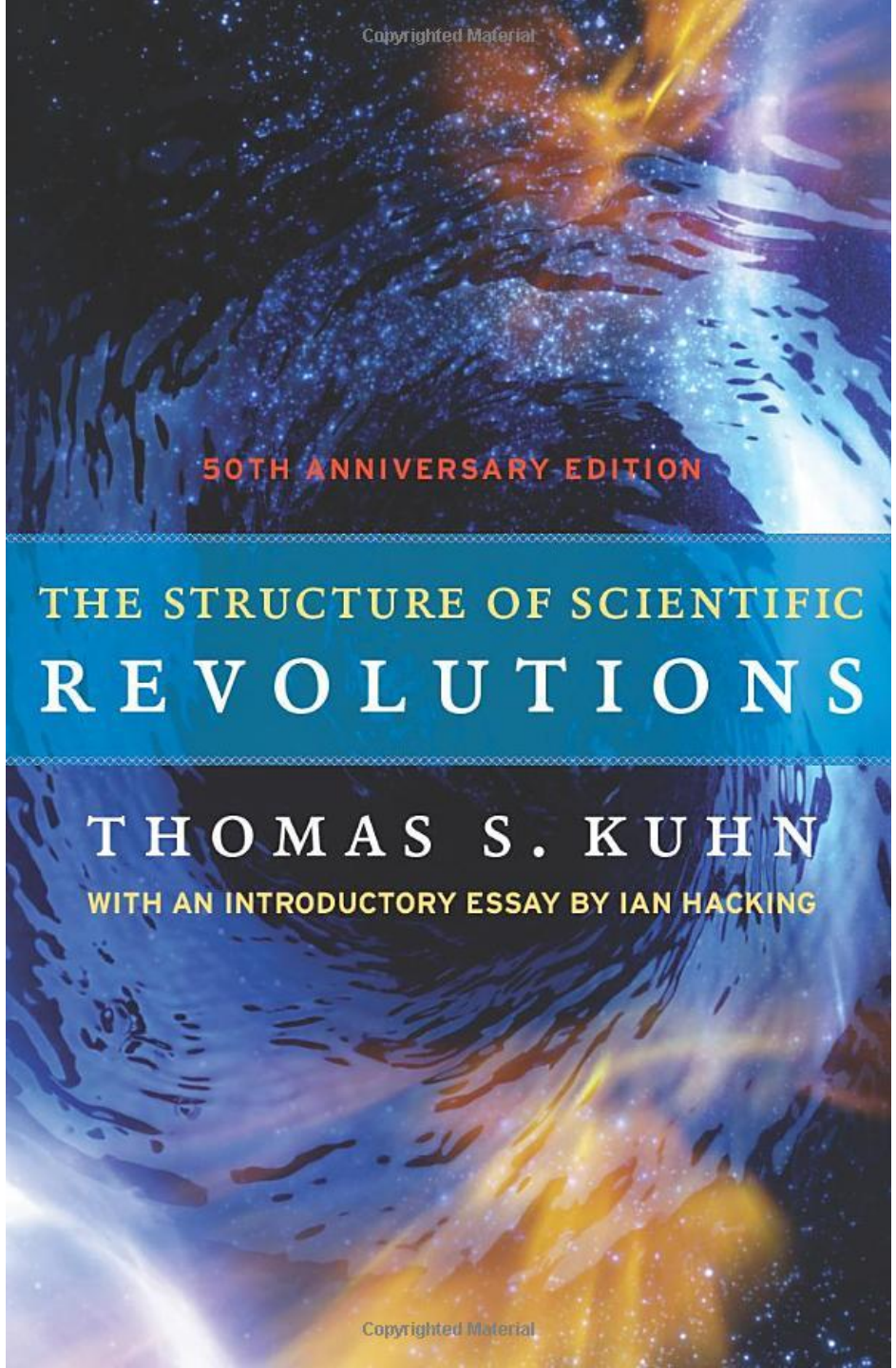
The New York Times

OPINION

Make Your Daughter Practice Math. She'll Thank You Later.

The way we teach math in America hurts all students, but it may be hurting girls the most.

Aug. 7, 2018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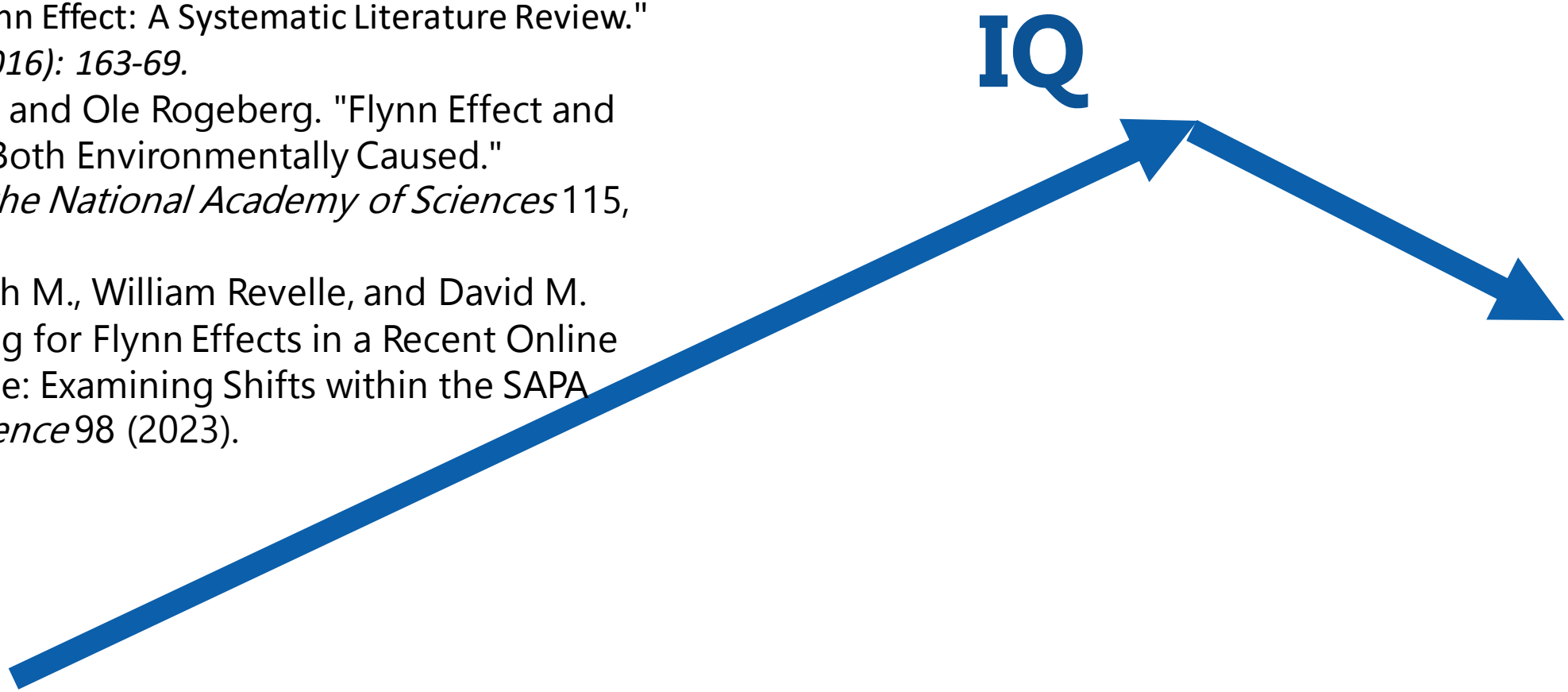
The Flynn Effect

Flynn, James R. "The Mean IQ of Americans: Massive Gains 1932 to 1978." *Psychological Bulletin 95, no. 1 (1984): 29.*

- Dutton, Edward, Dimitri van der Linden, and Richard Lynn. "The Negative Flynn Effect: A Systematic Literature Review." *Intelligence 59 (2016): 163-69.*
- Bratsberg, Bernt, and Ole Rogeberg. "Flynn Effect and Its Reversal Are Both Environmentally Caused." *Proceedings of the National Academy of Sciences* 115, no. 26 (2018):
- Dworak, Elizabeth M., William Revelle, and David M. Condon. "Looking for Flynn Effects in a Recent Online U.S. Adult Sample: Examining Shifts within the SAPA Project." *Intelligence* 98 (2023).



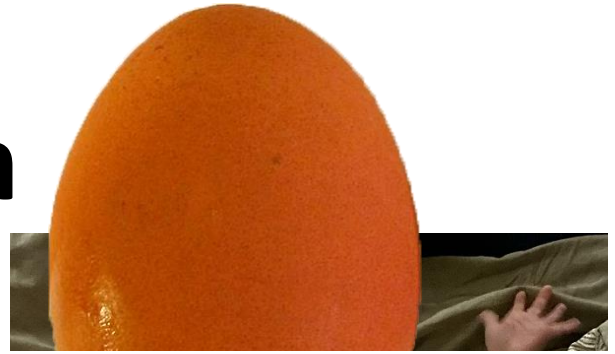
APMreports.

https://features.apmreports.org/sold-a-story/

Sold a Story

How Teaching Kids to Read Went So Wrong

Different types of knowledge

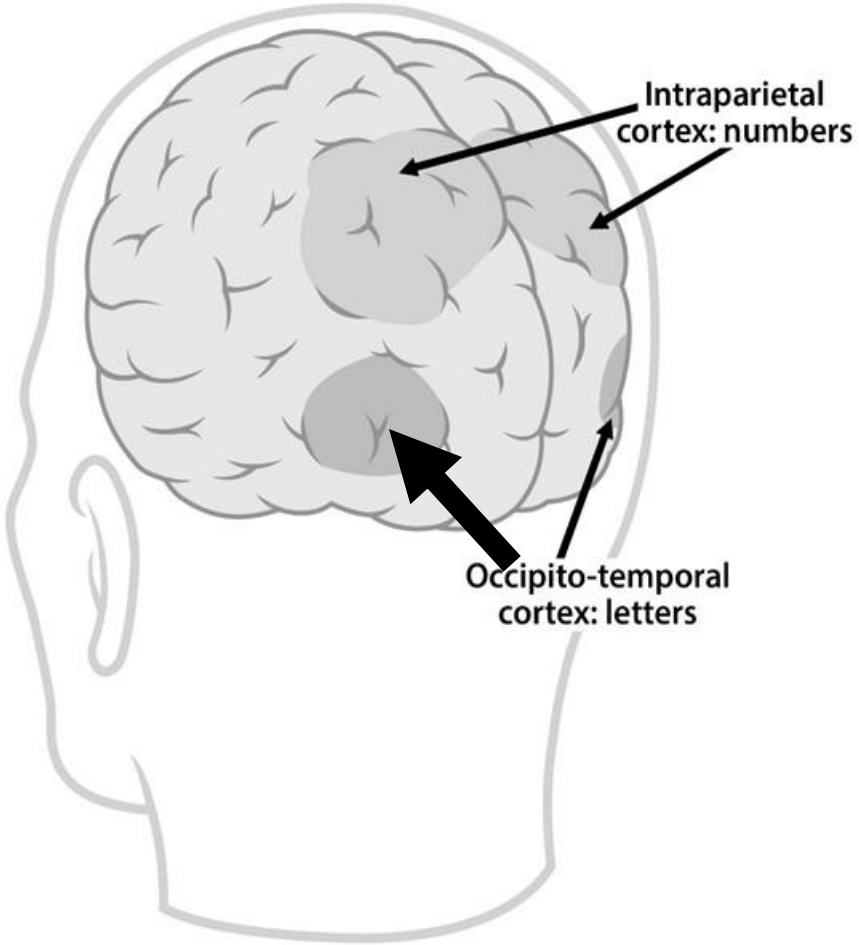


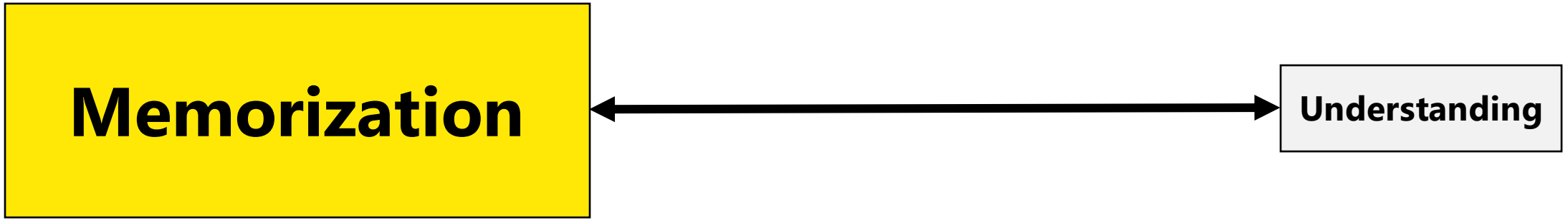
Easy stuff (Biologically primary knowledge)

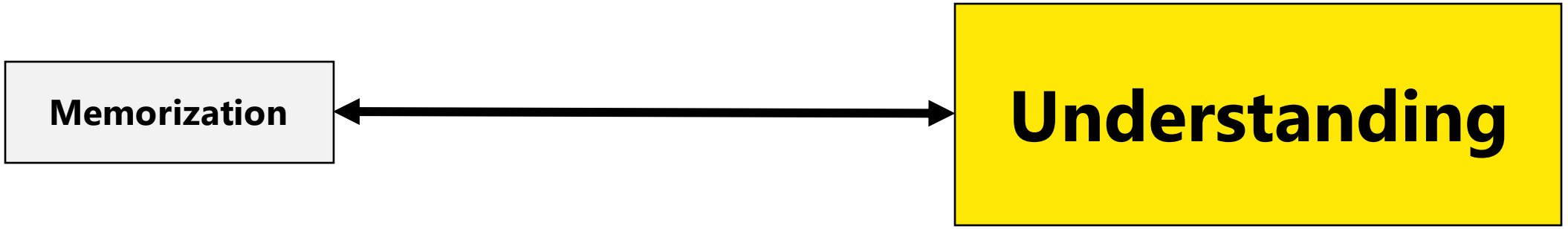
- Recognize faces
- Listen to and speak a first language
- Acquired easily without explicit instruction

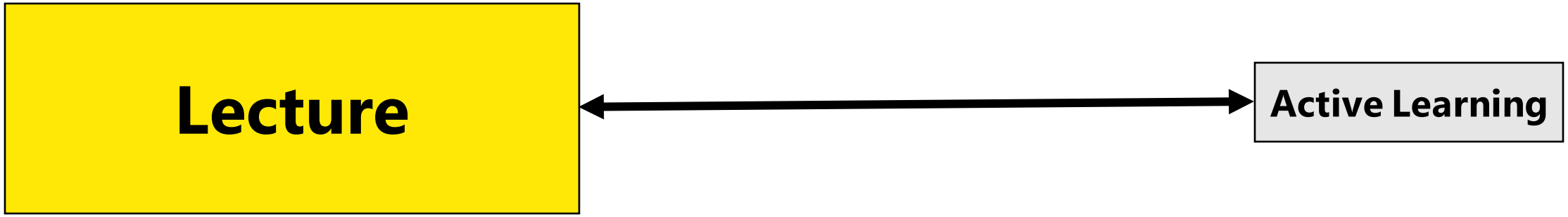
Hard stuff (Biologically secondary knowledge)

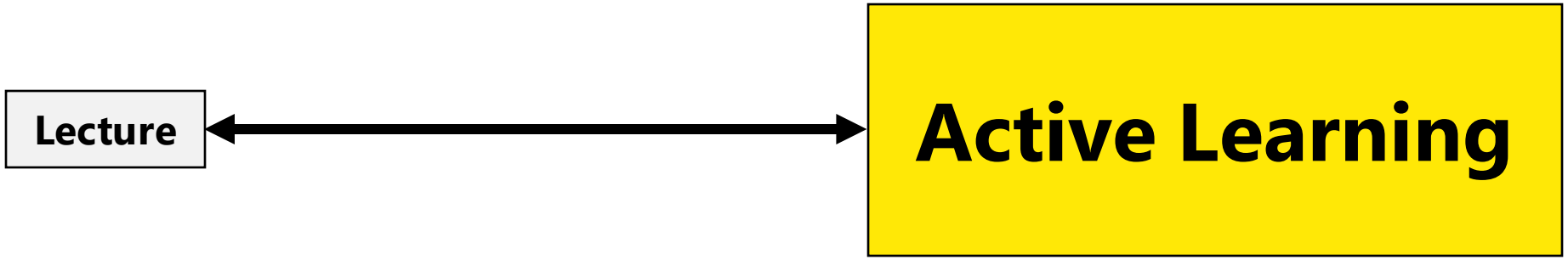
- Reading and writing
- Mathematics
- Not evolved to acquire—
  need to repurpose other neural circuits

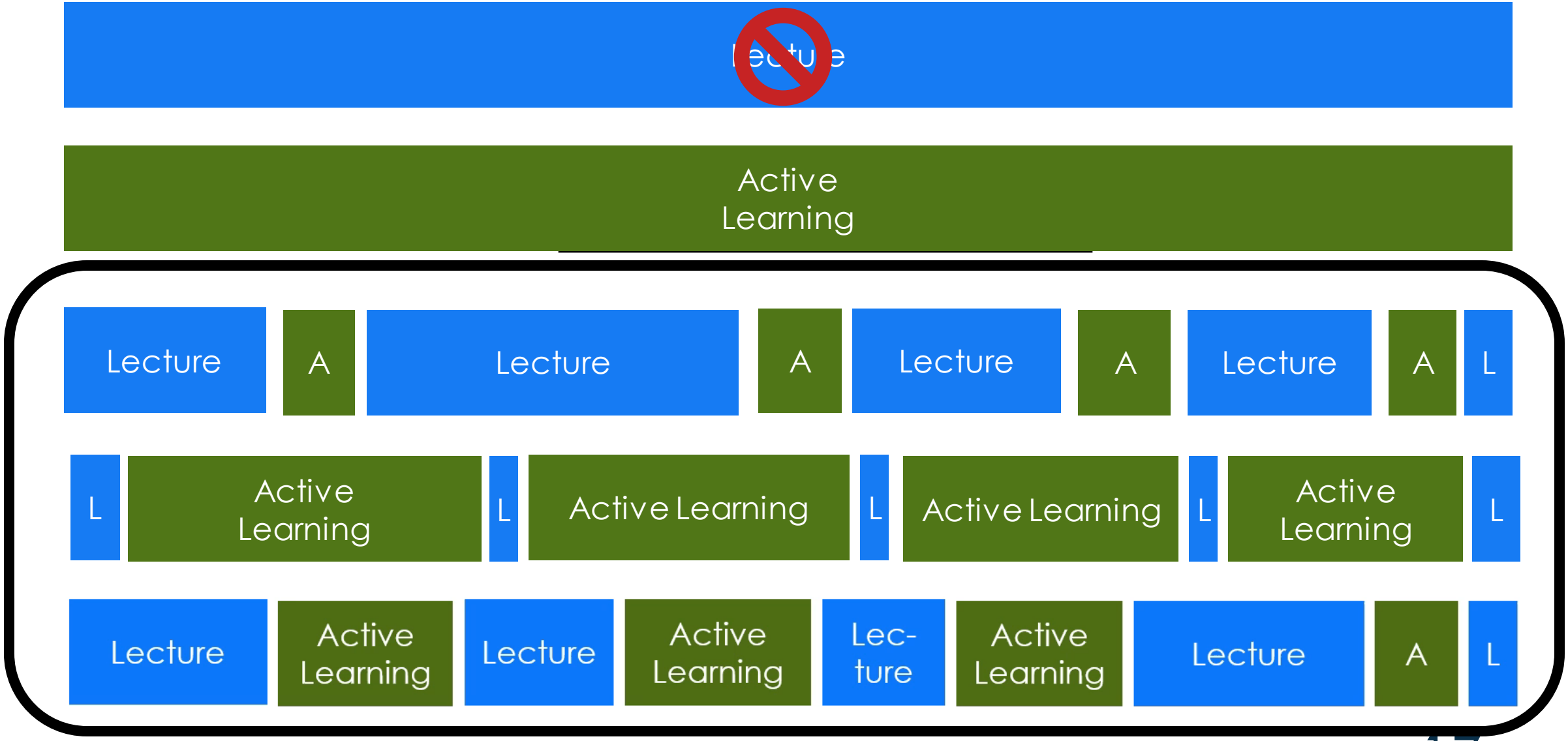



Memorization
Understanding


Memorization
Understanding


Lecture
Active Learning

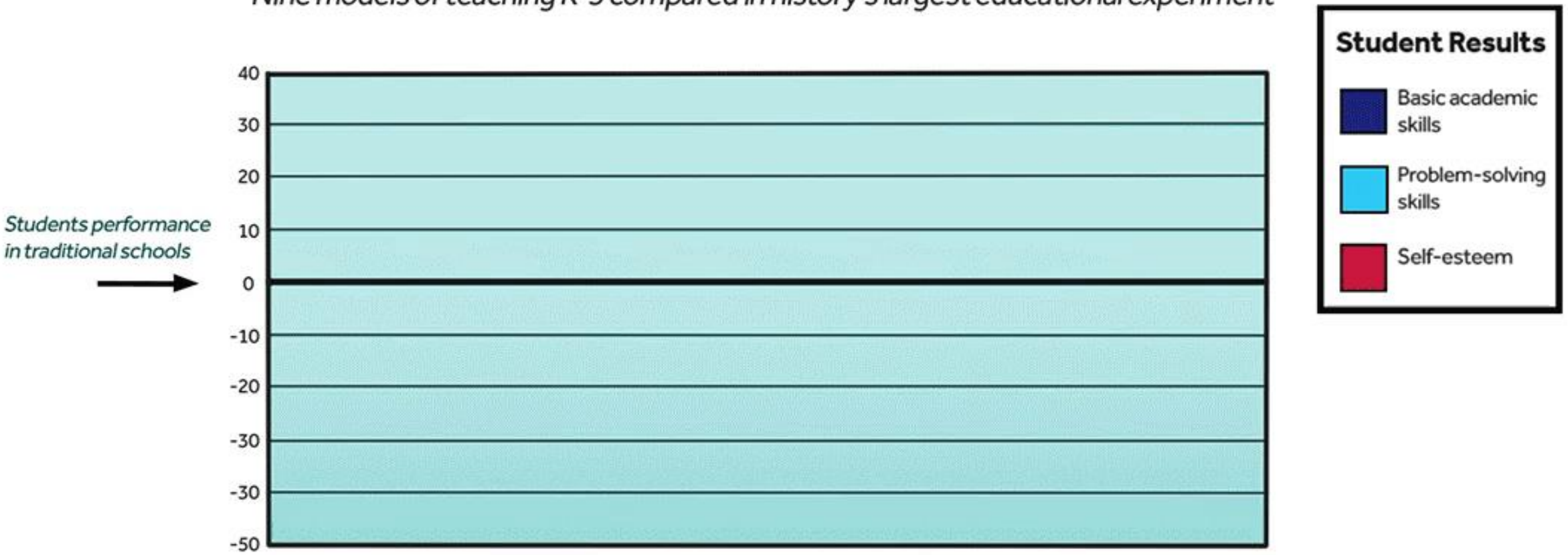

Lecture
Active Learning



Direct instruction

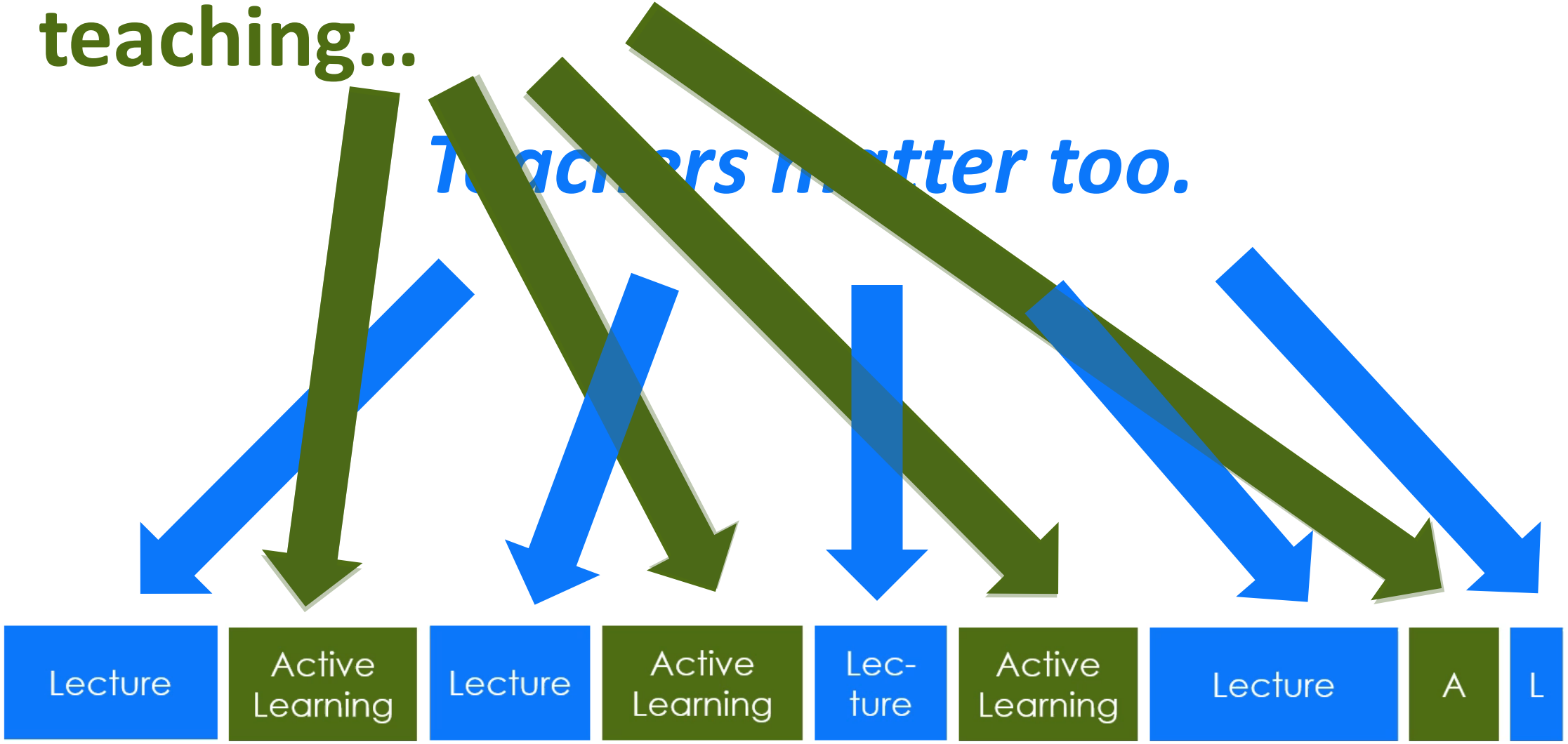
Project Follow Through, 1967 - 1977

Nine models of teaching K-3 compared in history's largest educational experiment



In a world of student-centered teaching…

Teachers matter too.



The 10 skills you need to thrive in the Fourth Industrial Revolution

in 2020

1. Complex Problem Solving
2. Critical Thinking
3. Creativity
4. People Management
5. Coordinating with Others
6. Emotional Intelligence
7. Judgment and Decision Making
8. Service Orientation
9. Negotiation
10. Cognitive Flexibility

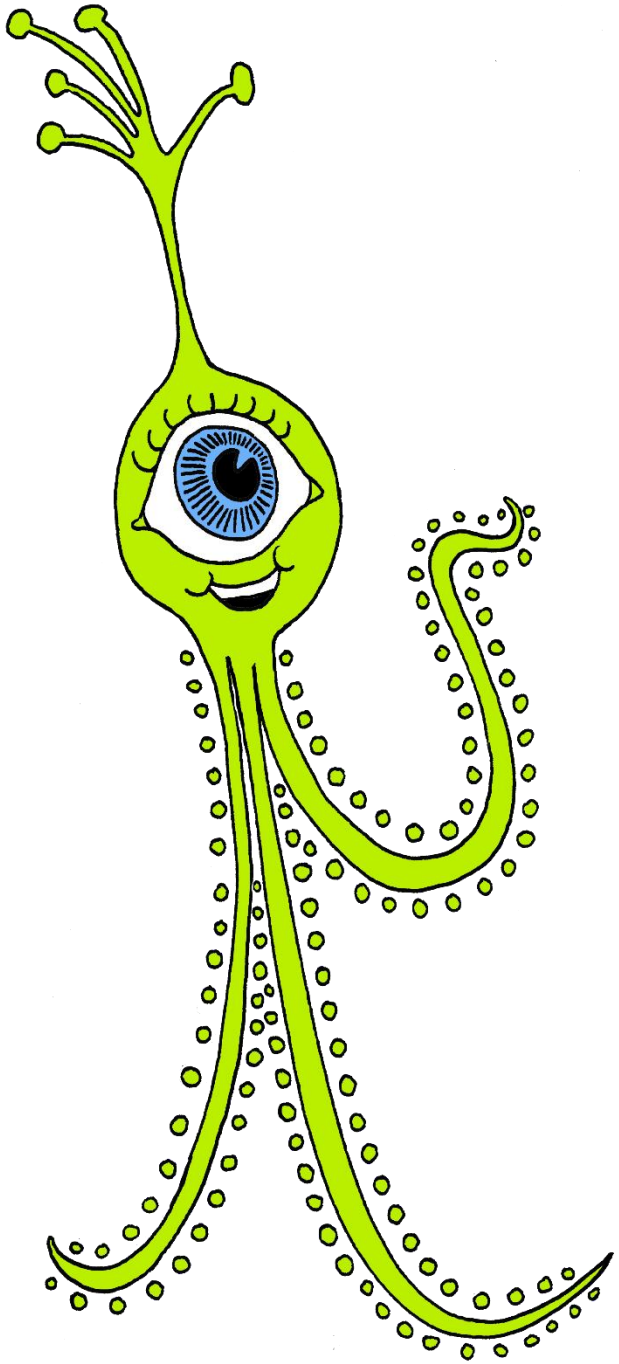
Top 10 skills of 2025

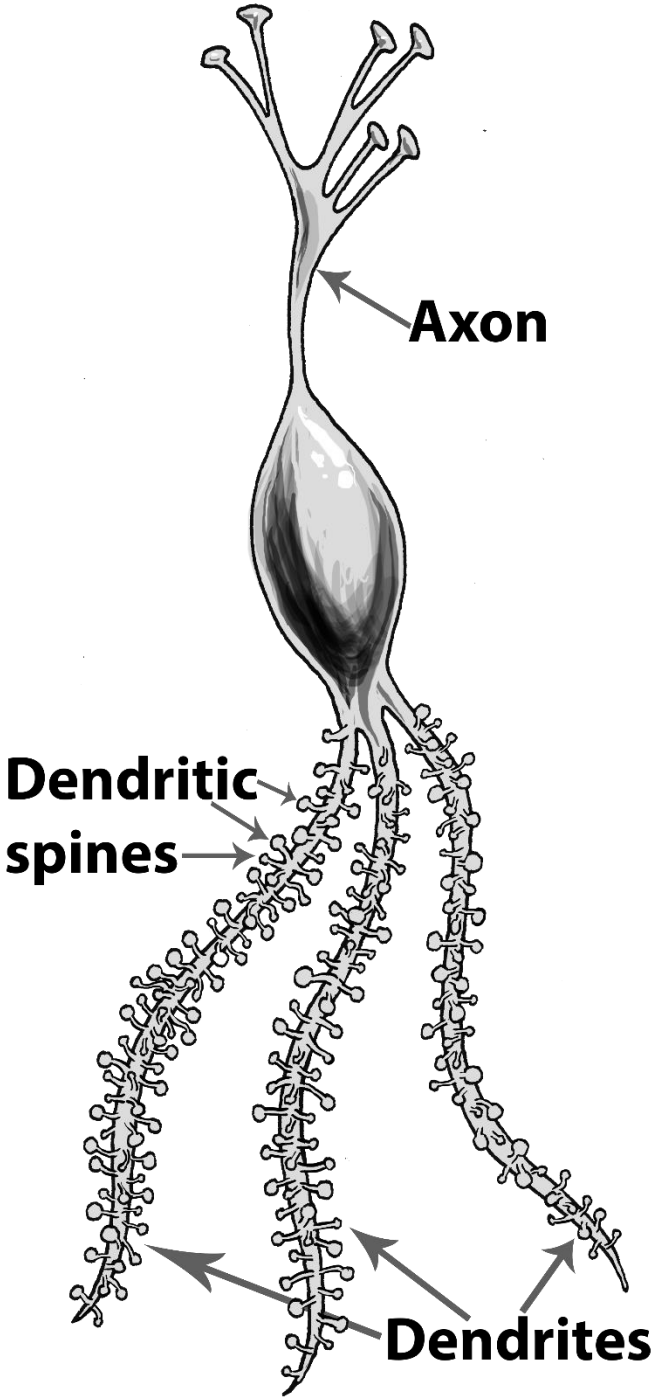
- Analytical thinking and innovation
- Active learning and learning strategies
- Complex problem-solving
- Critical thinking and analysis
- Creativity, originality and initiative
- Leadership and social influence
- Technology use, monitoring and control
- Technology design and programming
- Resilience, stress tolerance and flexibility
- Reasoning, problem-solving and ideation

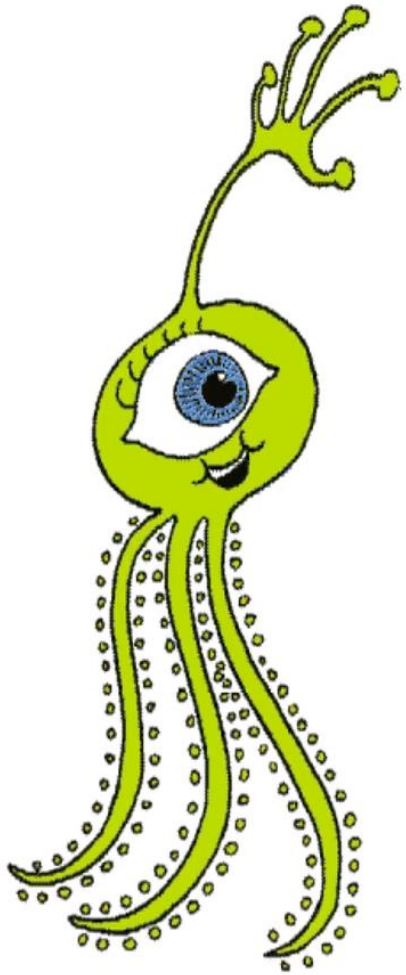
Source: Future of Jobs Report 2020, World Economic Forum.

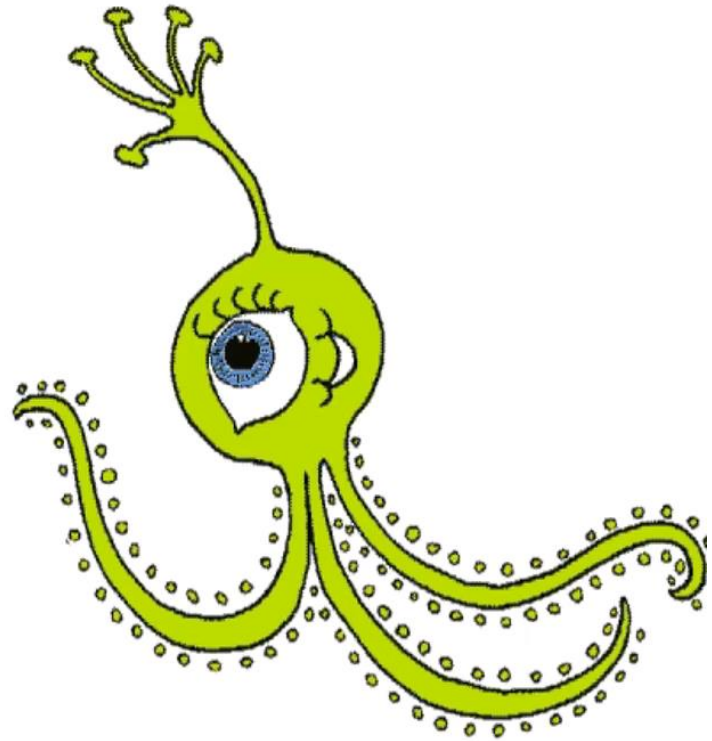
Source: **Future of jobs report – world economic forum**

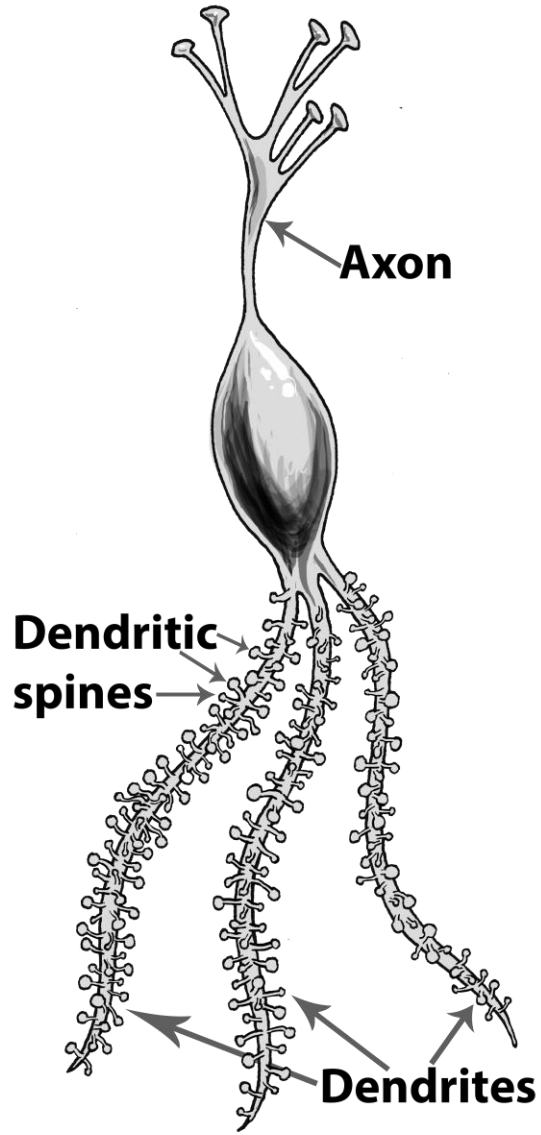

Axon
Dendritic
spines




Axon
Dendritic spines
Dendrites



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Dendritic spines
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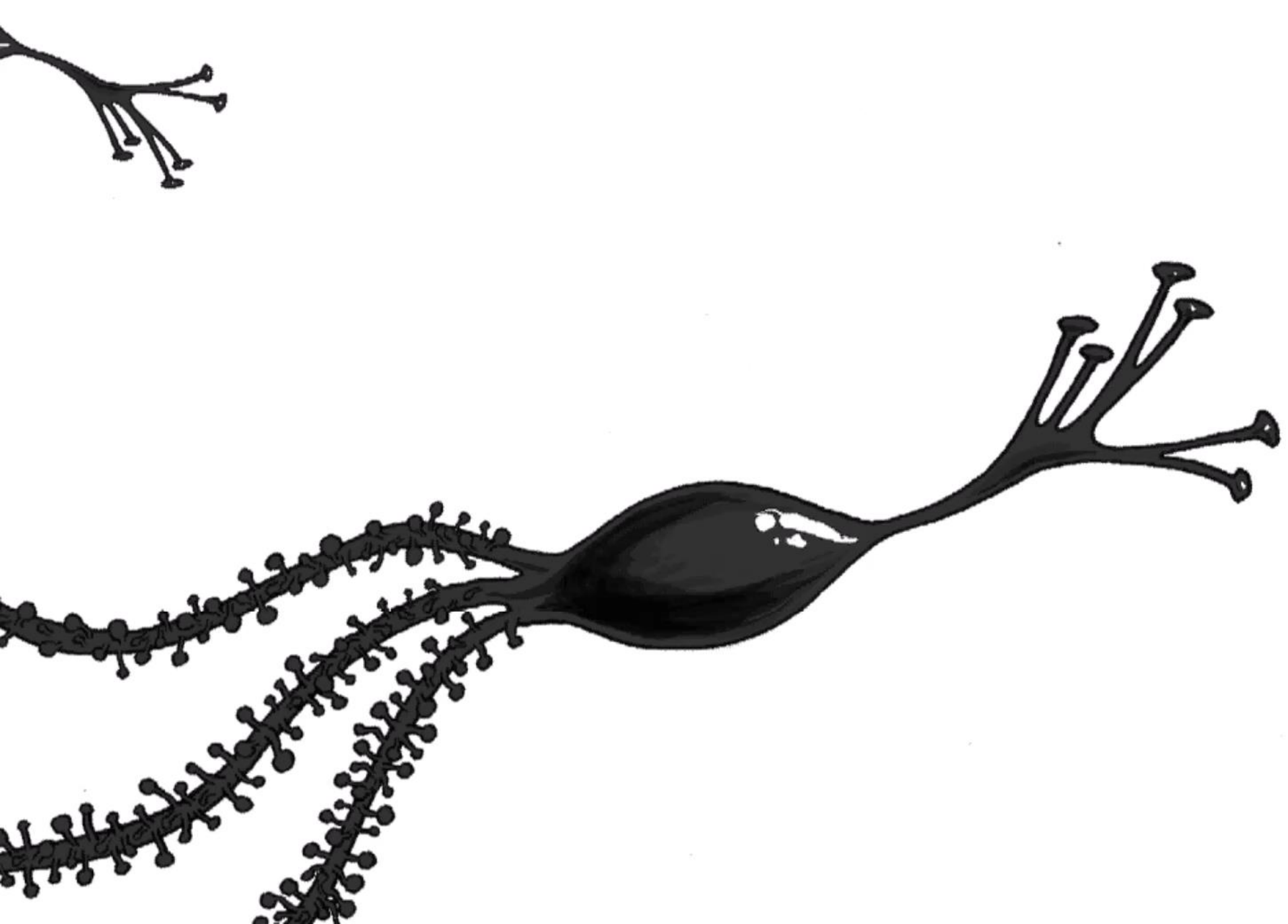
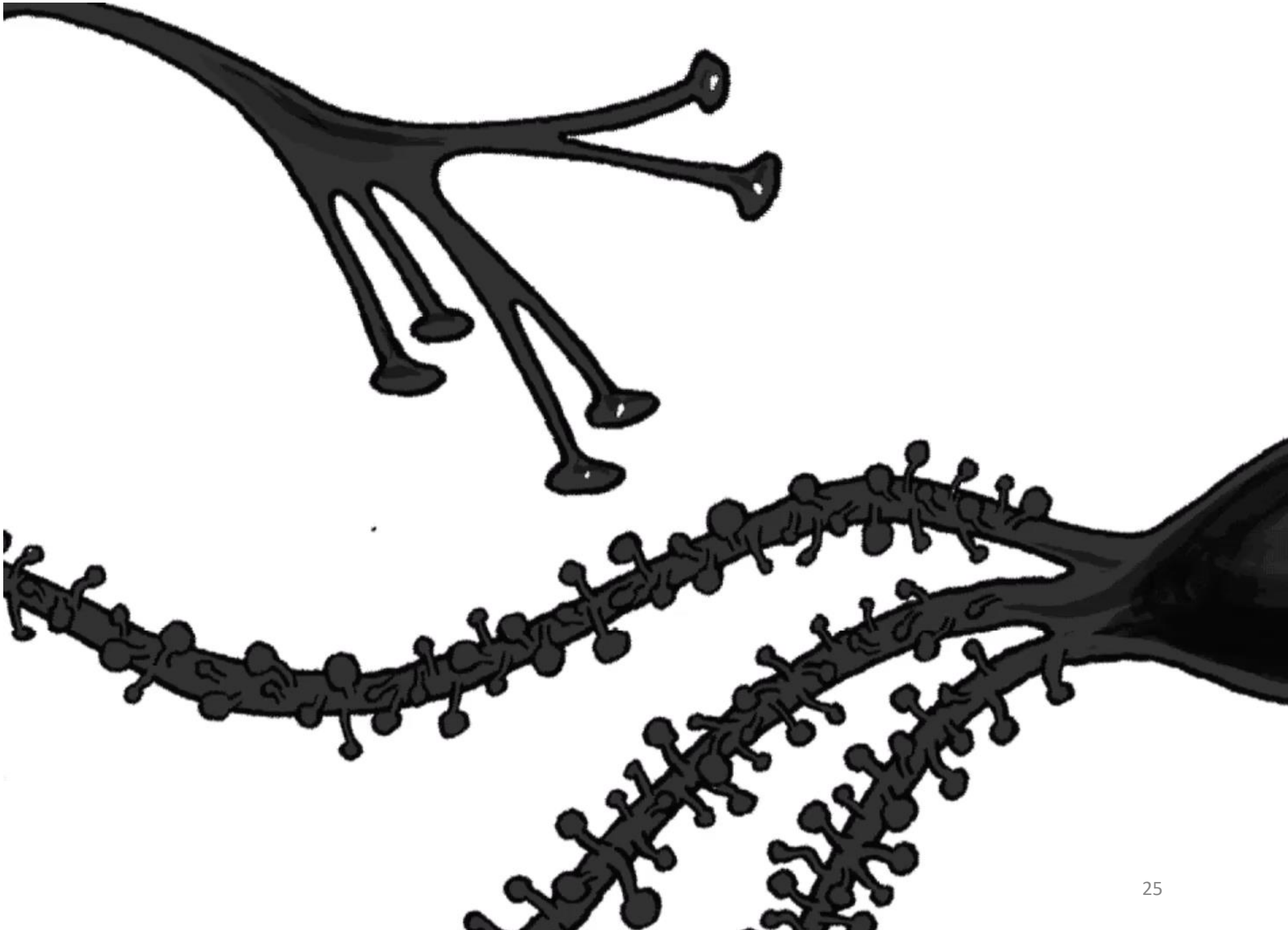
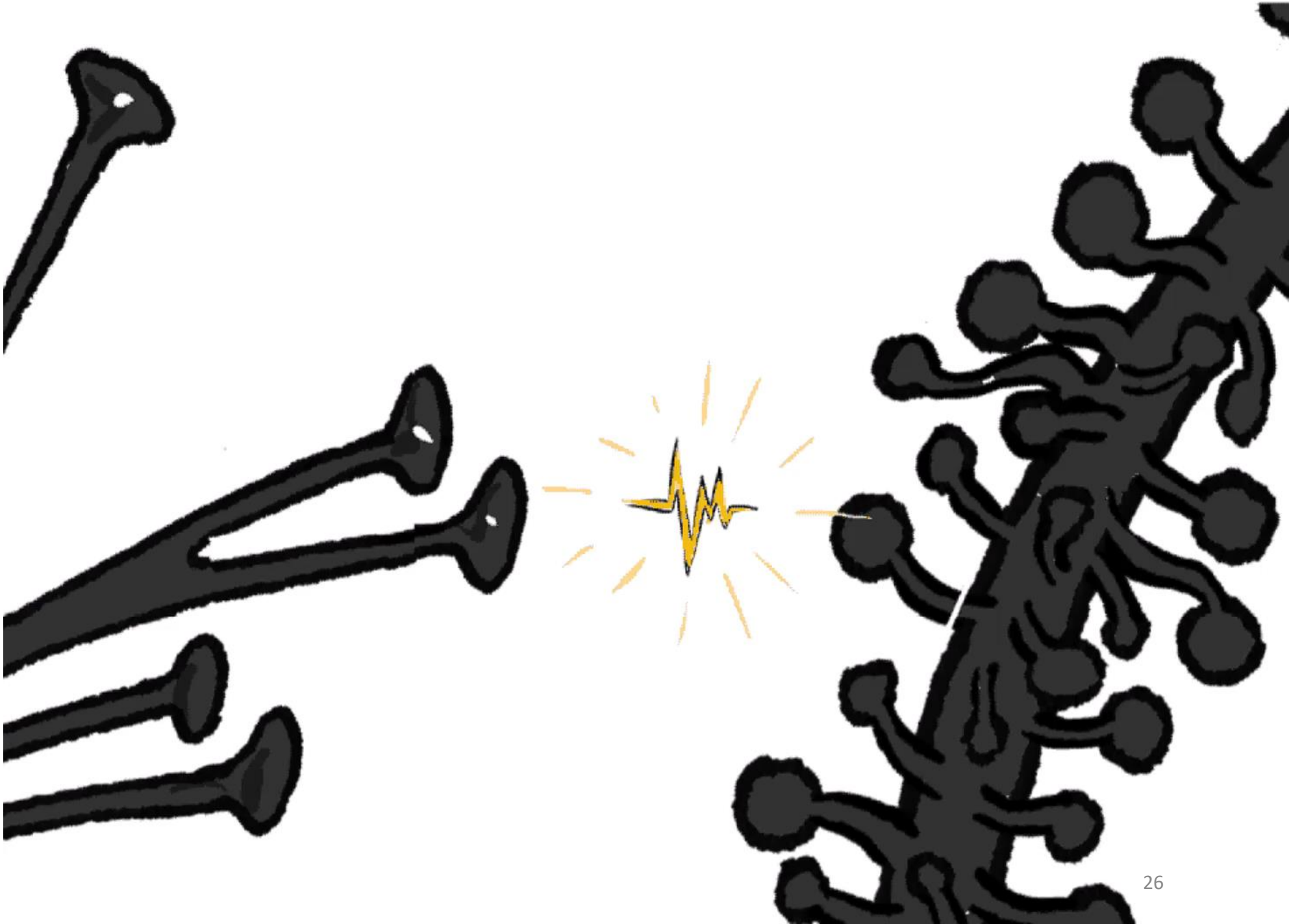


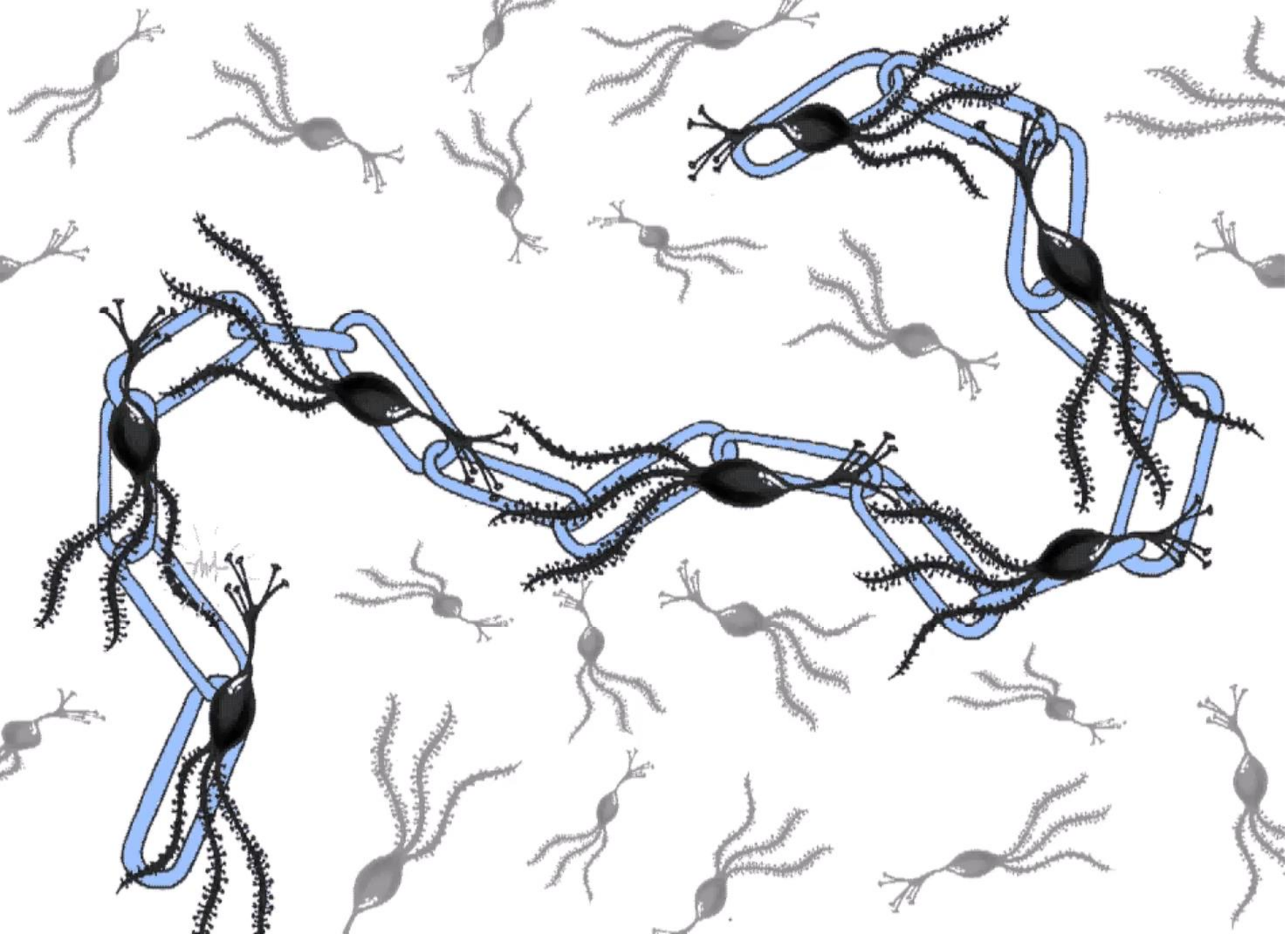
Neurons send signals

Neurons create sets of links when you learn something.



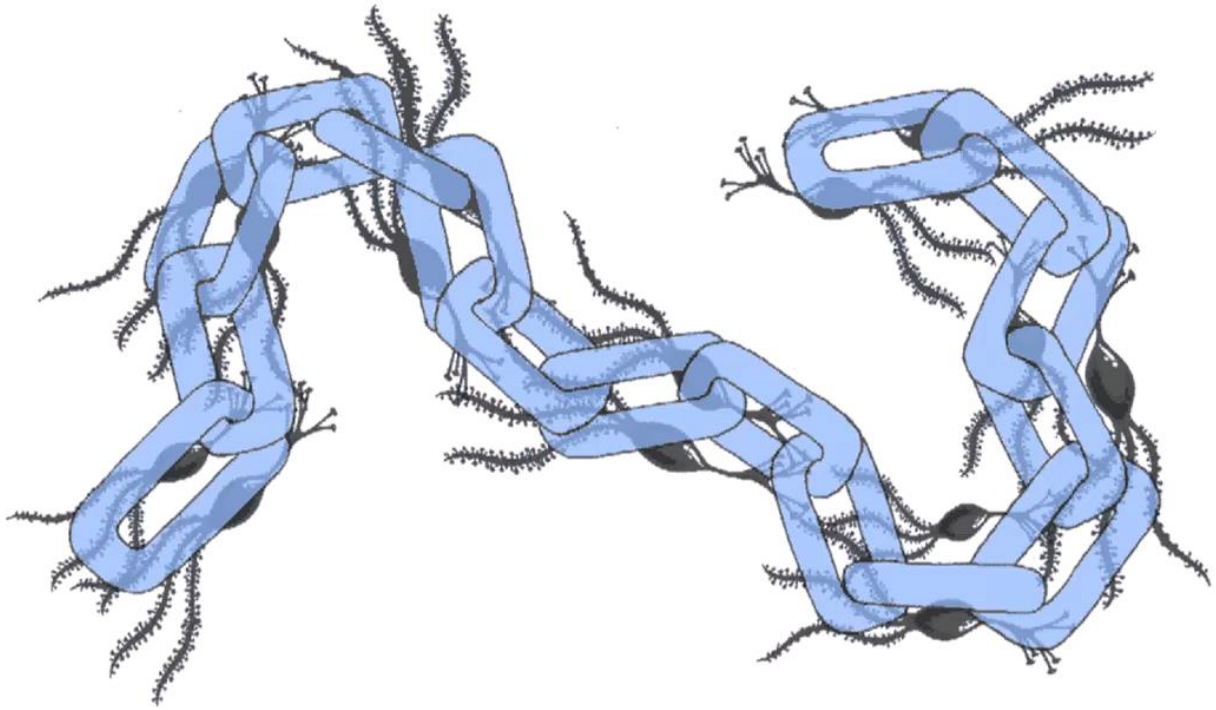
Connections strengthen with practice





These are like sets of links in a chain.

The value of metaphor

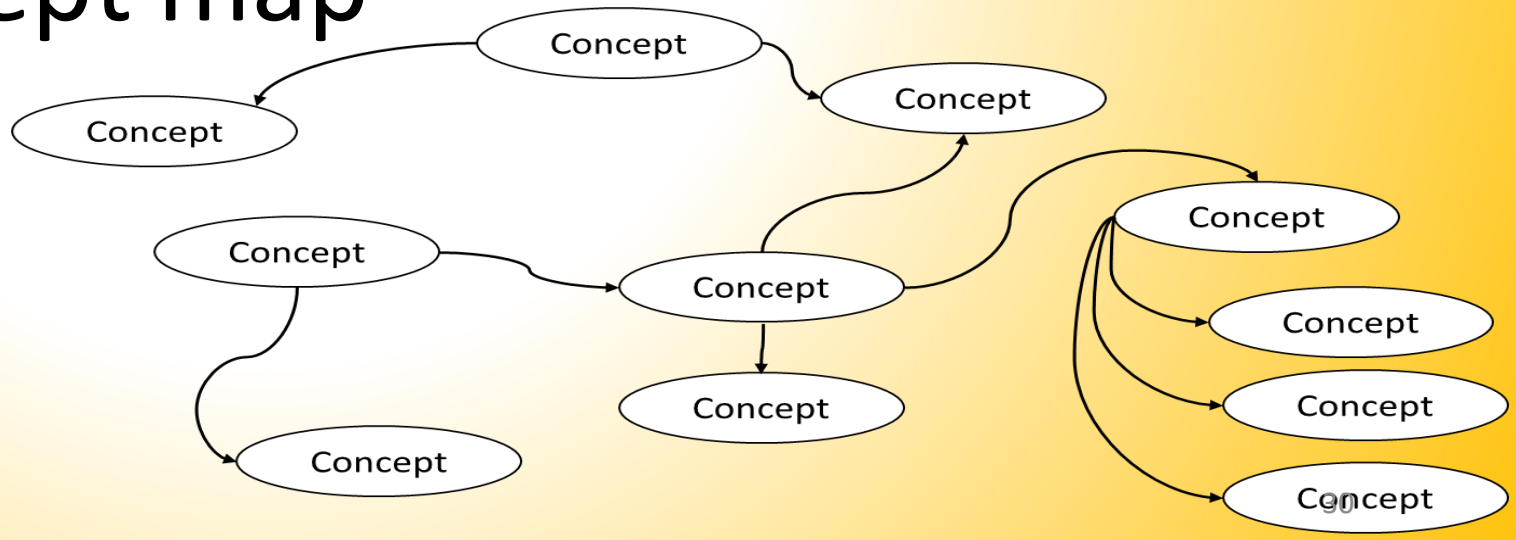


How to come up with metaphors

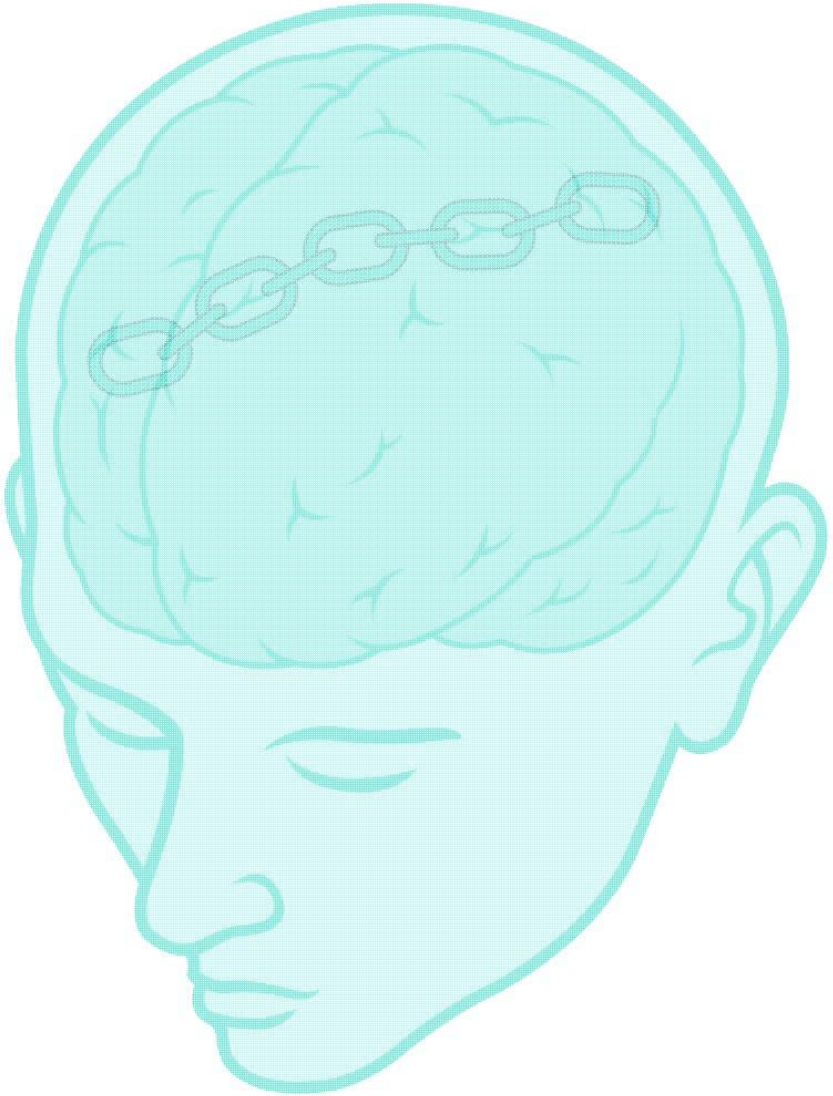
- Steal them
- Ask yourself what a concept is like (the wackier, the better)
- Look online
- Ask your students to develop metaphors

What is the most powerful technique to help people learn most efficiently?

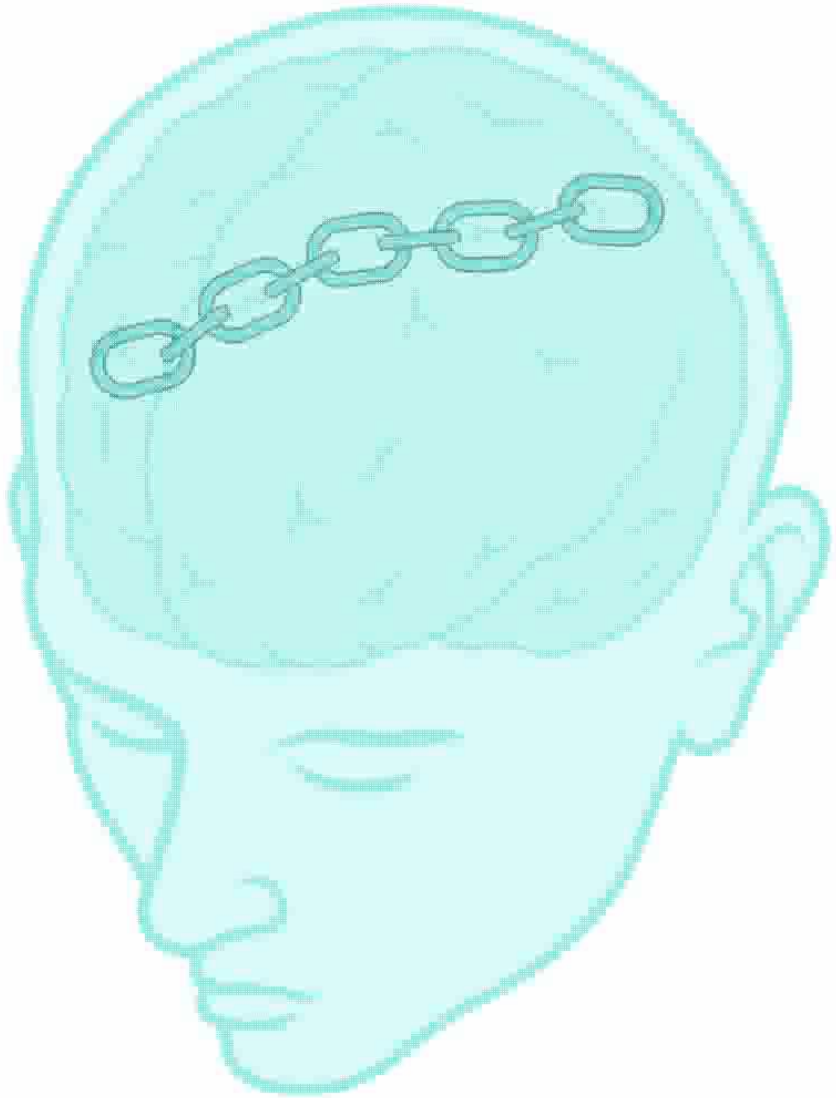
- Reread
- Highlight or underline
- Retrieval practice (“recall”)
- Create a concept map



Retrieval Practice



Retrieval Practice



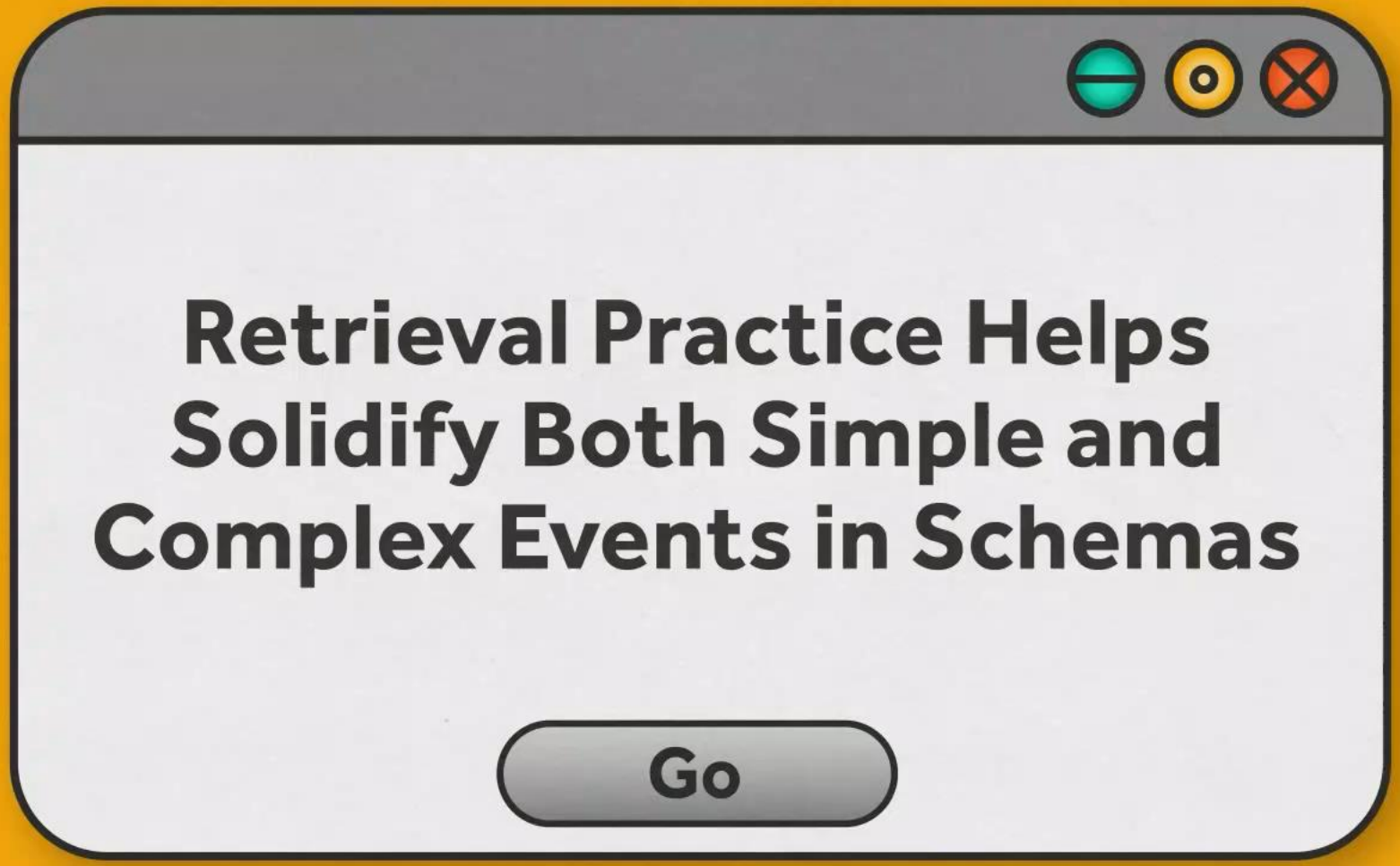
Initial learning

Mapping

. Blunt

activities that encourage elaborative studying
ractice retrieving and reconstructing knowle
cticing retrieval produces greater gains in m
cept mapping. The advantage of retrieval pra

Week 3, Lesson 1: Retrieval Practice, Events, and Schemas



Mental models

Complex normal matrix

Krebs cycle

Retrieval practice

Week 4 - Lesson 1: Attention, Partnership and Teleprompters

Humor

Comedian

Humor Does NOT Mean Being a Comedian

Go

Entertain

Diffuse Mode

www.coursera.org/
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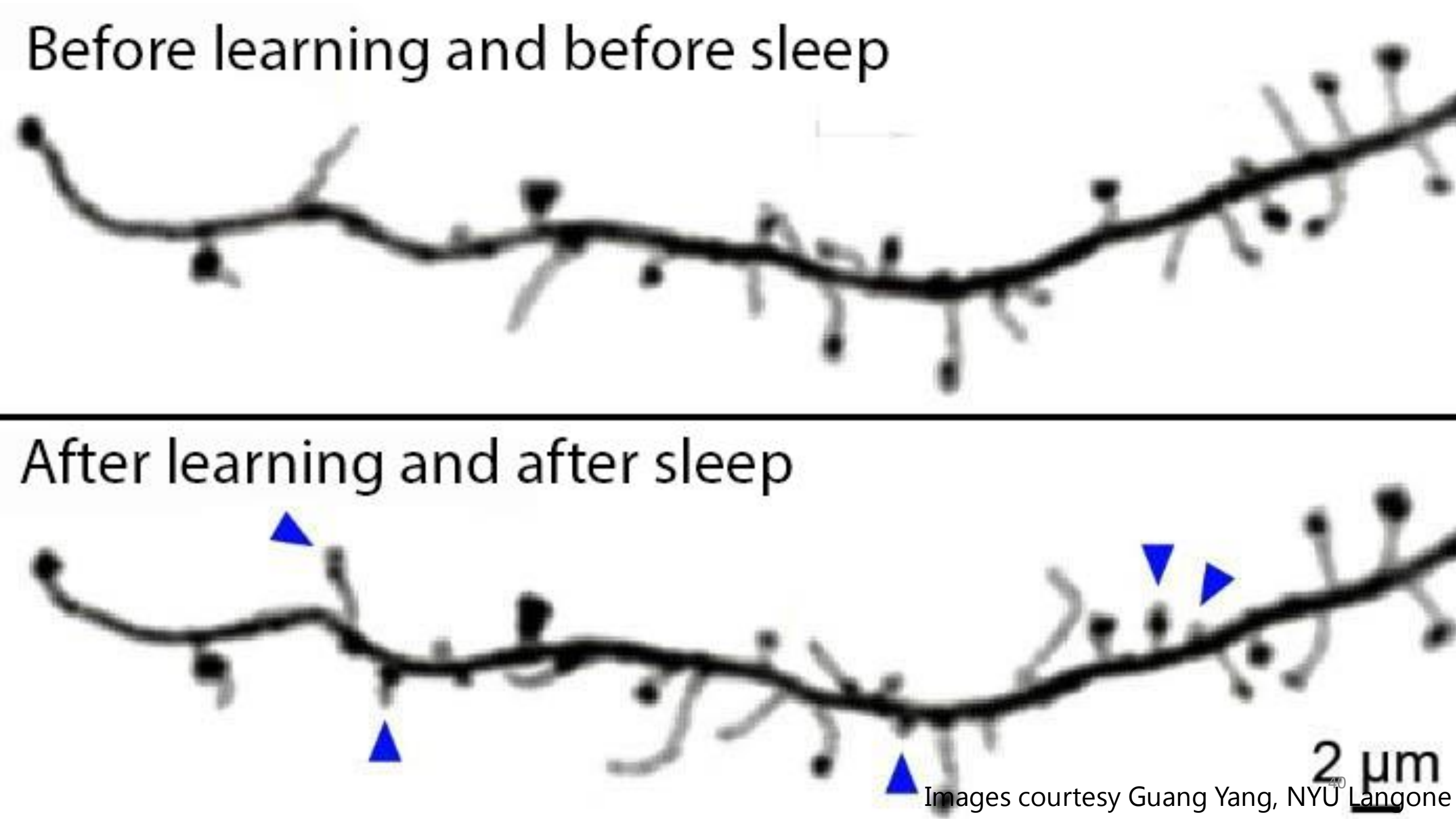
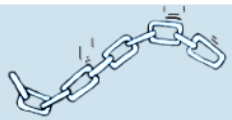
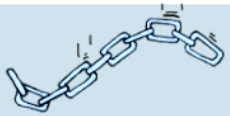
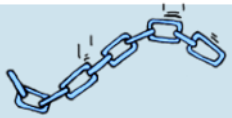
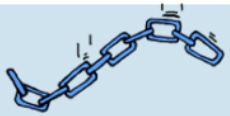
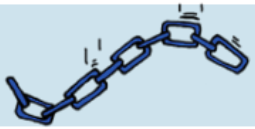
Before learning and before sleep

Images courtesy Guang Yang, NYU Langone



Images courtesy Guang Yang, NYU Langone

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
						

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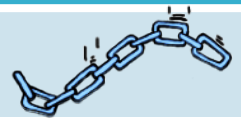
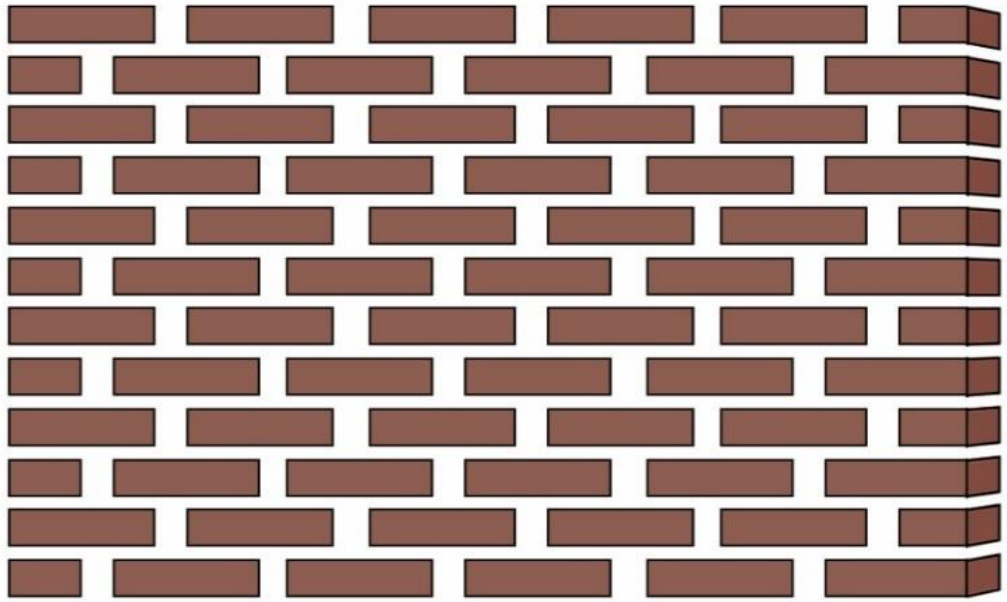
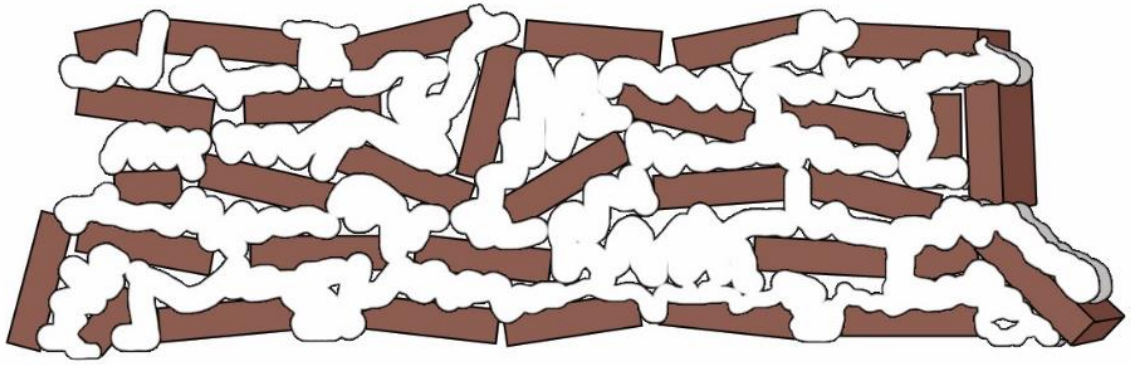
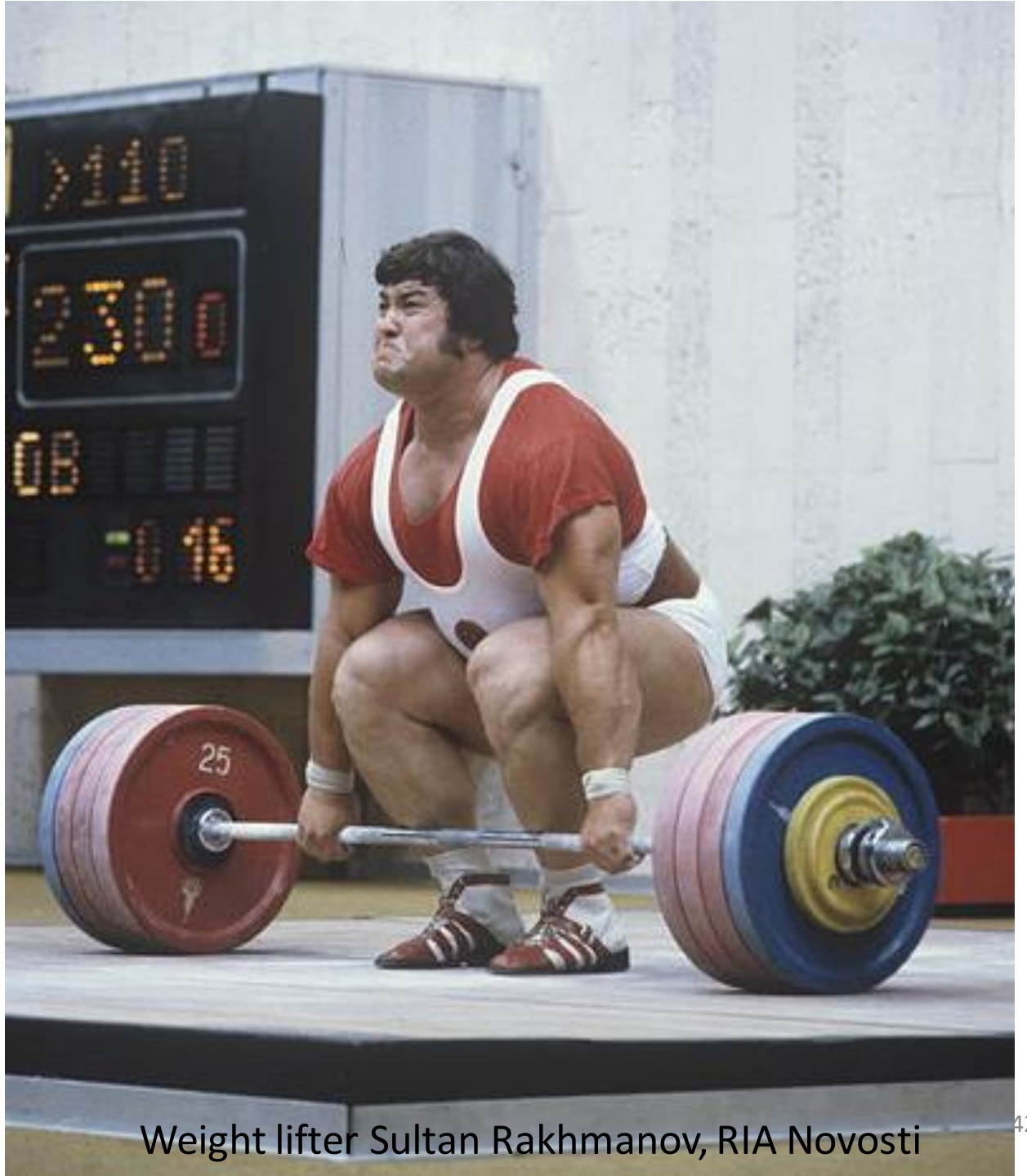
						





It takes time



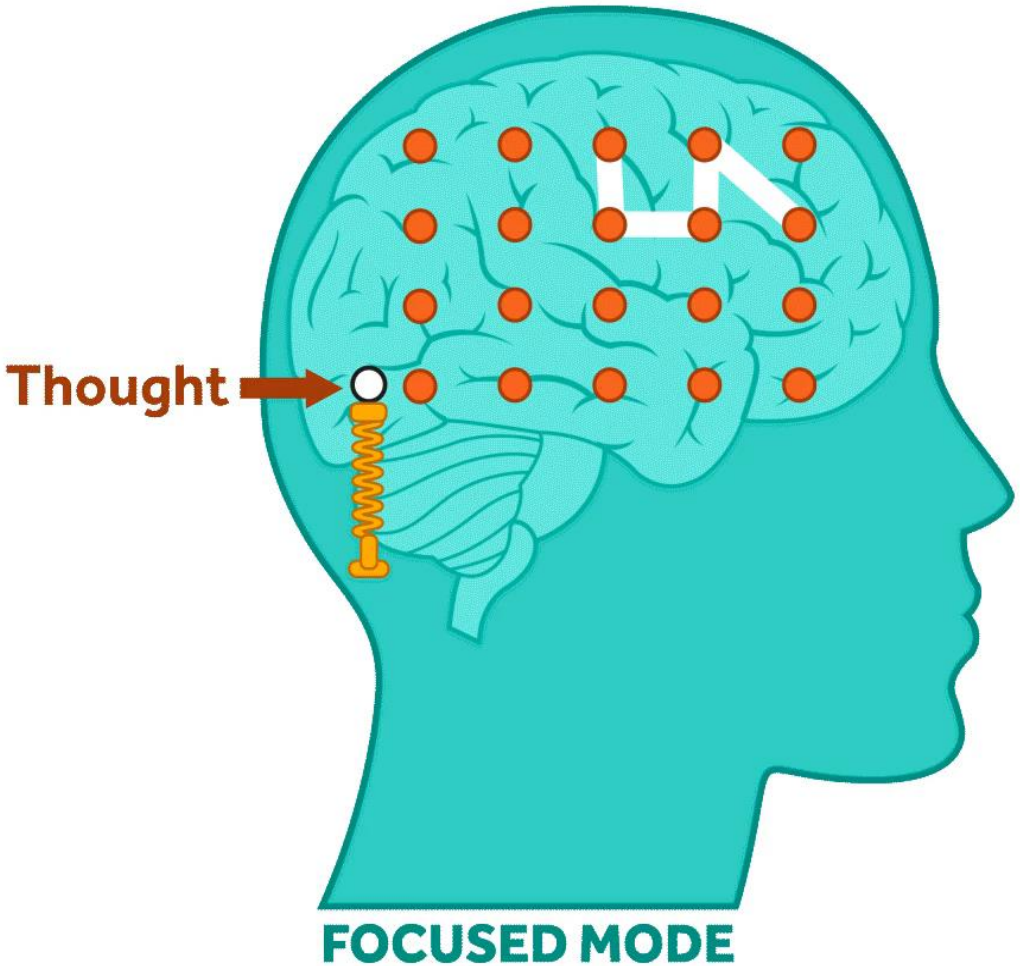
Weight lifter Sultan Rakhmanov, RIA Novosti

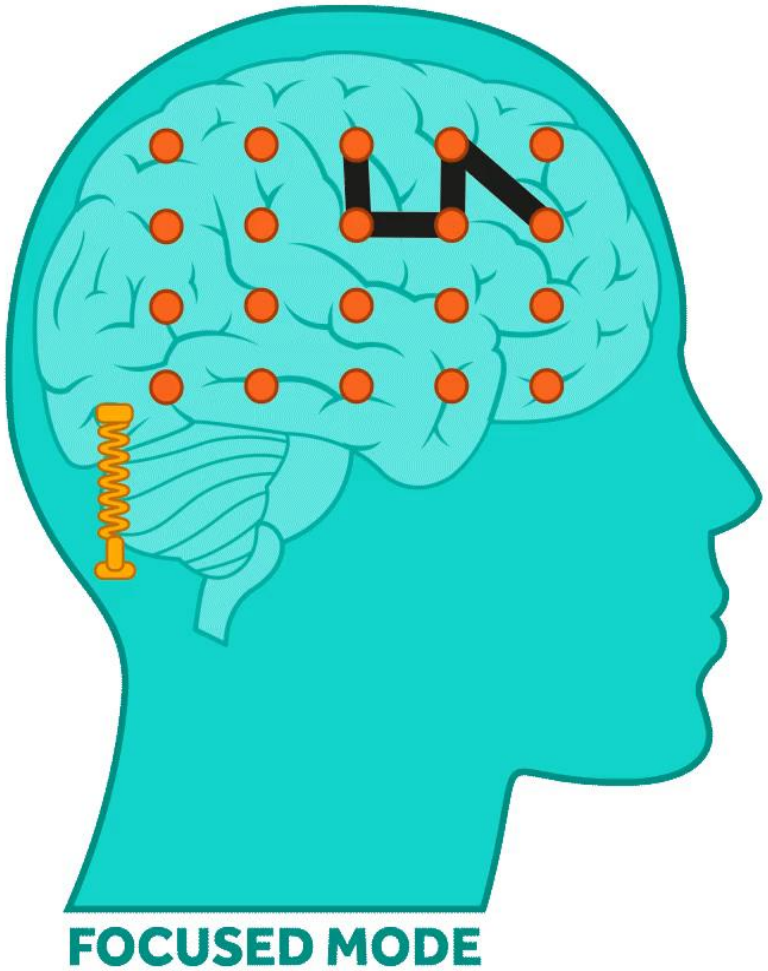
Focused mode

Diffuse mode

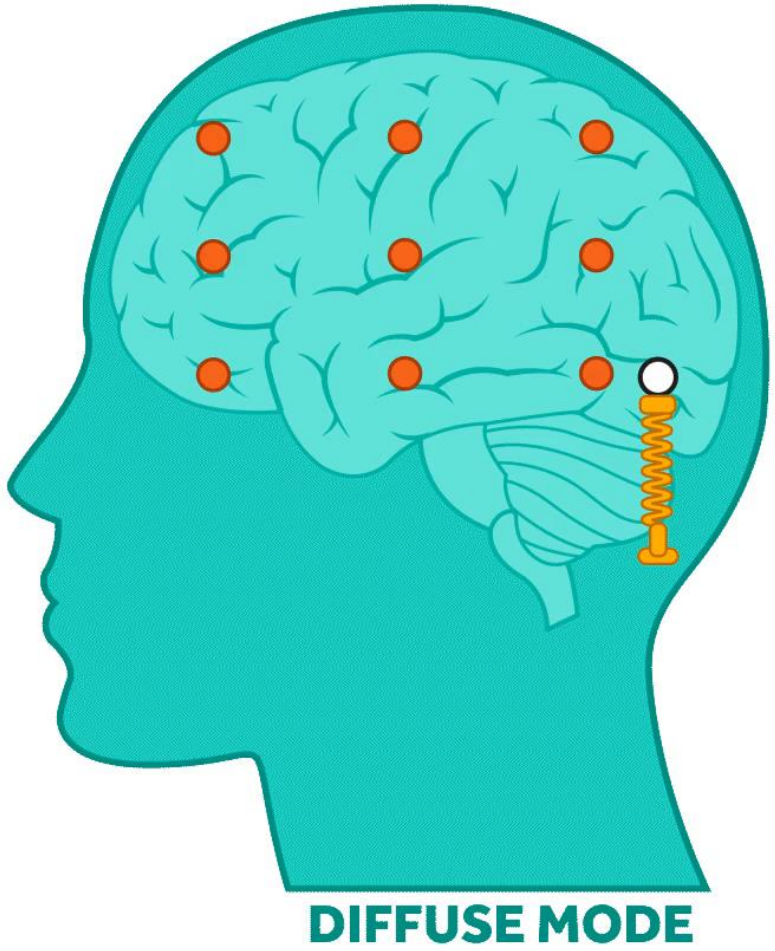

PINBALL
PINBALL
PINBALL


PINBALL
PINBALL
PINBALL


Thought
FOCUSED MODE

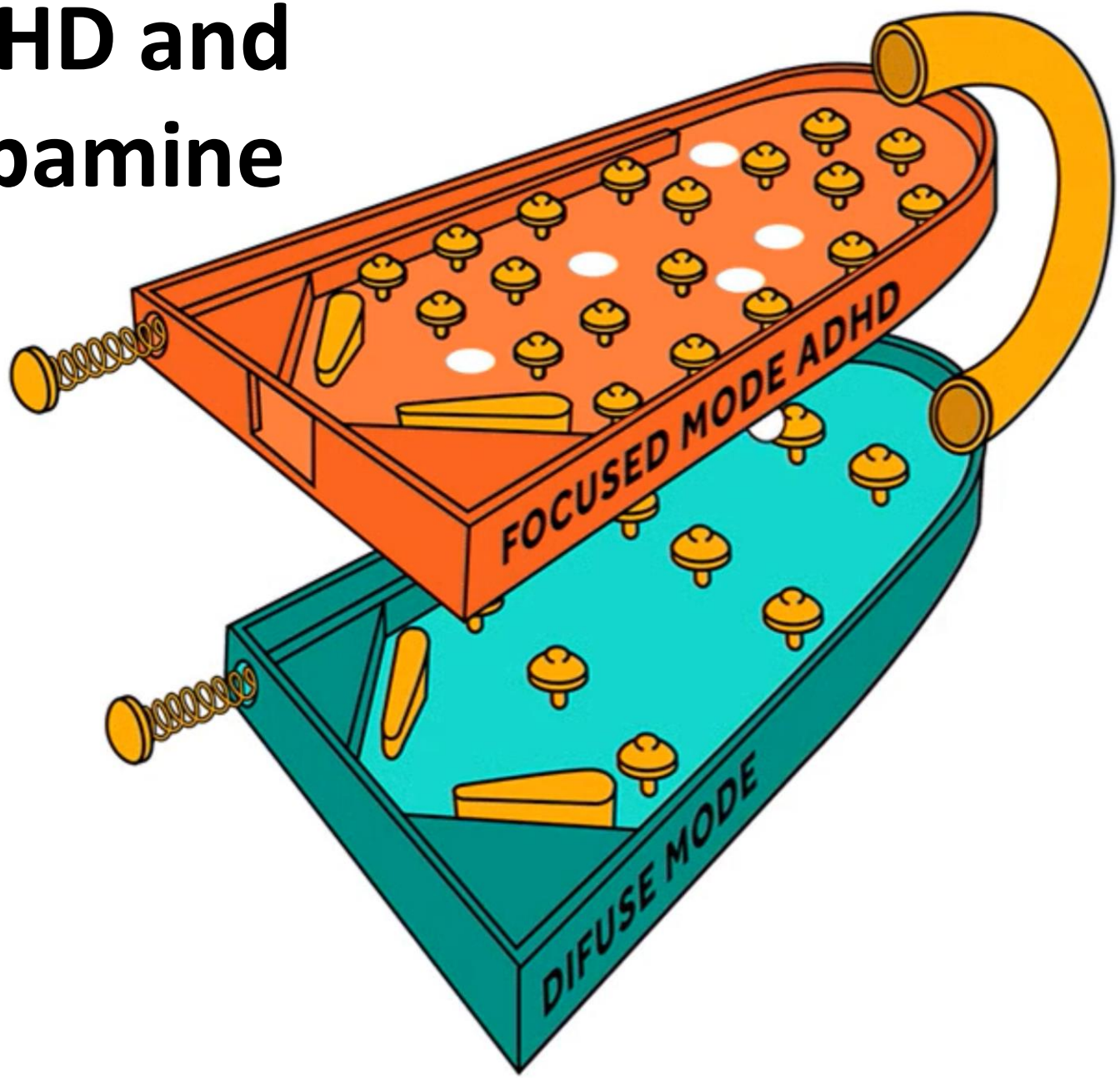


FOCUSED MODE



DIFFUSE MODE

ADHD and dopamine

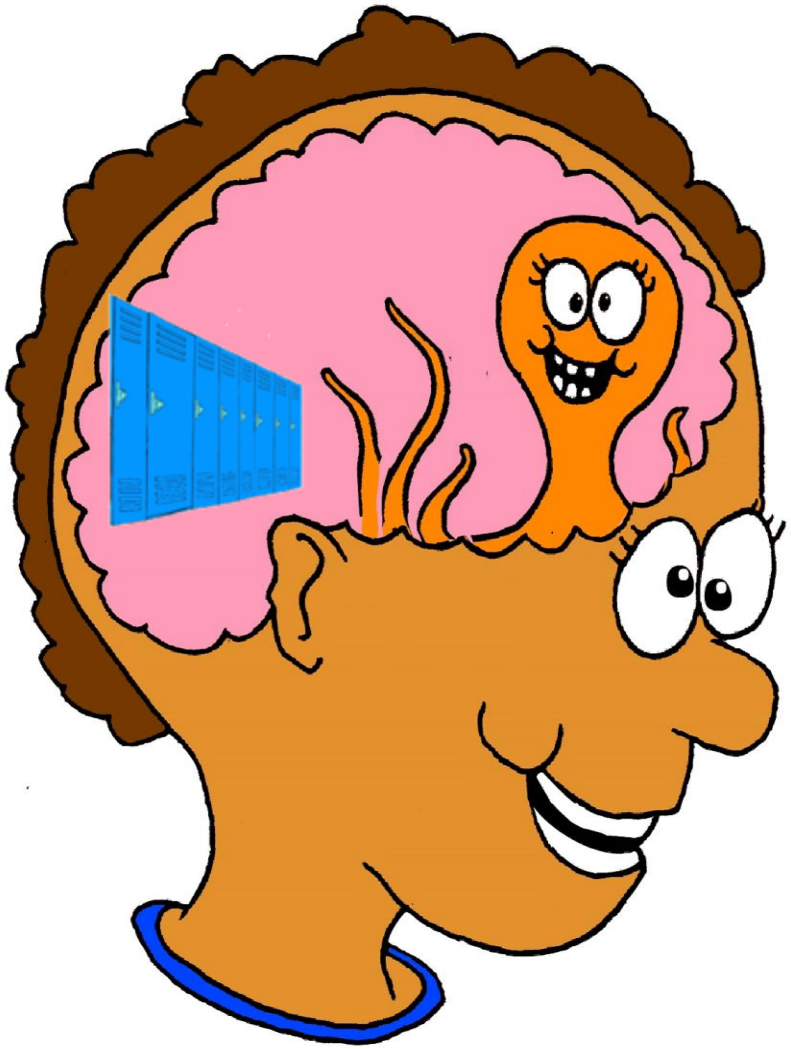


Break Out Groups

- Introduce yourselves
- Describe the difference between focused and diffuse mode.

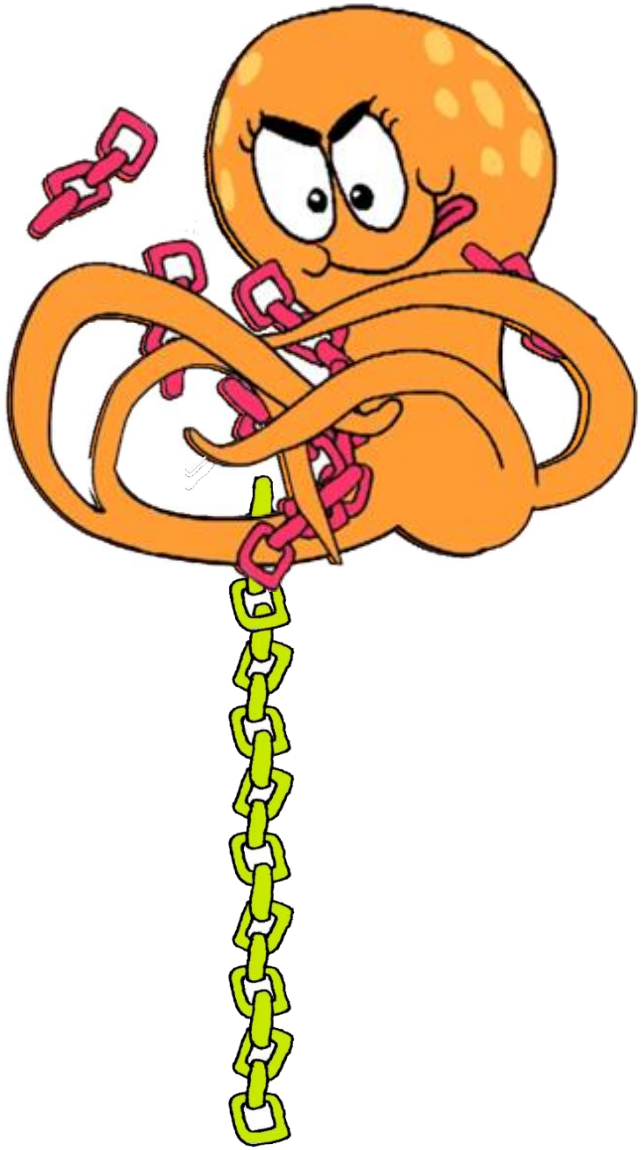
Working memory

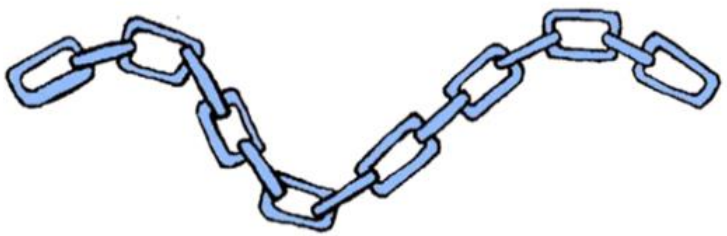
Long-term memory

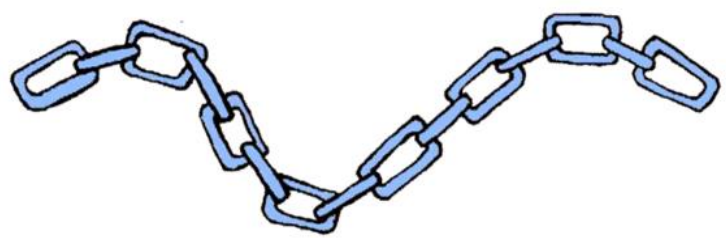


Working memory

Long-term memory

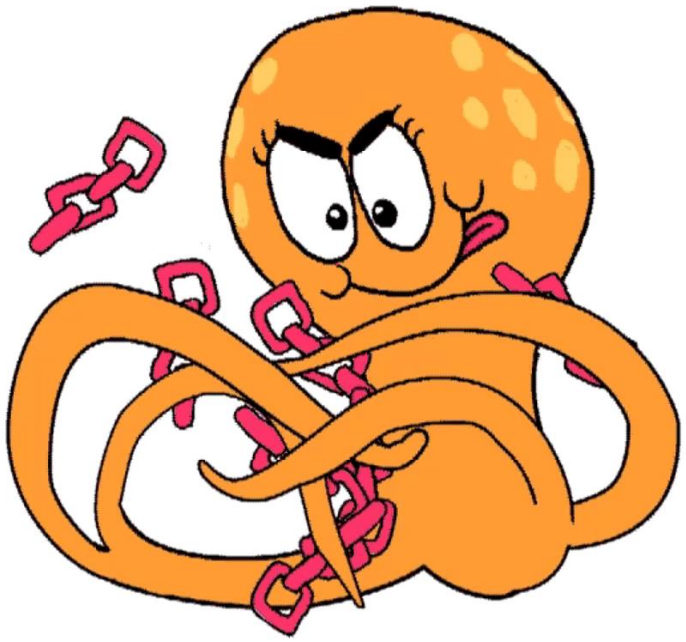




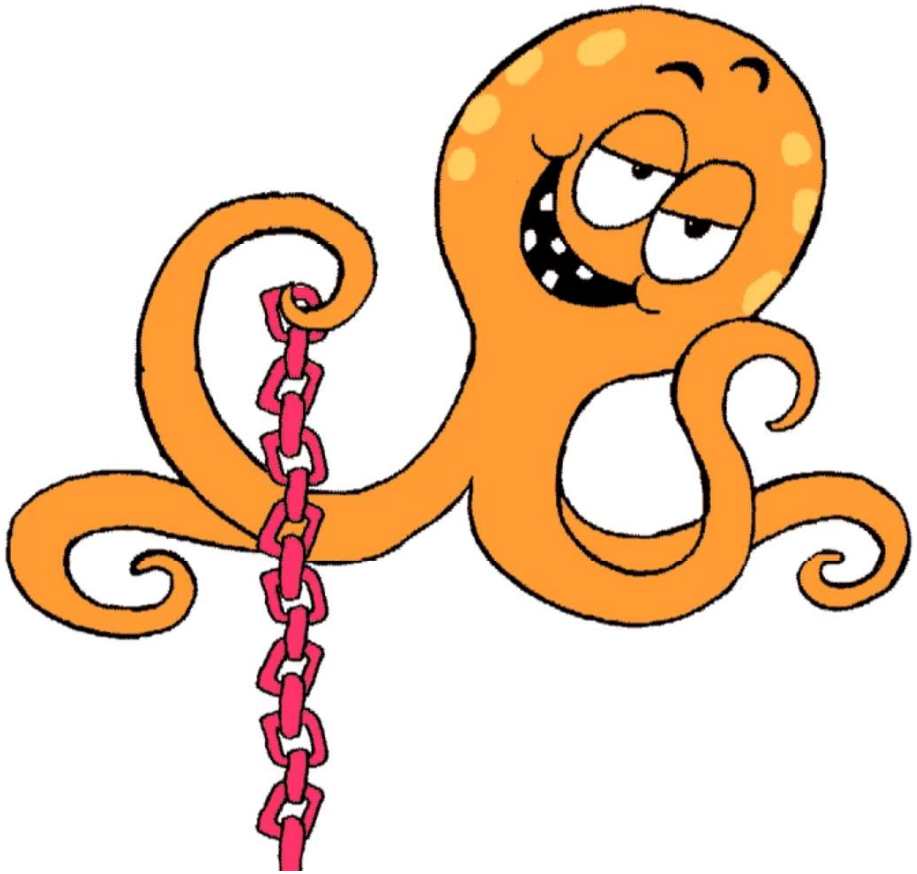



25 focused tangled octopus-20180922T134857Z-001.zip

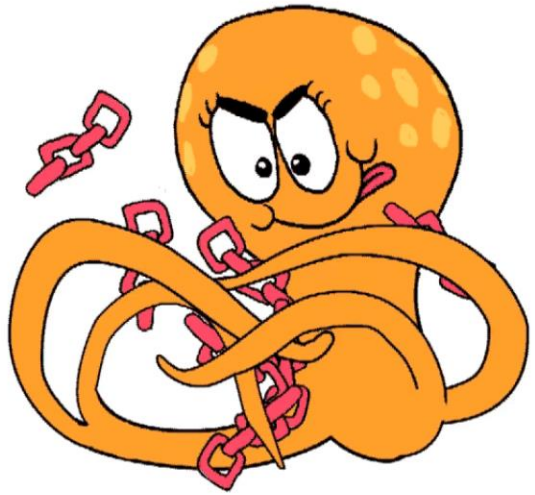

25 focused tangled octopus-20180922T134857Z-001.zip

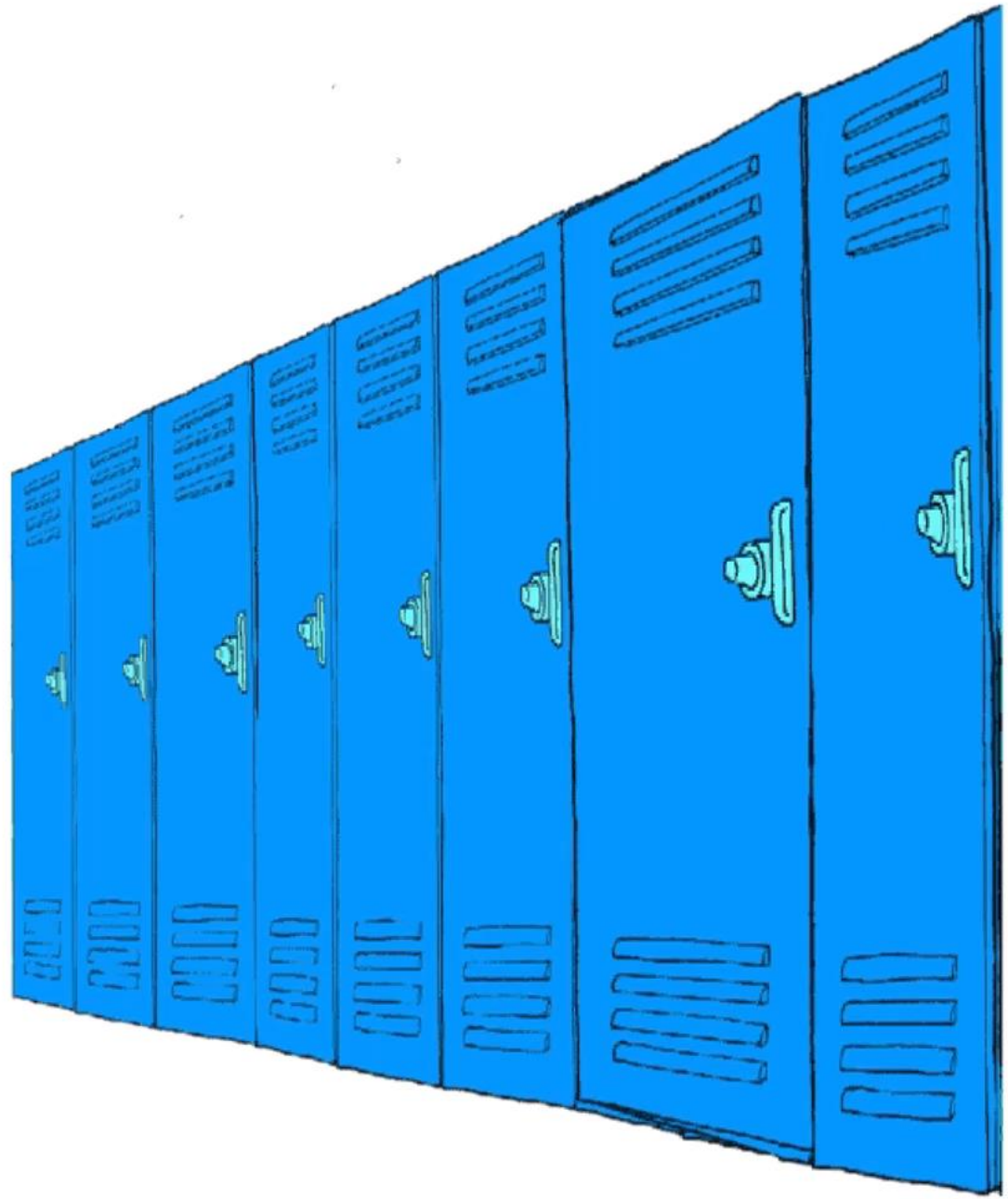


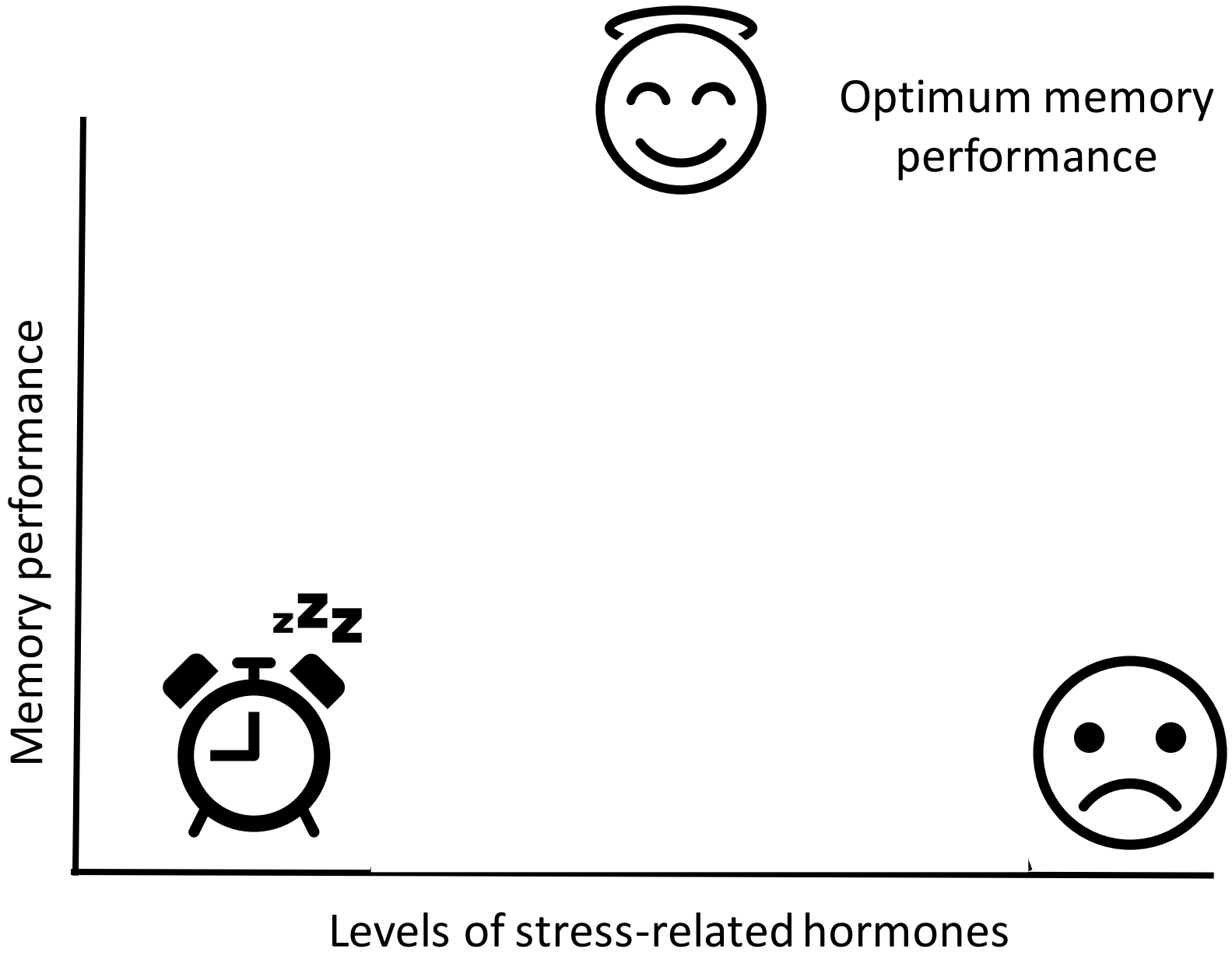
- Heavy cognitive load
- No working memory is available for anything else



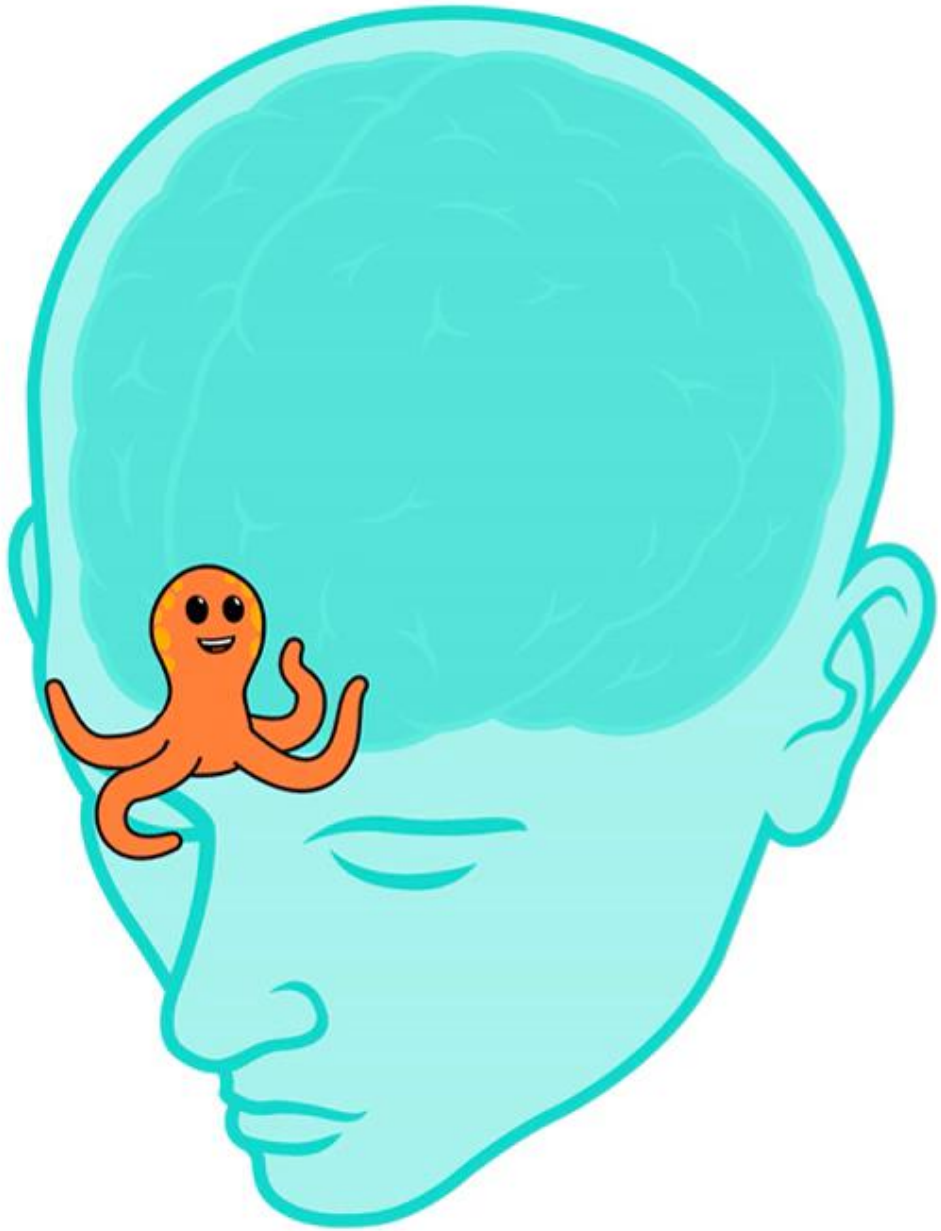
- Light cognitive load!
- Working memory is available for more complex thinking






Optimum memory performance
Memory performance
zZZ
Levels of stress-related hormones

Working memory capacities vary



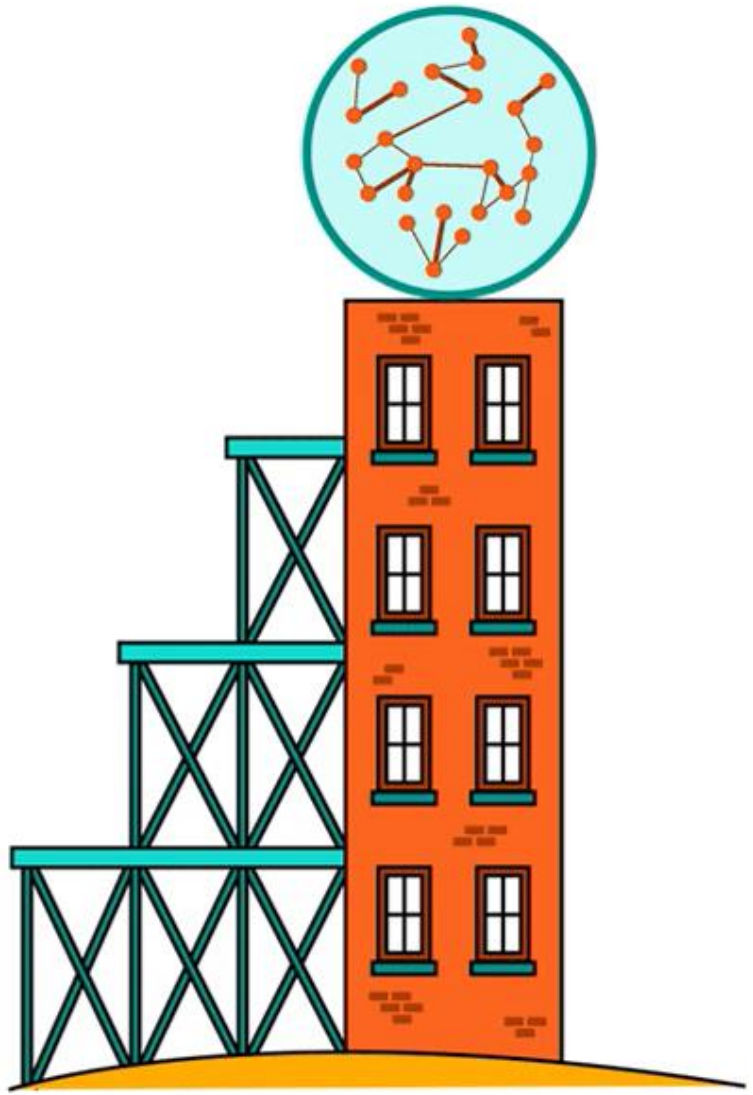
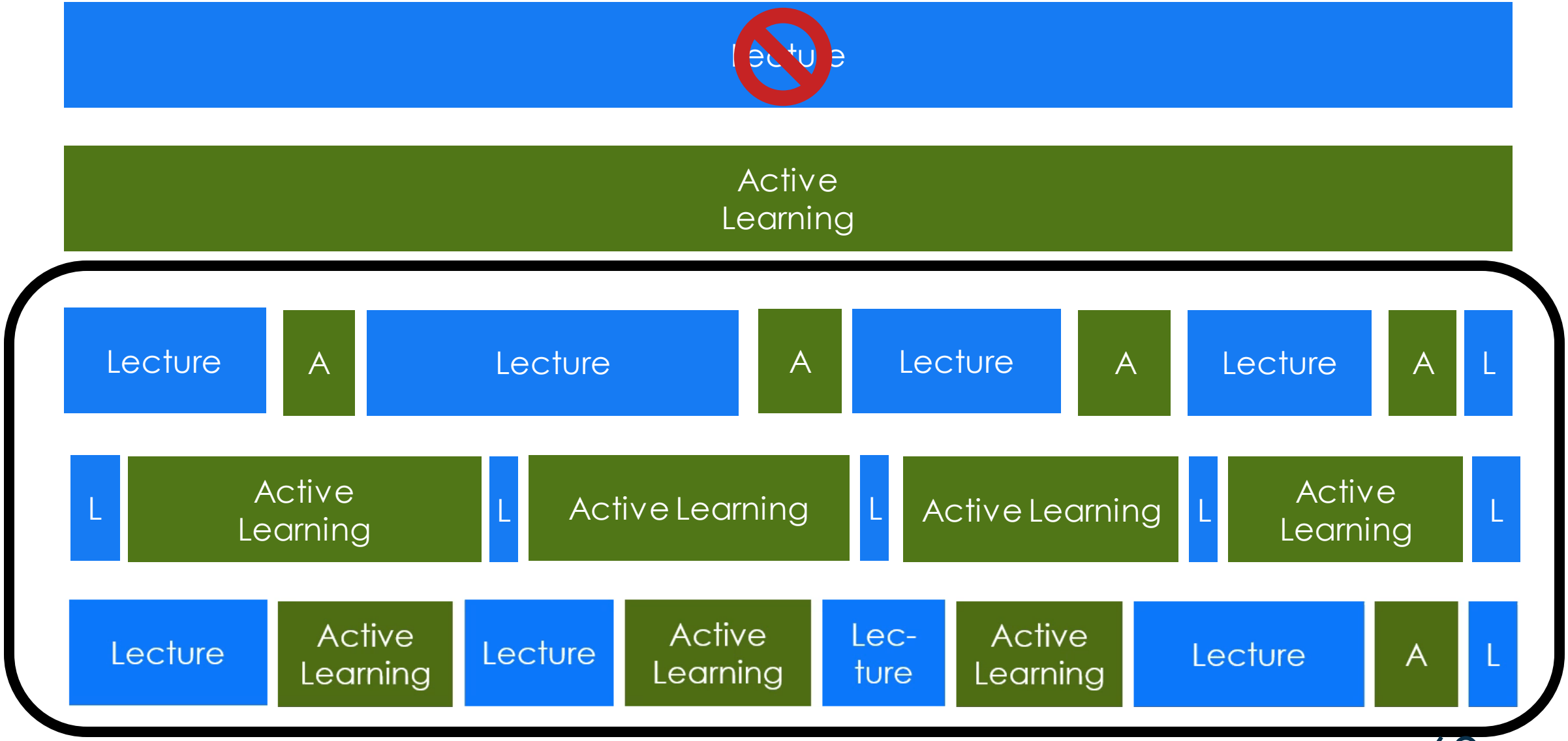
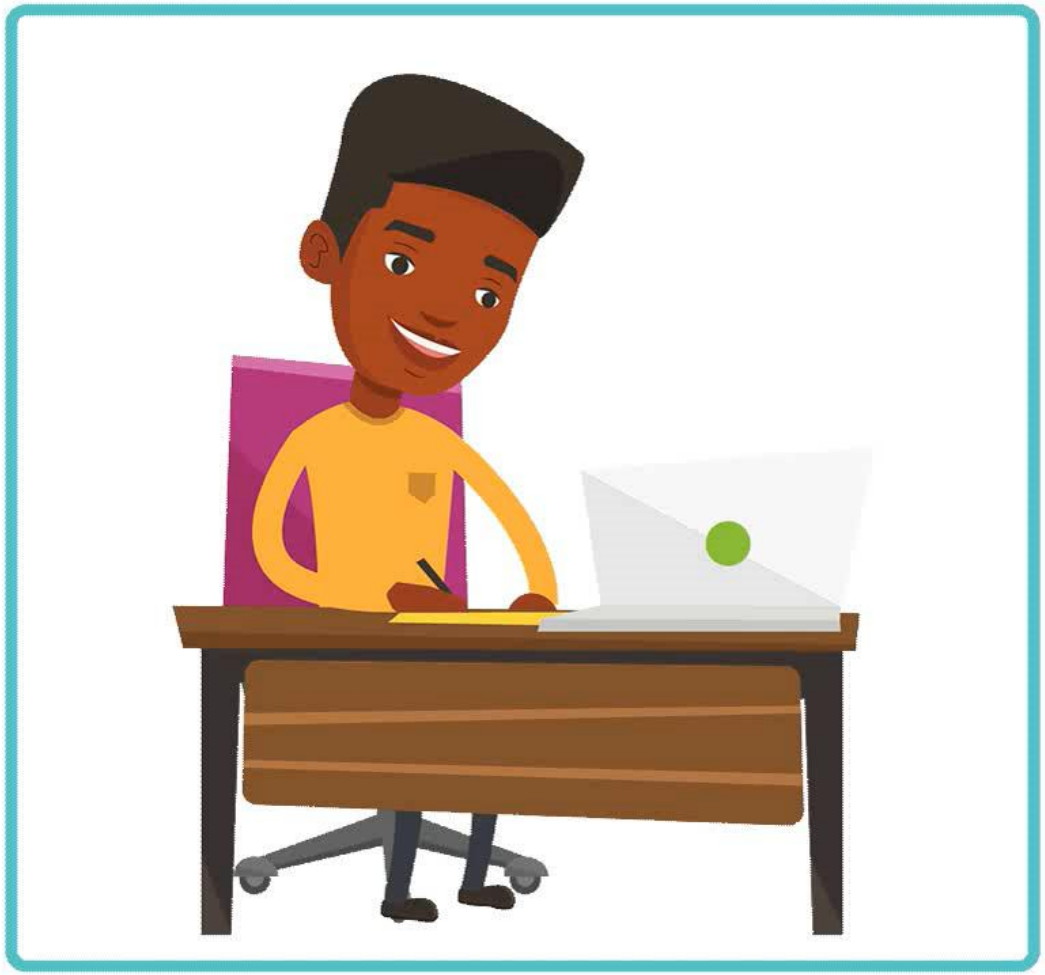


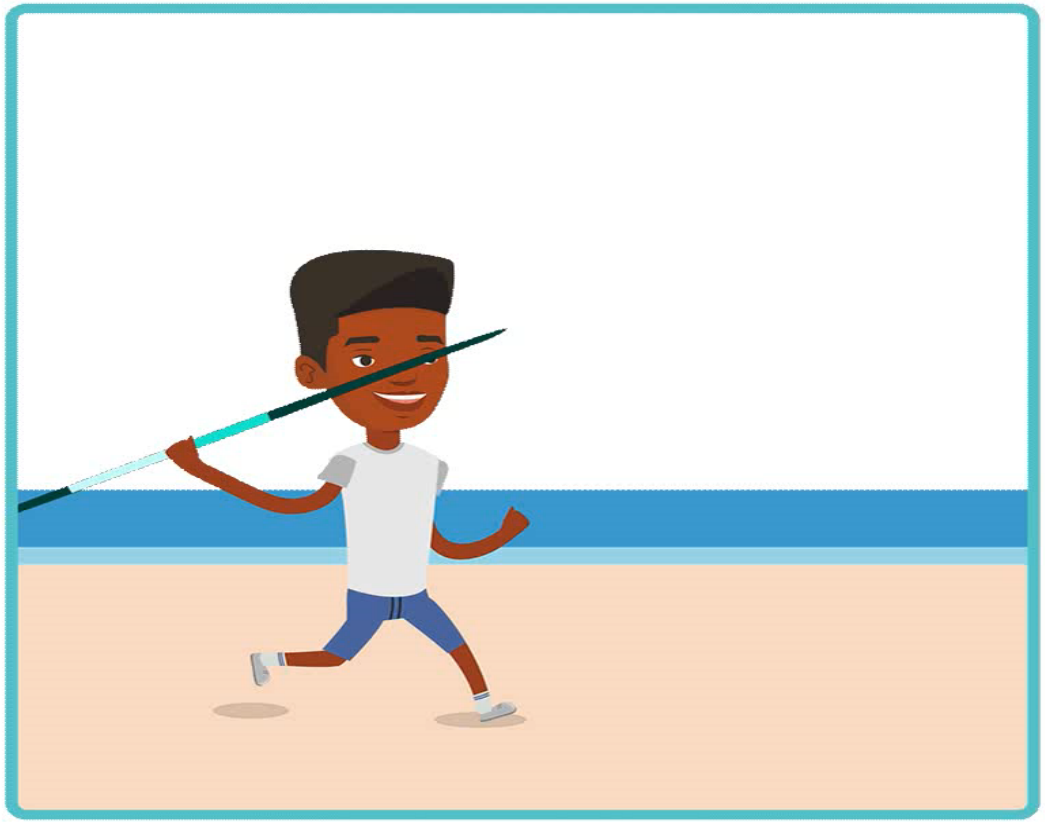
Photo by Erik van Leeuwen

Julius Yego



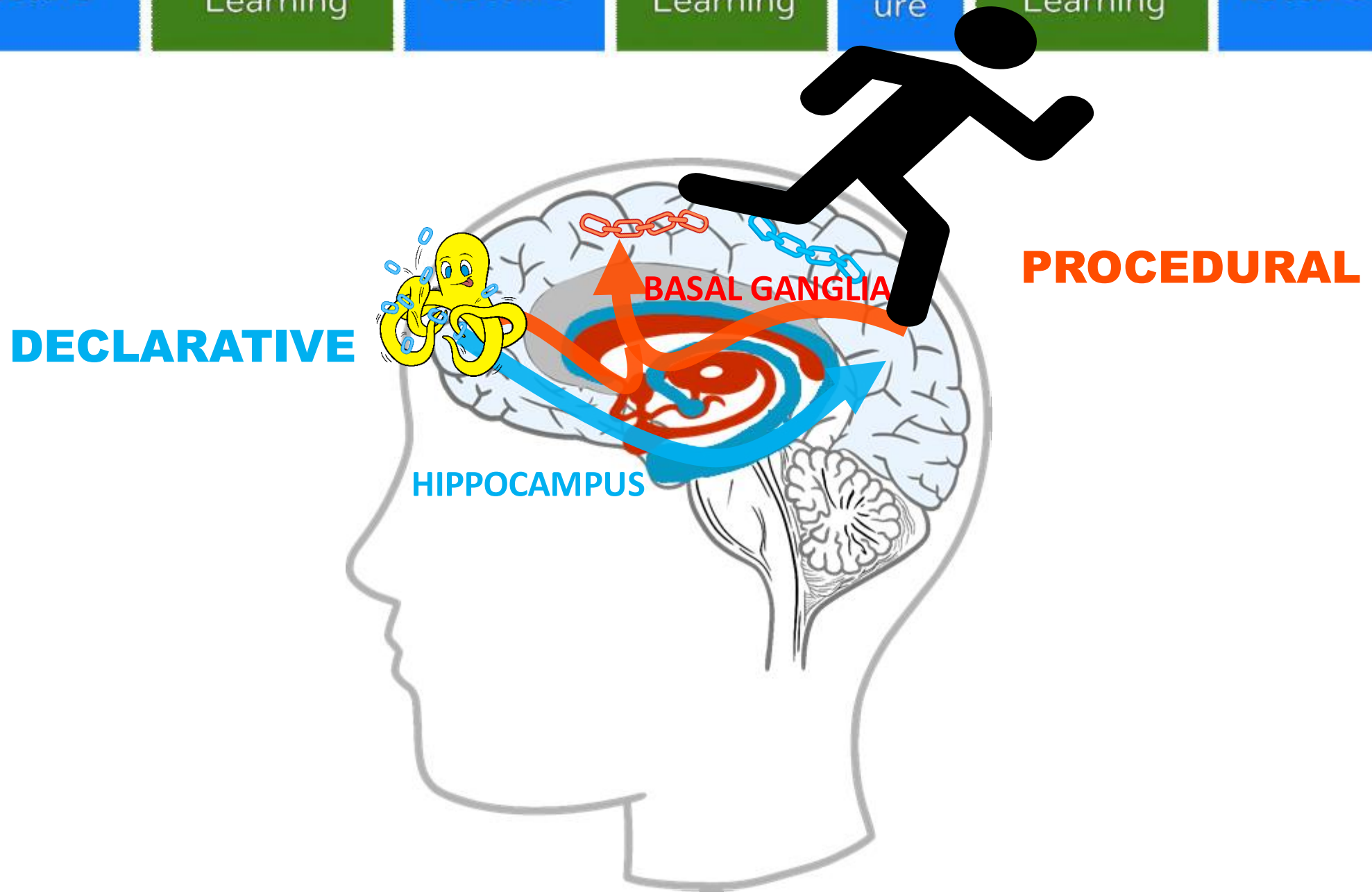
Direct instruction





Lecture	Active Learning	Lecture	Active Learning	Lect-ure	Active Learning	Lecture	

Lecture	Active Learning	Lecture	Active Learning	Lect-ure	Active Learning	Lecture	



DECLARATIVE

PROCEDURAL

RETRIEVAL PRACTICE

SPACED REPETITION

EXPLANATION

INTERLEAVING

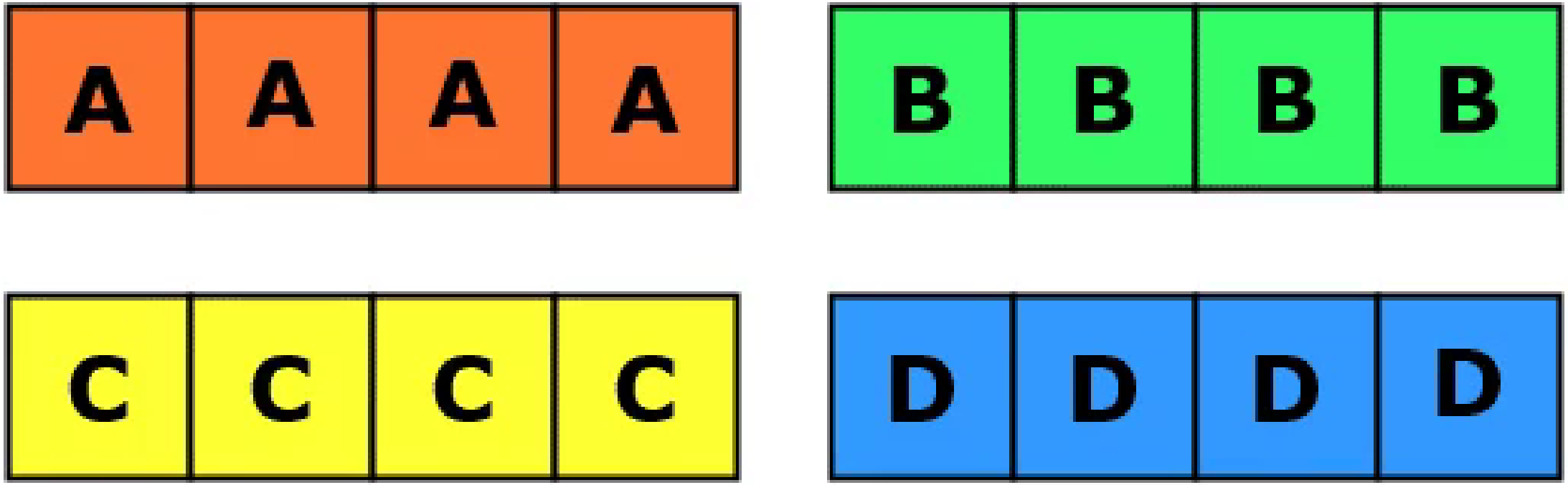
DECLARATIVE

- You're mostly conscious of it
- Develops through explicit instruction
- You can explain it.
- Involves sequential tasks.
- Fast to learn, slow to use.
- Flexible

PROCEDURAL

- You're not conscious of it
- Develops through *practice*
- You can't explain it (or not easily)
- Involves complex patterns
- Slow to learn, fast to use
- Inflexible

Blocking versus Interleaving



Interleaving

Plain Assignment

Topic 7 problem 4

Topic 7 problem 9

Topic 7 problem 15

Topic 7 problem 17

Topic 7 problem 22

Interleaved Assignment

Topic 7 problem 4

Topic 4 problem 8

Topic 7 problem 9

Topic 6 problem 26

Topic 7 problem 15

Topic 5 problem 18

Topic 7 problem 17

Interleaving in language learning

- Present
- Past
- Future

Be careful with your interleaving!

Flash Anzan

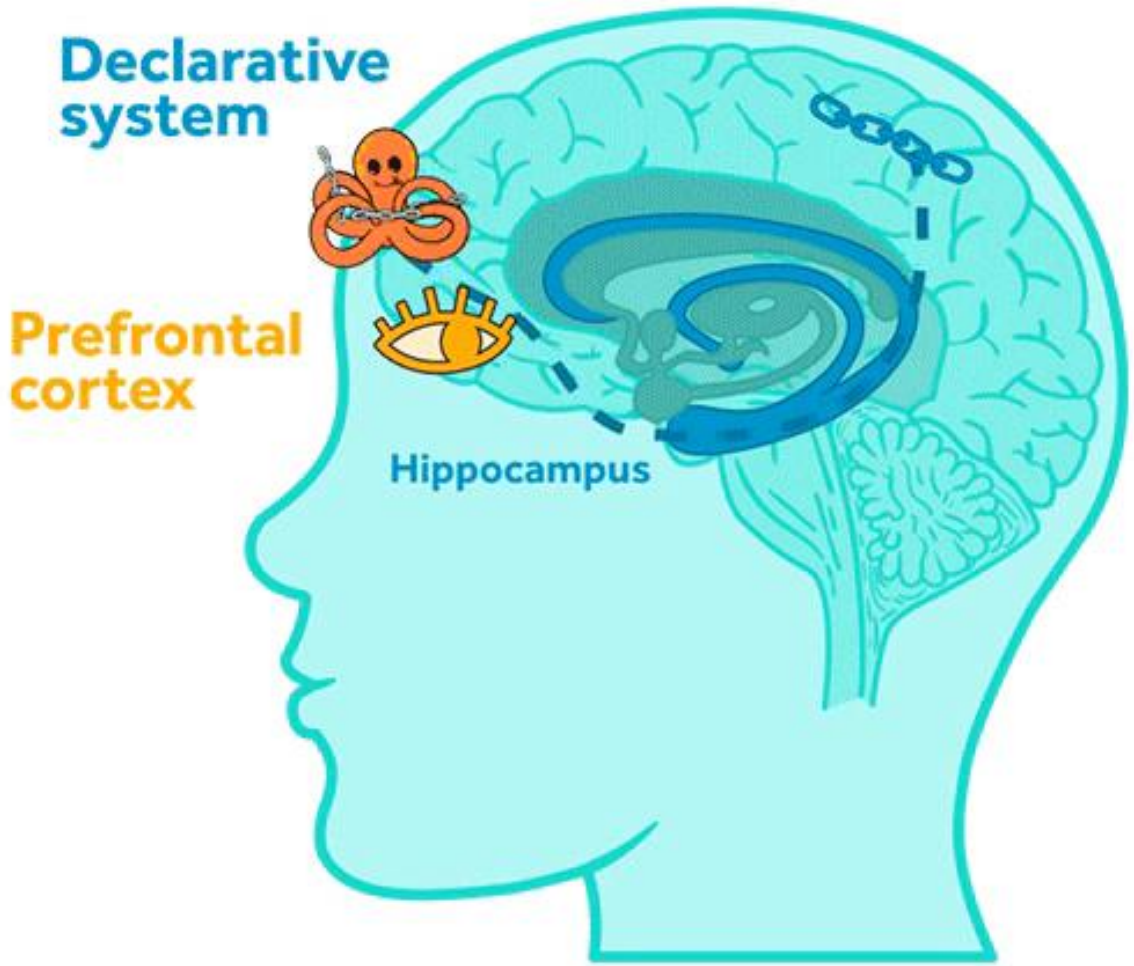
Shiritori

Shiritori *with* Flash Anzan

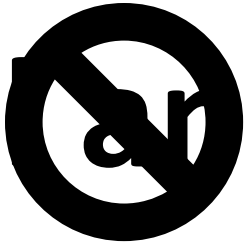
Alex Bellos: Flash Anzan Shiritori, https://www.youtube.com/watch?v=_vGMsVirYKs

Interleaving

How do links become procedural?

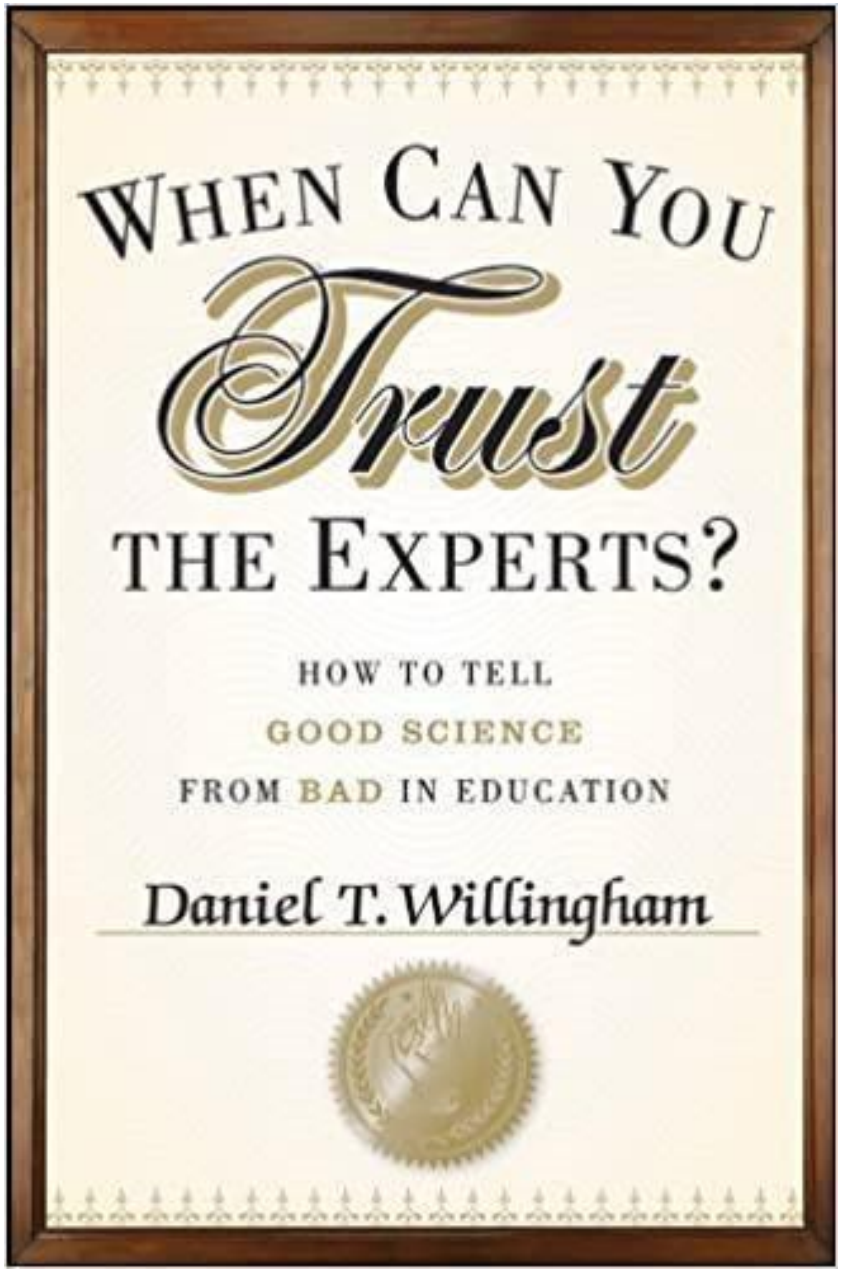


When you eliminate rote learning (“Drill and kill”)



You eliminate the easiest, best way the brain has to handle routine learning tasks.

Drill to skill!



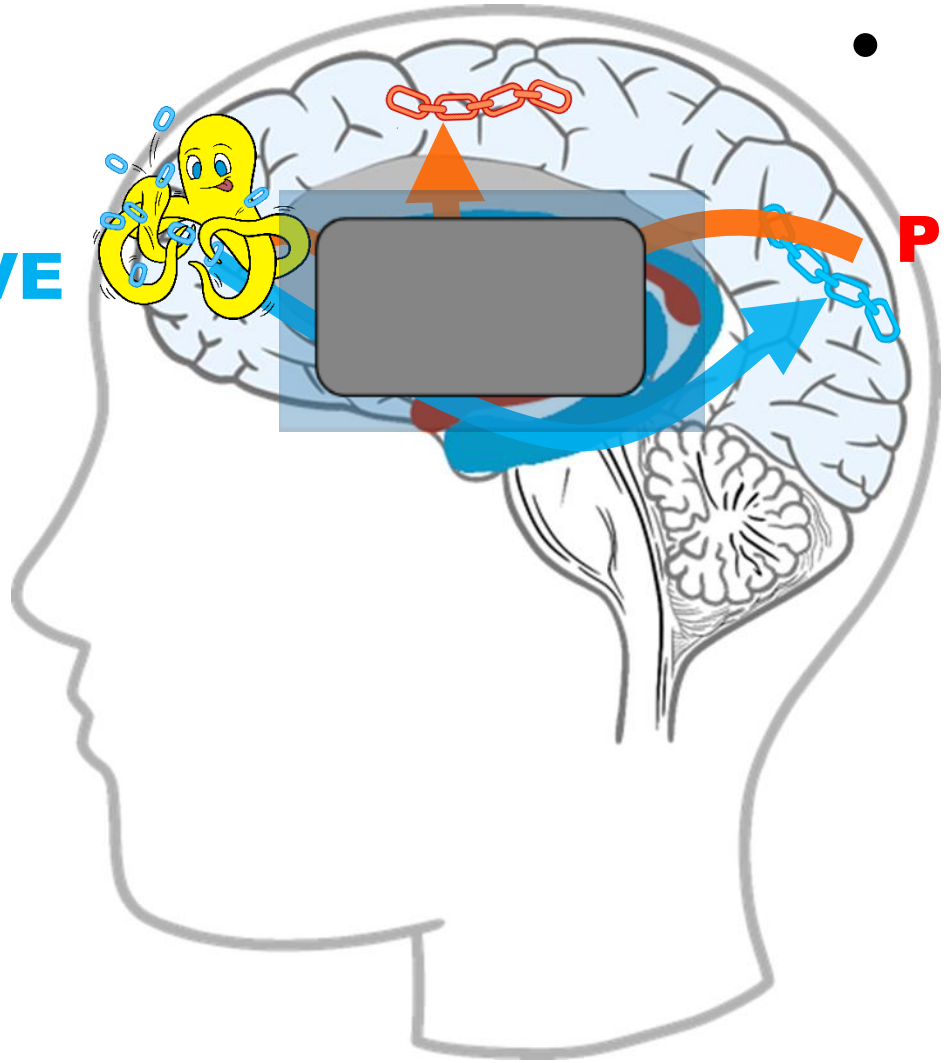
Educators fall into two groups:

Understand the world through:

- **Reason**
- **Experience**

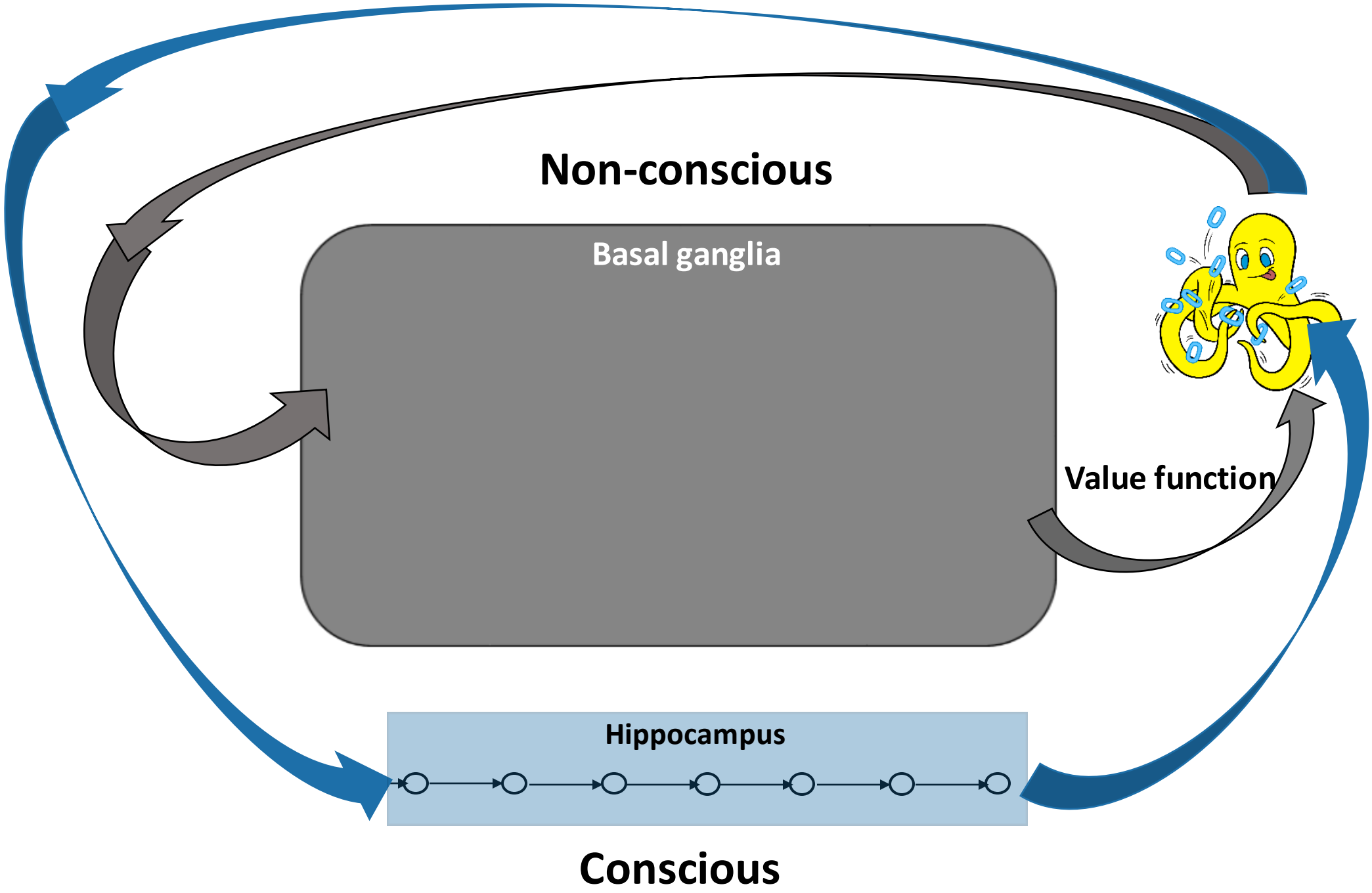
- **Reason**

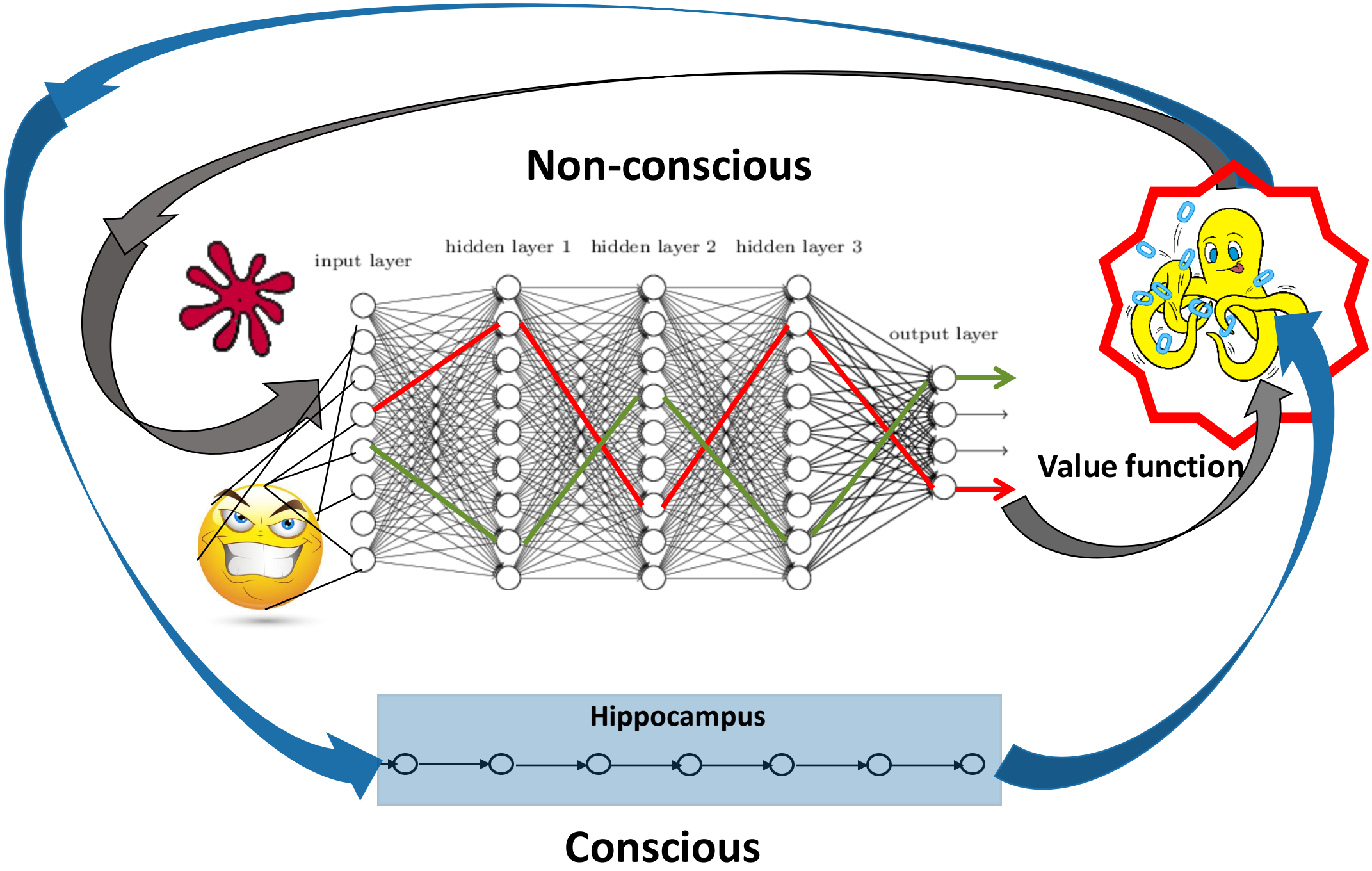
DECLARATIVE



- **Experience**

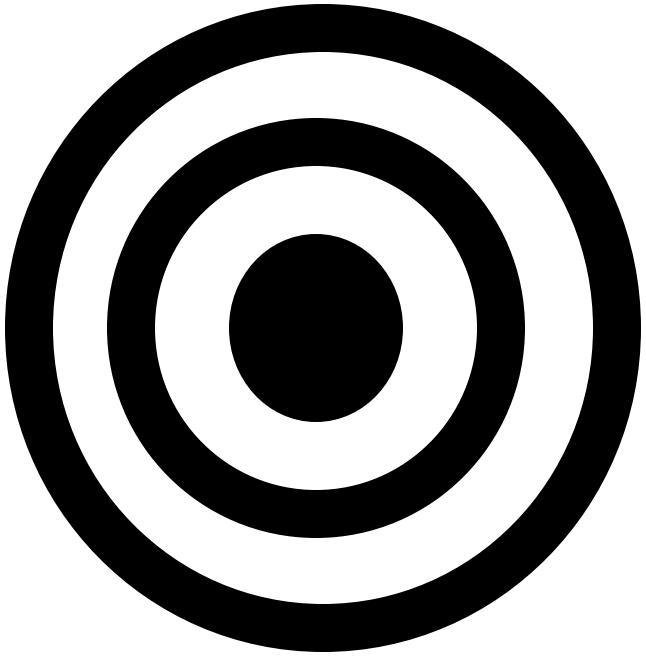
PROCEDURAL


Non-conscious
Basal ganglia
Value function
Hippocampus
Conscious


Non-conscious
input layer
hidden layer 1
hidden layer 2
hidden layer 3
output layer
Value function
Hippocampus
Conscious

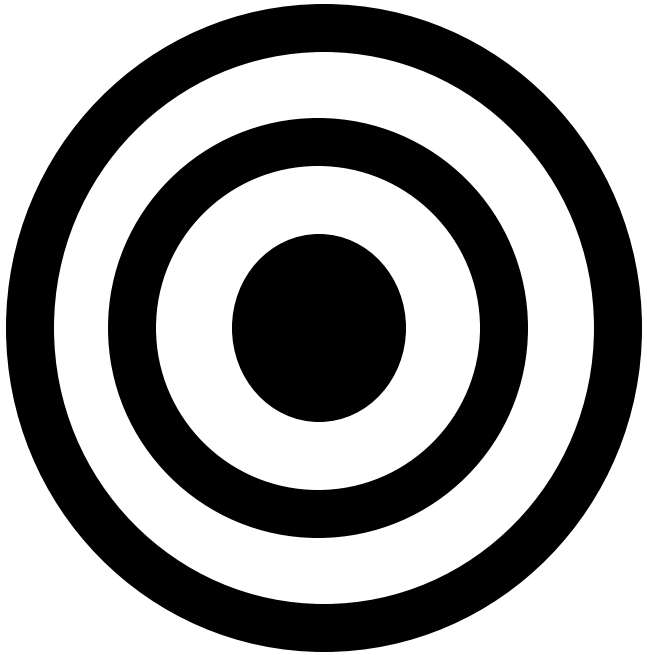
Characteristics of fast versus slow learners

- Fast but often inaccurate

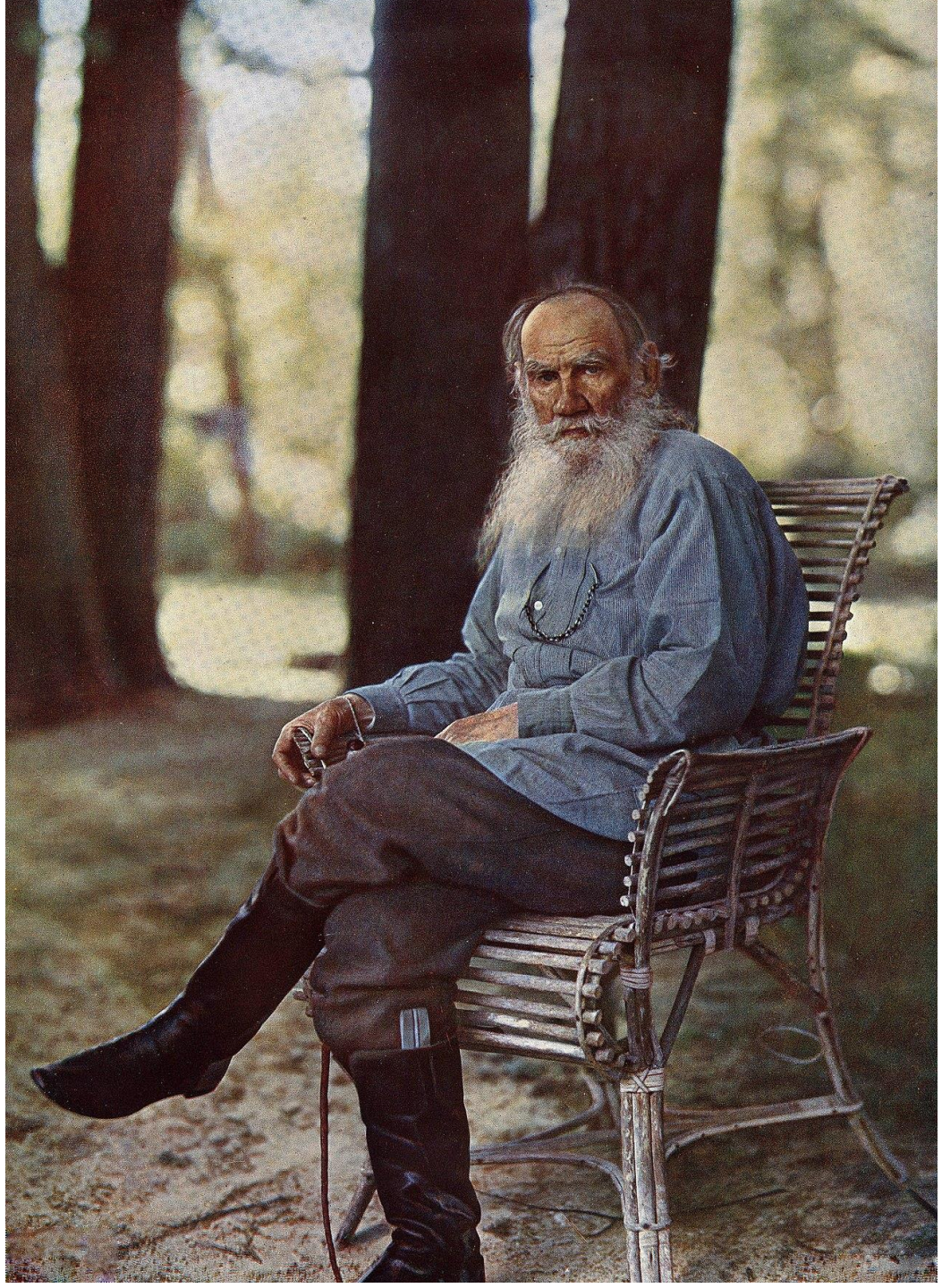


Inflexible

- Slow but more accurate



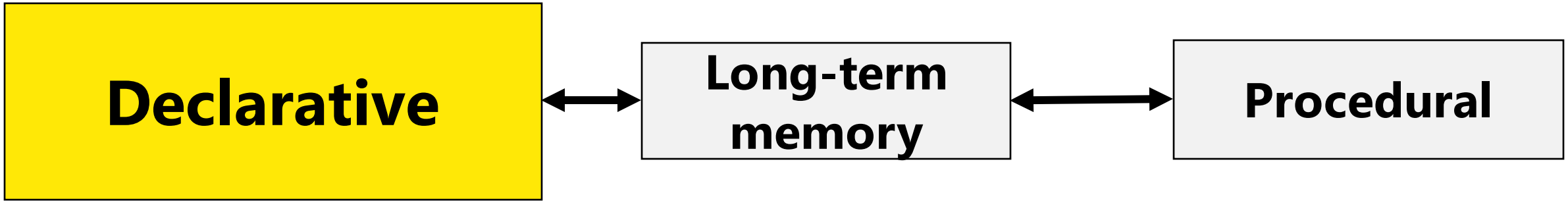
Flexible

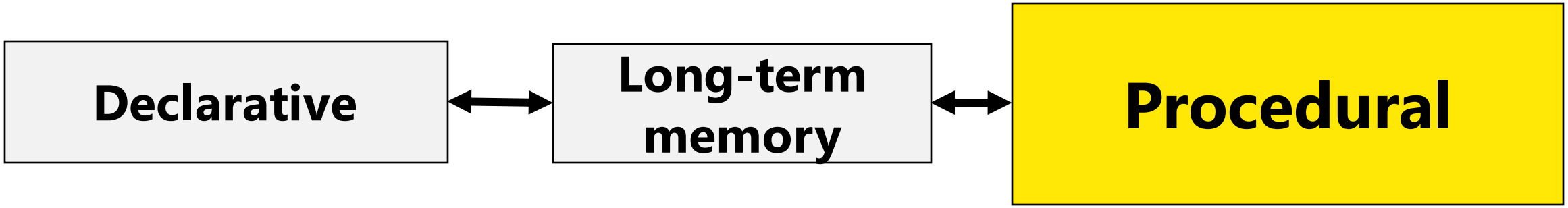


Leo Tolstoy

"…the simplest thing cannot be made clear to the most intelligent man if he is firmly persuaded that he knows already, without a shadow of doubt, what is laid before him."

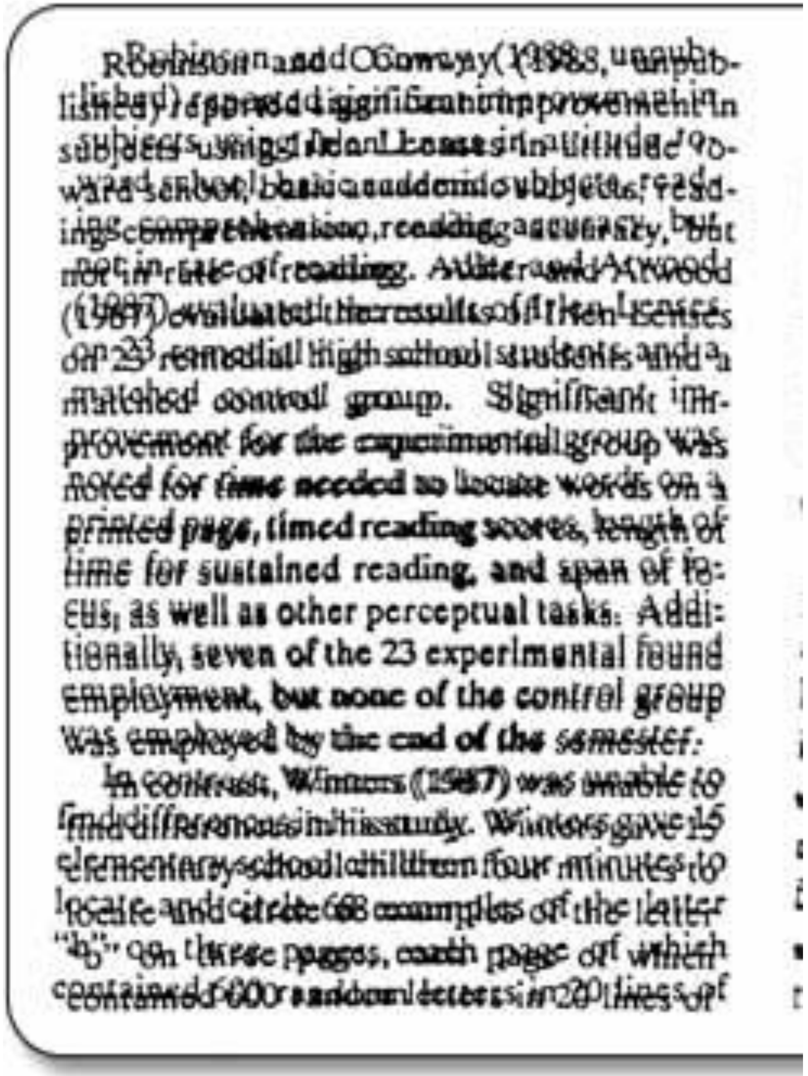

Declarative
Long-term memory
Procedural


Declarative
Long-term memory
Procedural


Declarative
Long-term memory
Procedural


Declarative
Long-term memory
Procedural

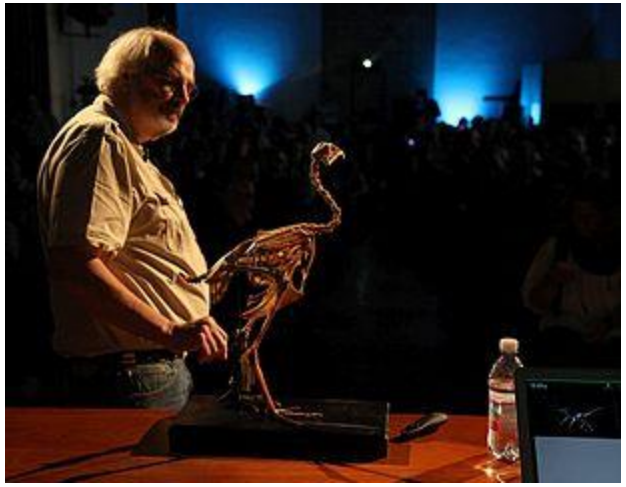
- Learning through one system can inhibit learning through the other
- Word-laden math impedes those with dyslexia

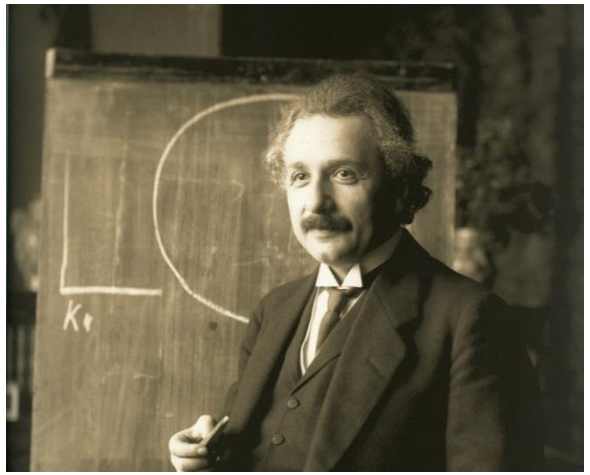


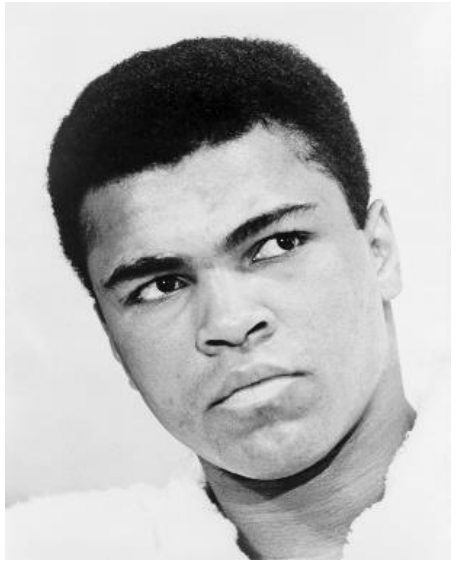
Robinson and Conway (1988, unpublished) reported significant improvement in subjects using Irlen Lenses in attitude toward school, basic academic subjects, reading comprehension, reading accuracy, but not in rate of reading. Adler and Atwood (1987) evaluated the results of Irlen Lenses on 23 remedial high school students and a matched control group. Significant improvement for the experimental group was noted for time needed to locate words on a printed page, timed reading scores, length of time for sustained reading, and span of focus, as well as other perceptual tasks. Additionally, seven of the 23 experimental found employment, but none of the control group was employed by the end of the semester.

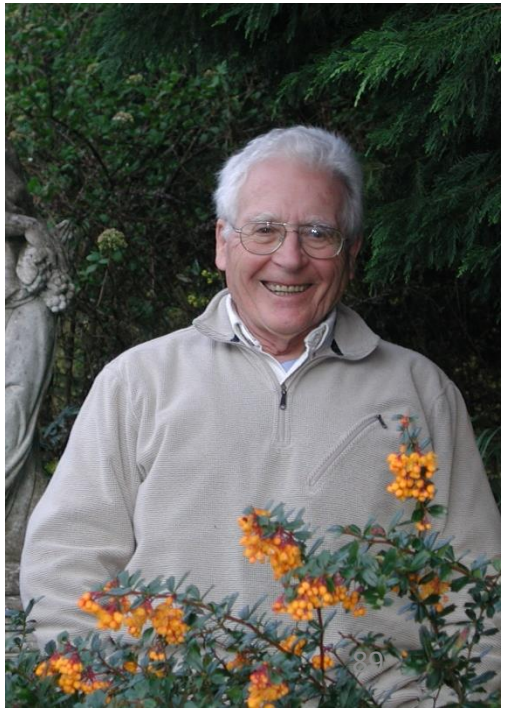
In contrast, Winters (1987) was unable to find differences in his study. Winters gave 15 elementary school children four minutes to locate and circle 68 examples of the letter "b" on three pages, each page of which contained 600 random letters in 20 lines of

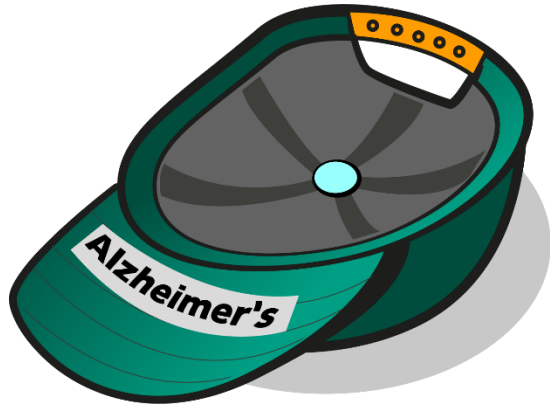
Nature loves heterogeneity
—Terrence Sejnowski



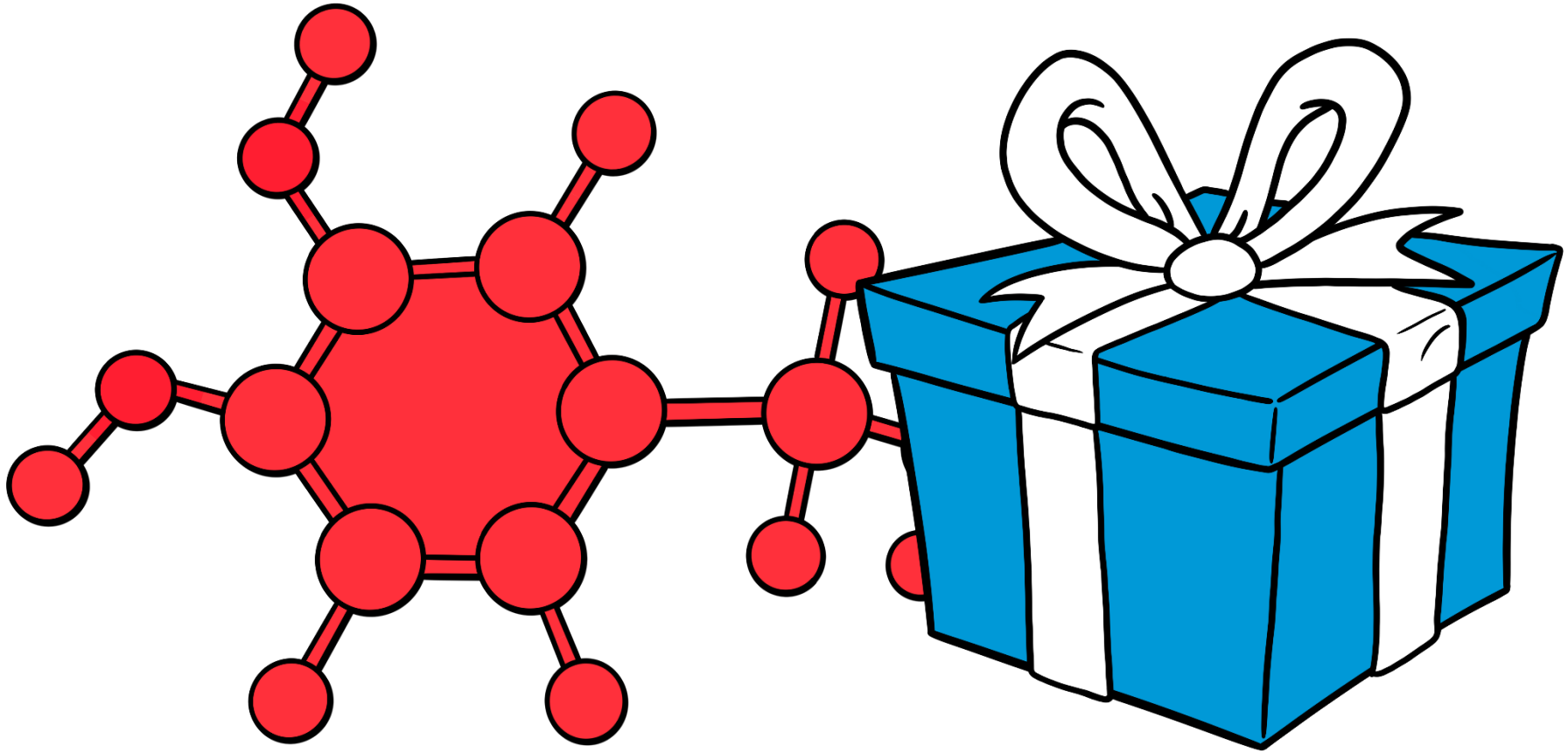




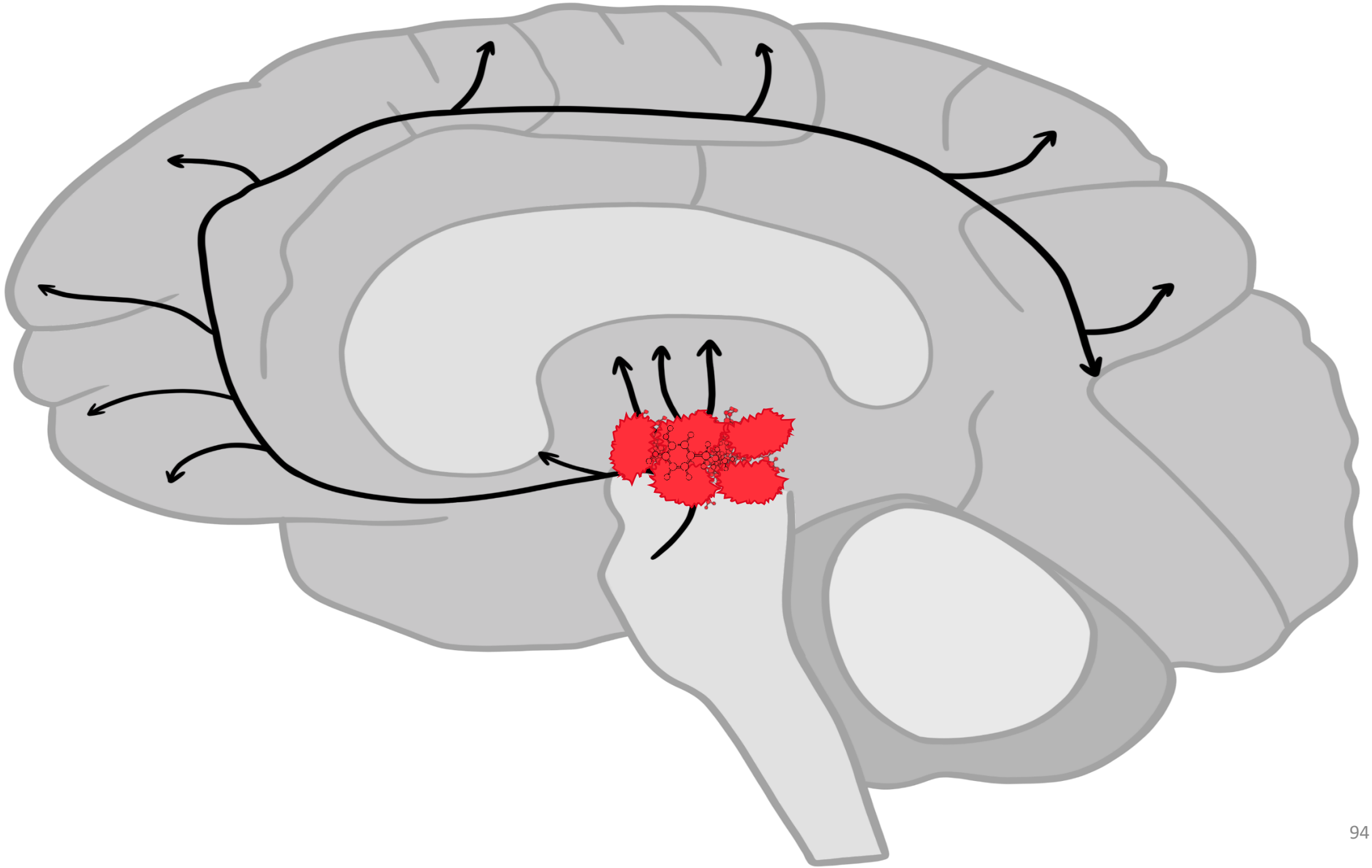


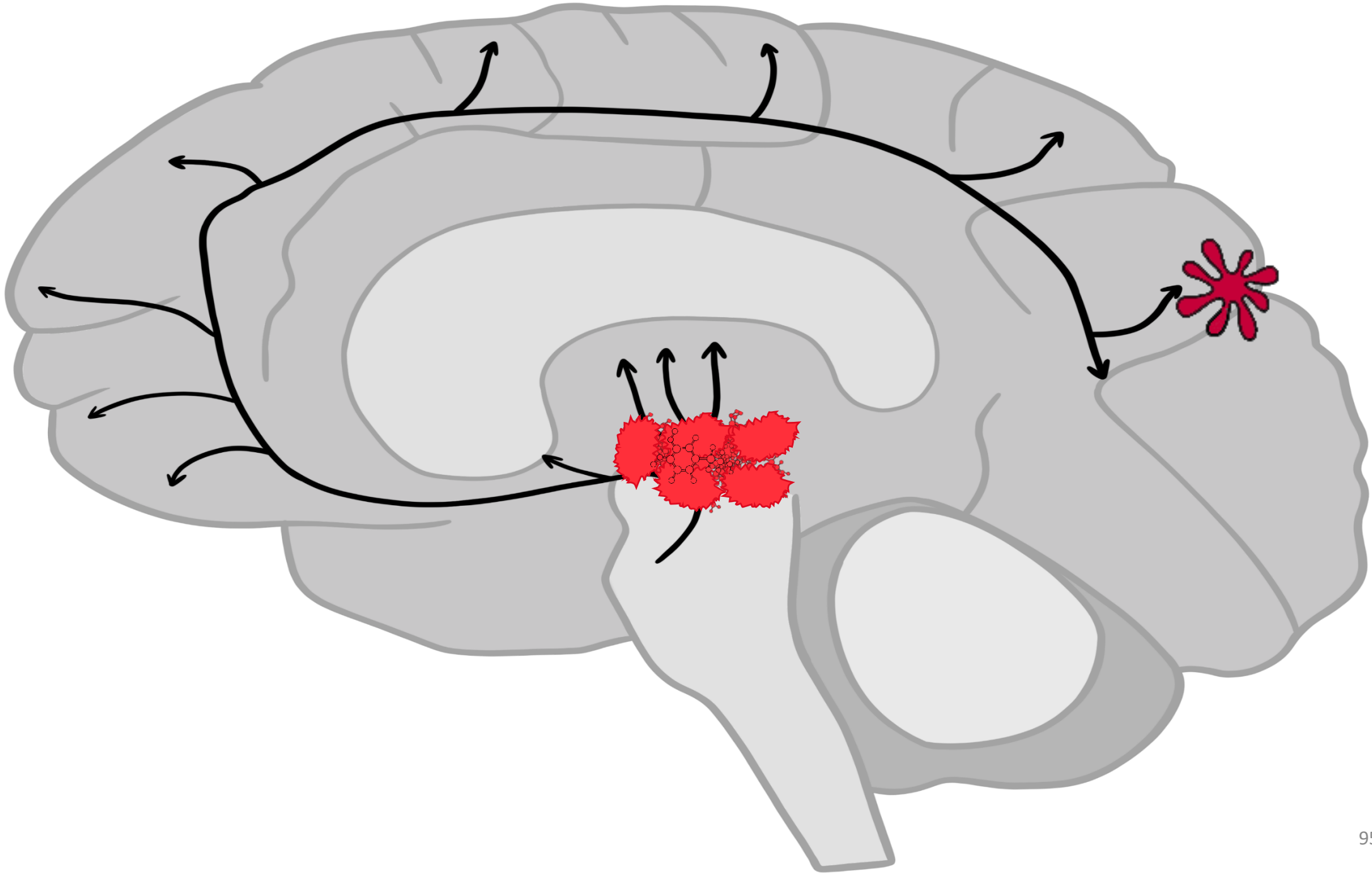


“Map Habit”

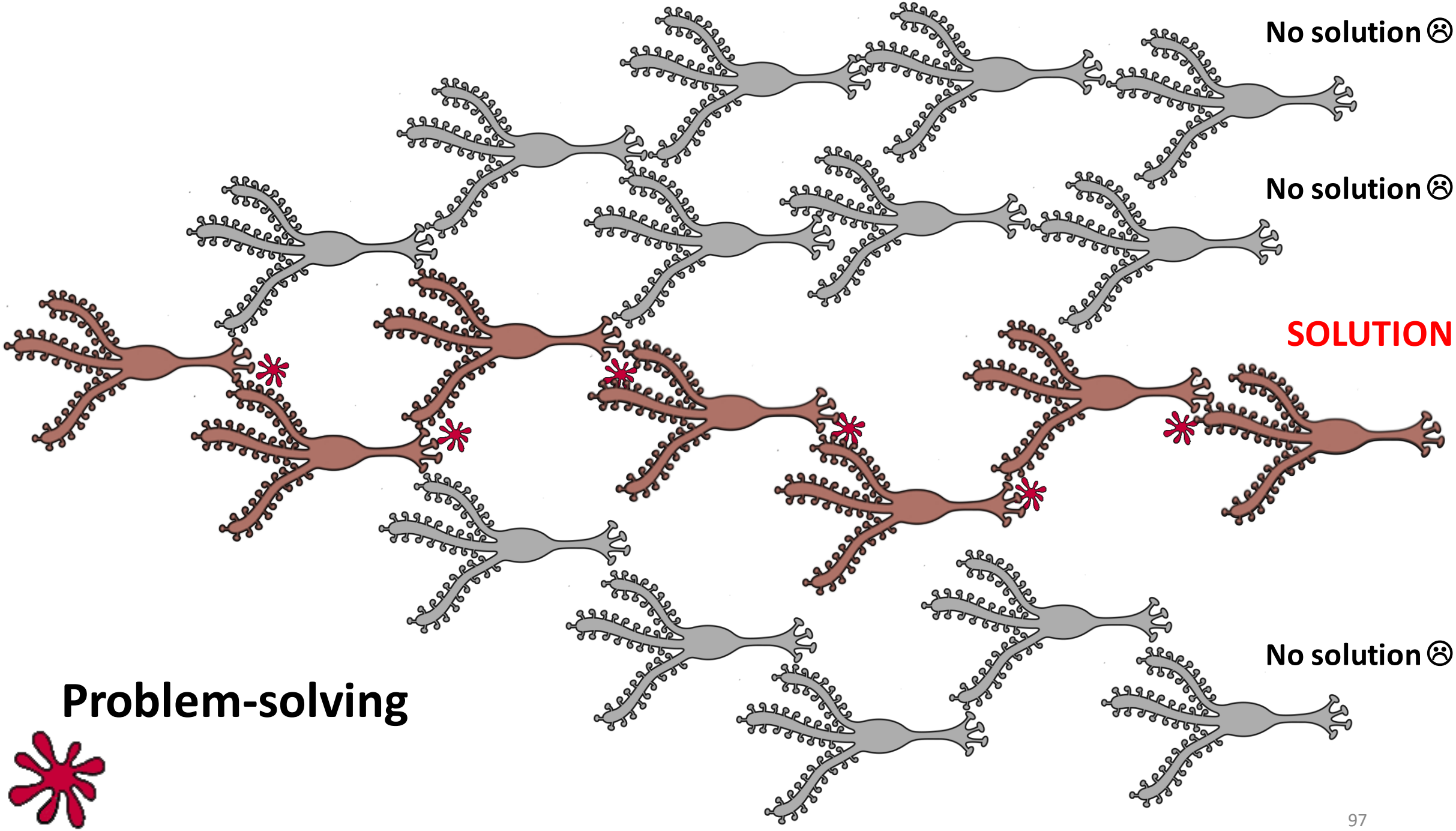


Dopamine—the “feel good molecule”

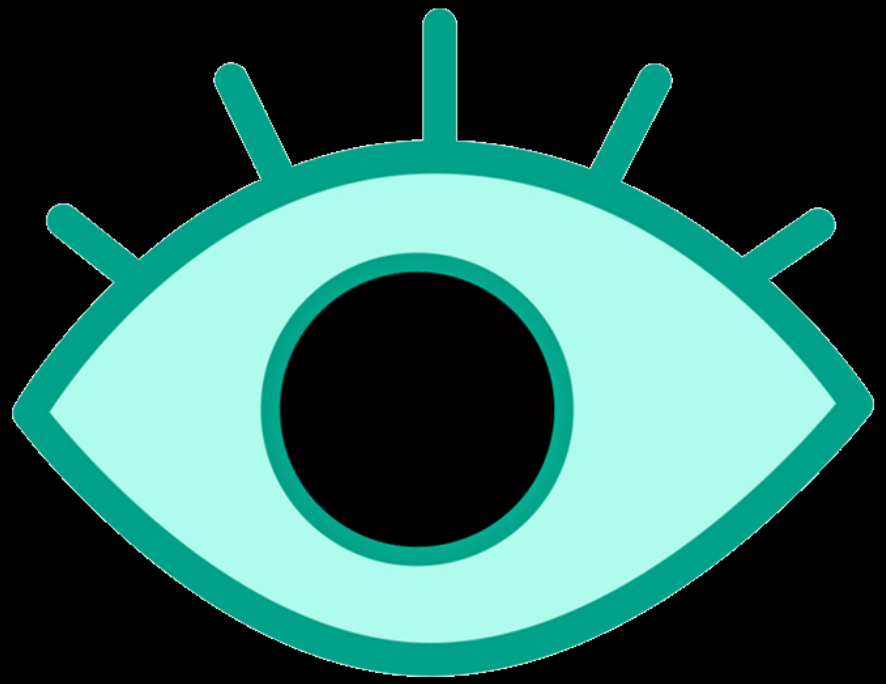


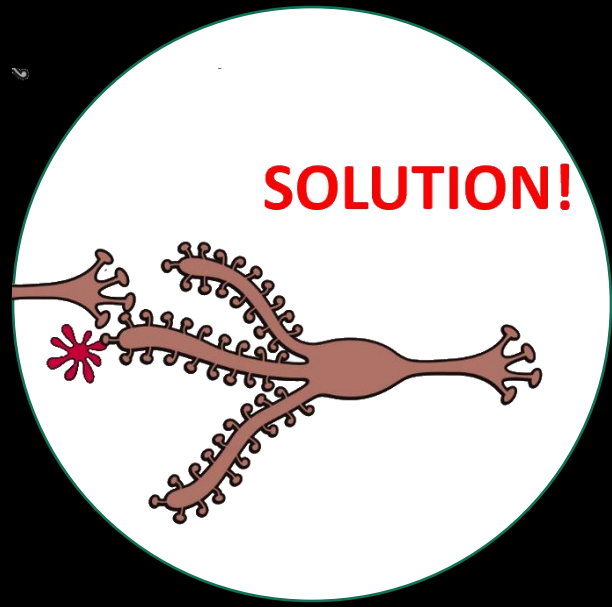


Mice with inactivated dopamine systems *can't learn anything new.*

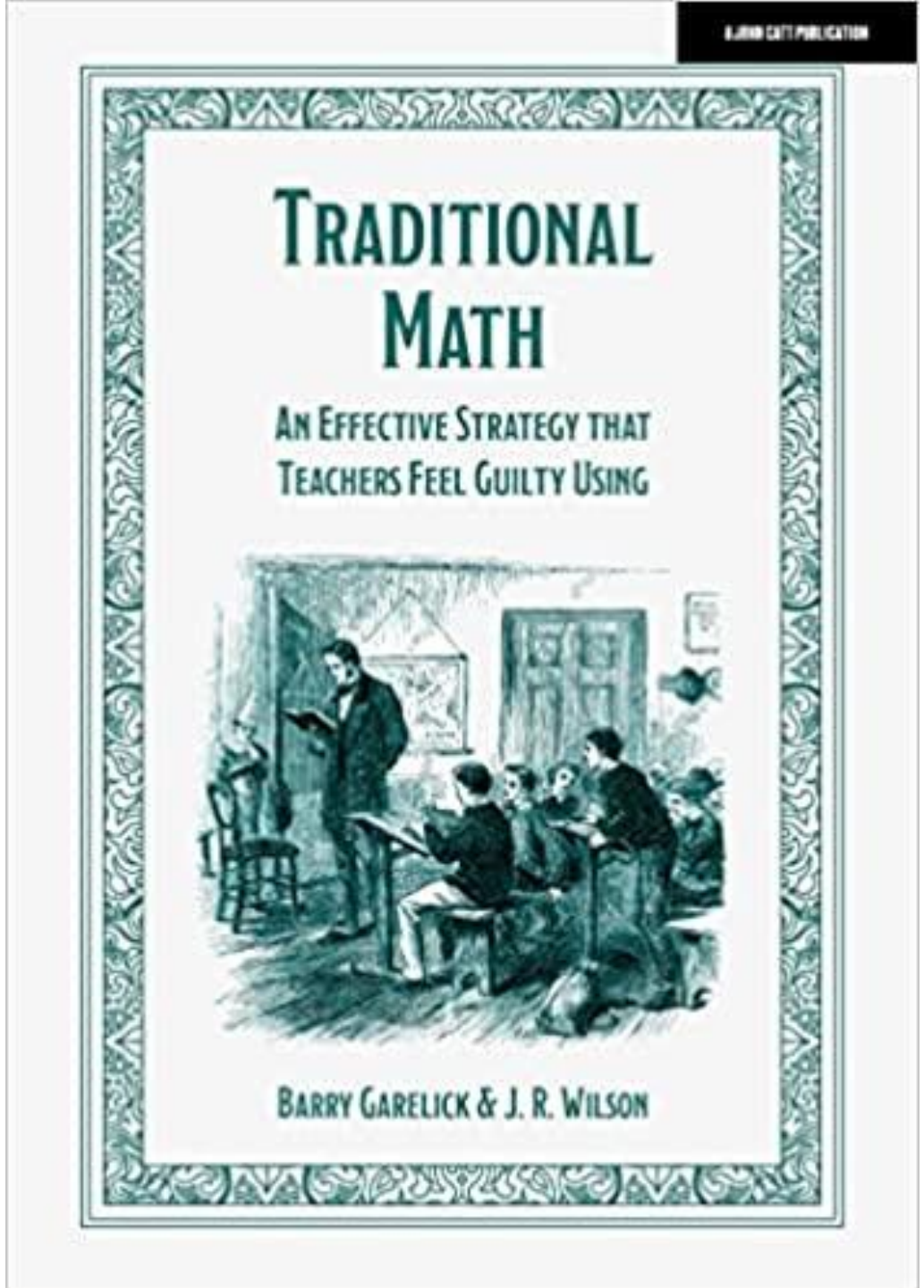

No solution ☹
No solution ☹
SOLUTION!
No solution ☹
Problem-solving

Hooks & curiosity suppress diffuse mode and enhance focus

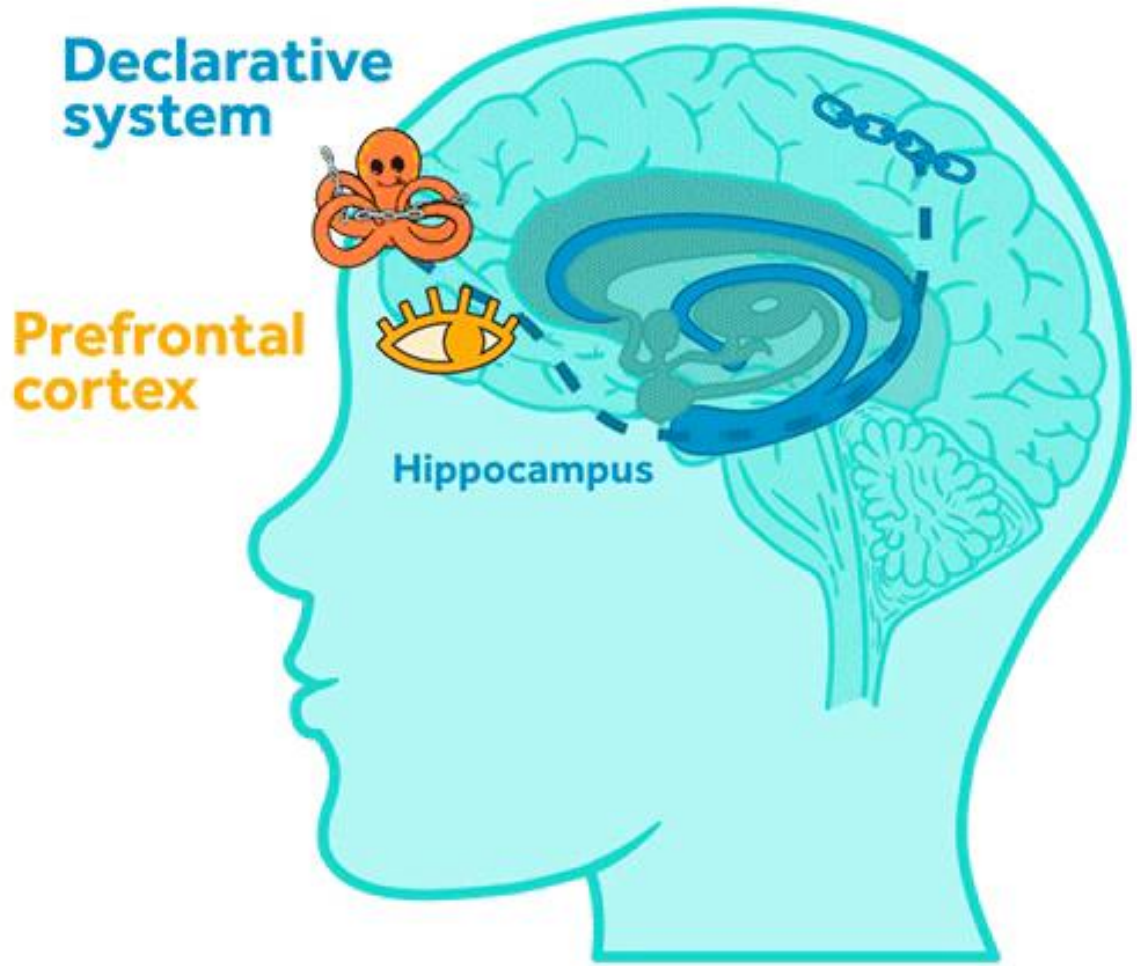


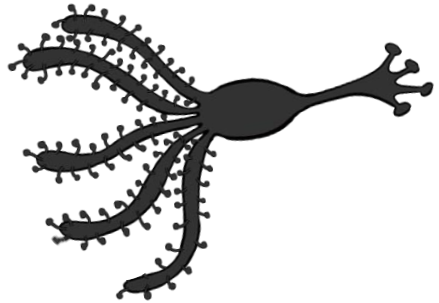
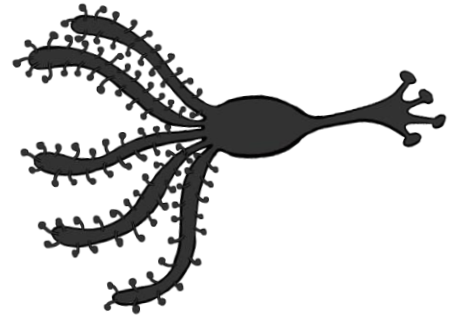
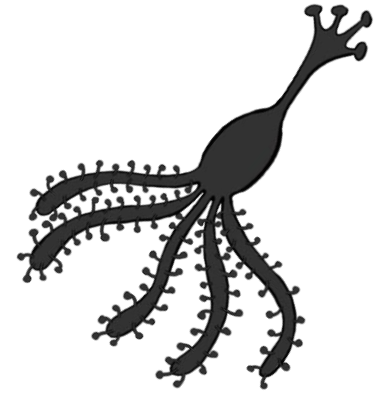
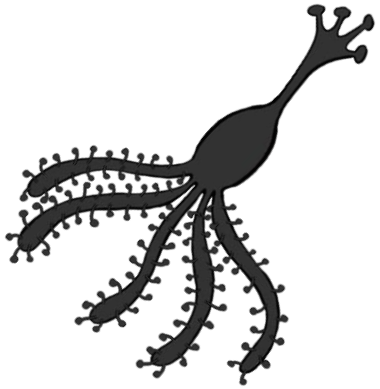
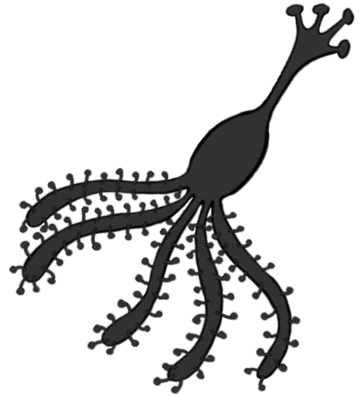
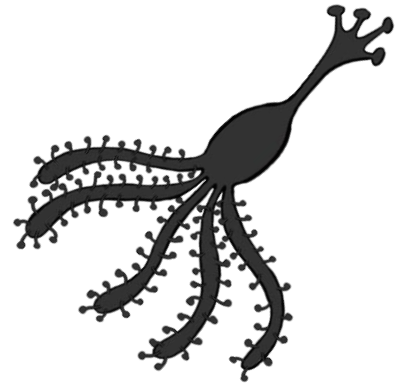


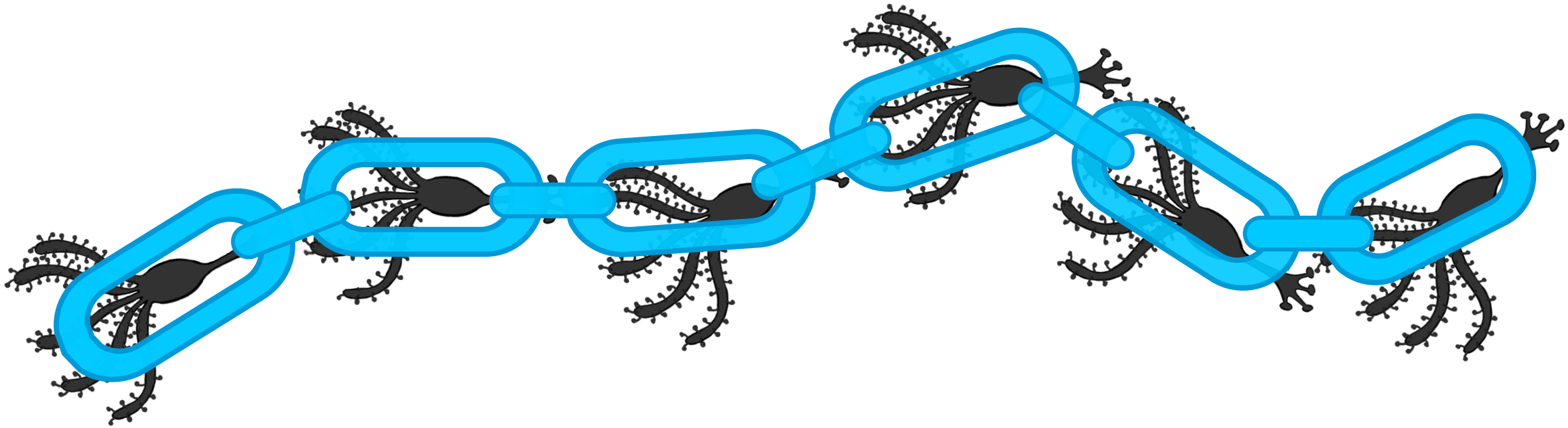
Julius Yego


TRADITIONAL
MATH
AN EFFECTIVE STRATEGY THAT
TEACHERS FEEL GUILTY USING
BARRY GARELICK & J. R. WILSON

How do links become procedural?

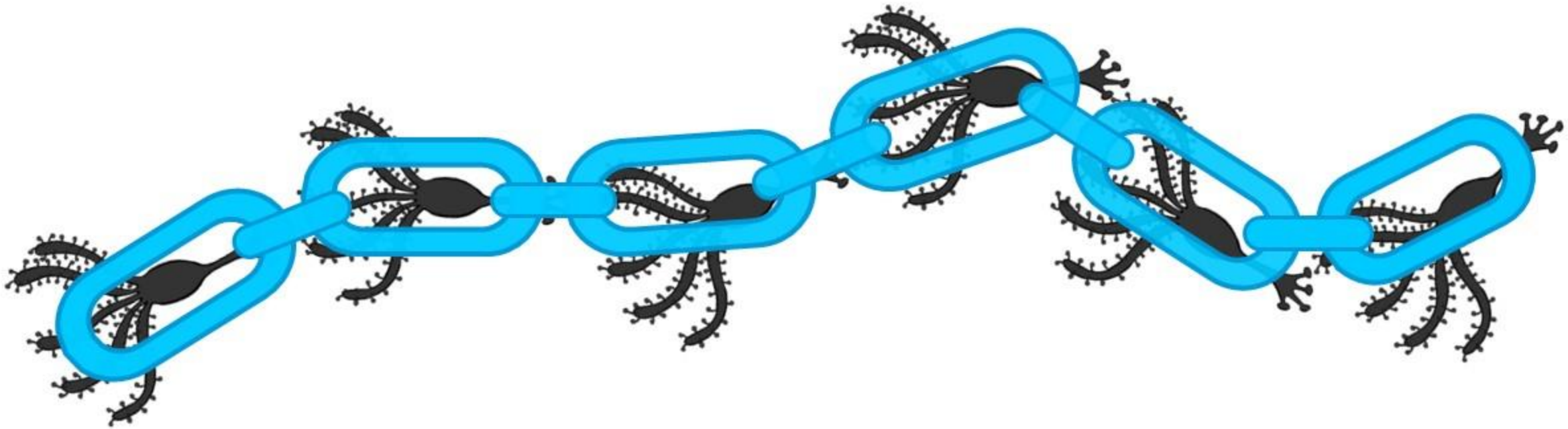




How does the brain construct conceptions?

Through map-making!

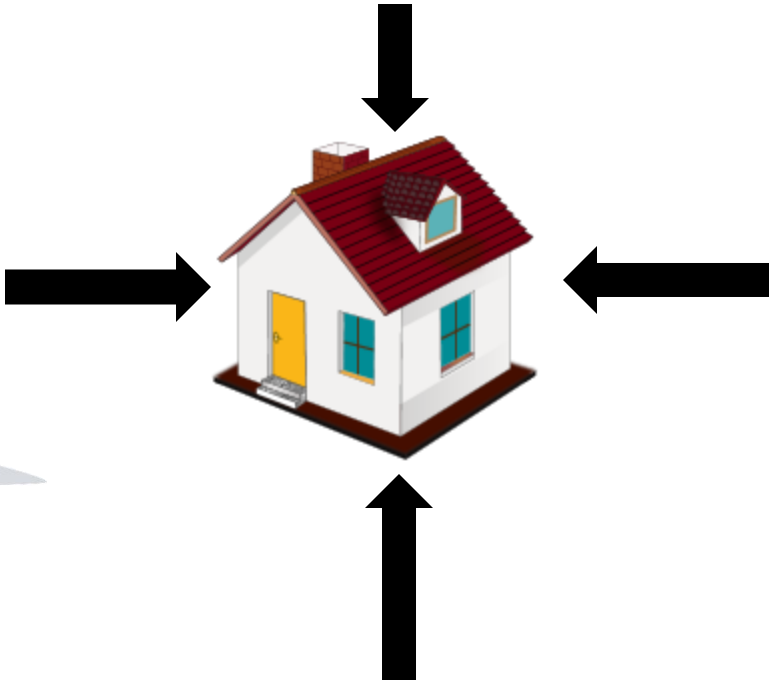


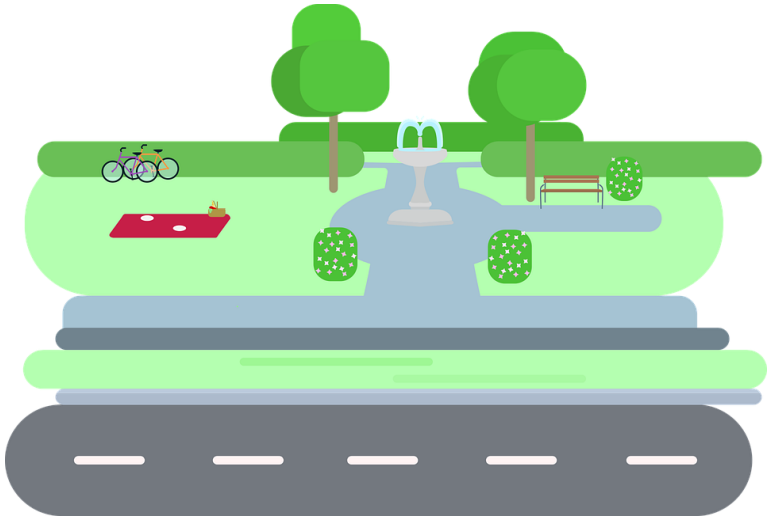
How does the brain construct conceptions?

Through map-making!

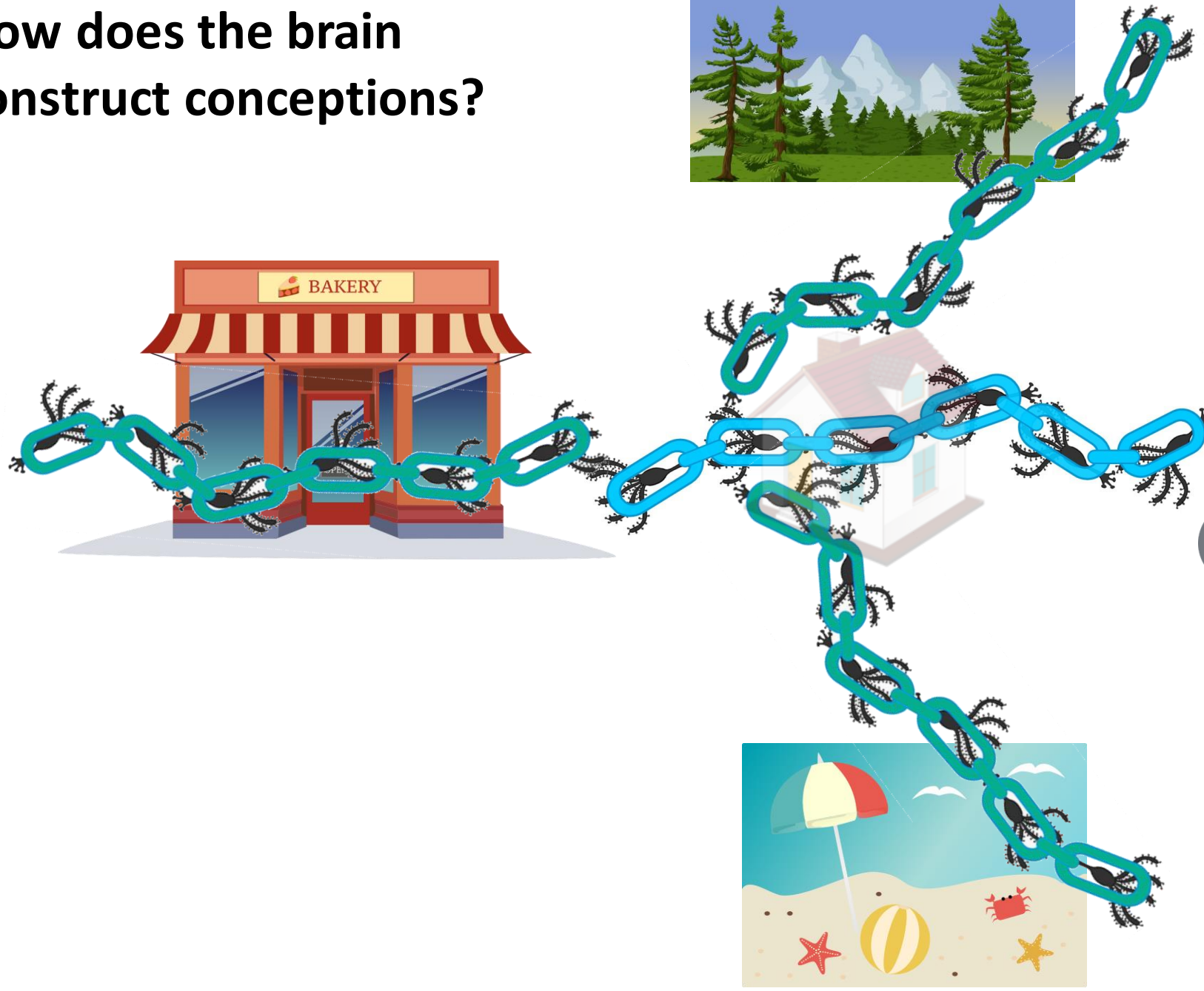
How does the brain construct conceptions?

Through map-making!

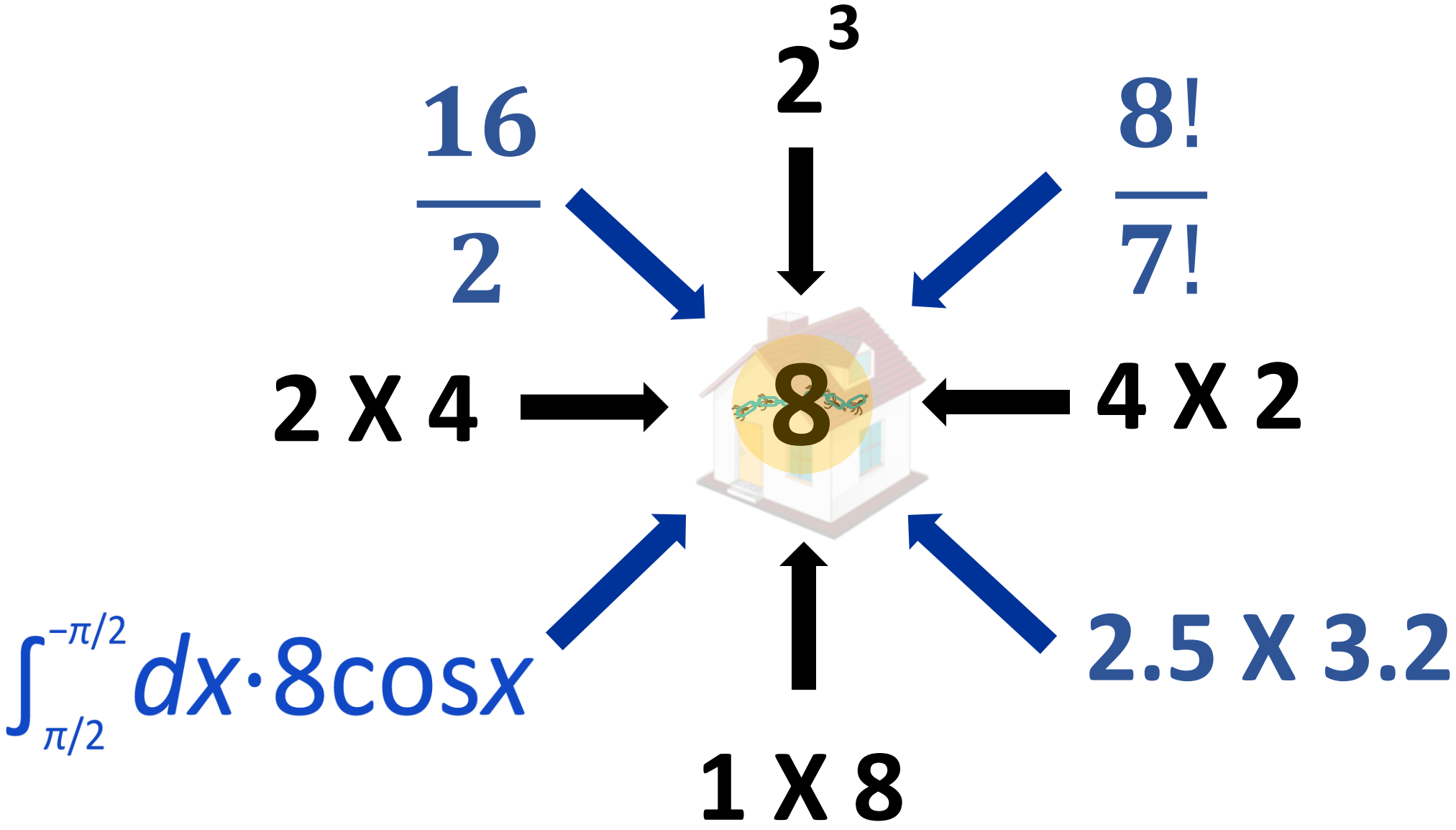




How does the brain construct conceptions?



Through map-making!

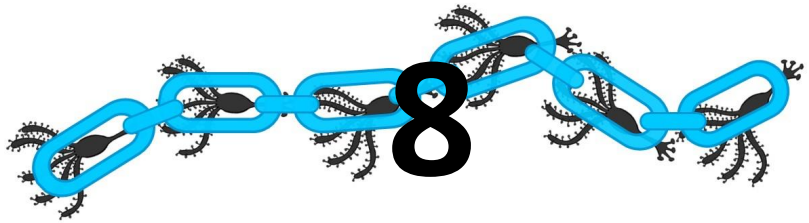

$\frac{16}{2}$
2^3
$\frac{8!}{7!}$
2 X 4
8
4 X 2
$\int_{\pi/2}^{-\pi/2} dx \cdot 8\cos x$
1 X 8
2.5 X 3.2

$\frac{16}{2}$

2^3

$\frac{8!}{7!}$

2 X 4



8

4 X 2

$\int_{\pi/2}^{-\pi/2} dx \cdot 8\cos x$

1 X 8

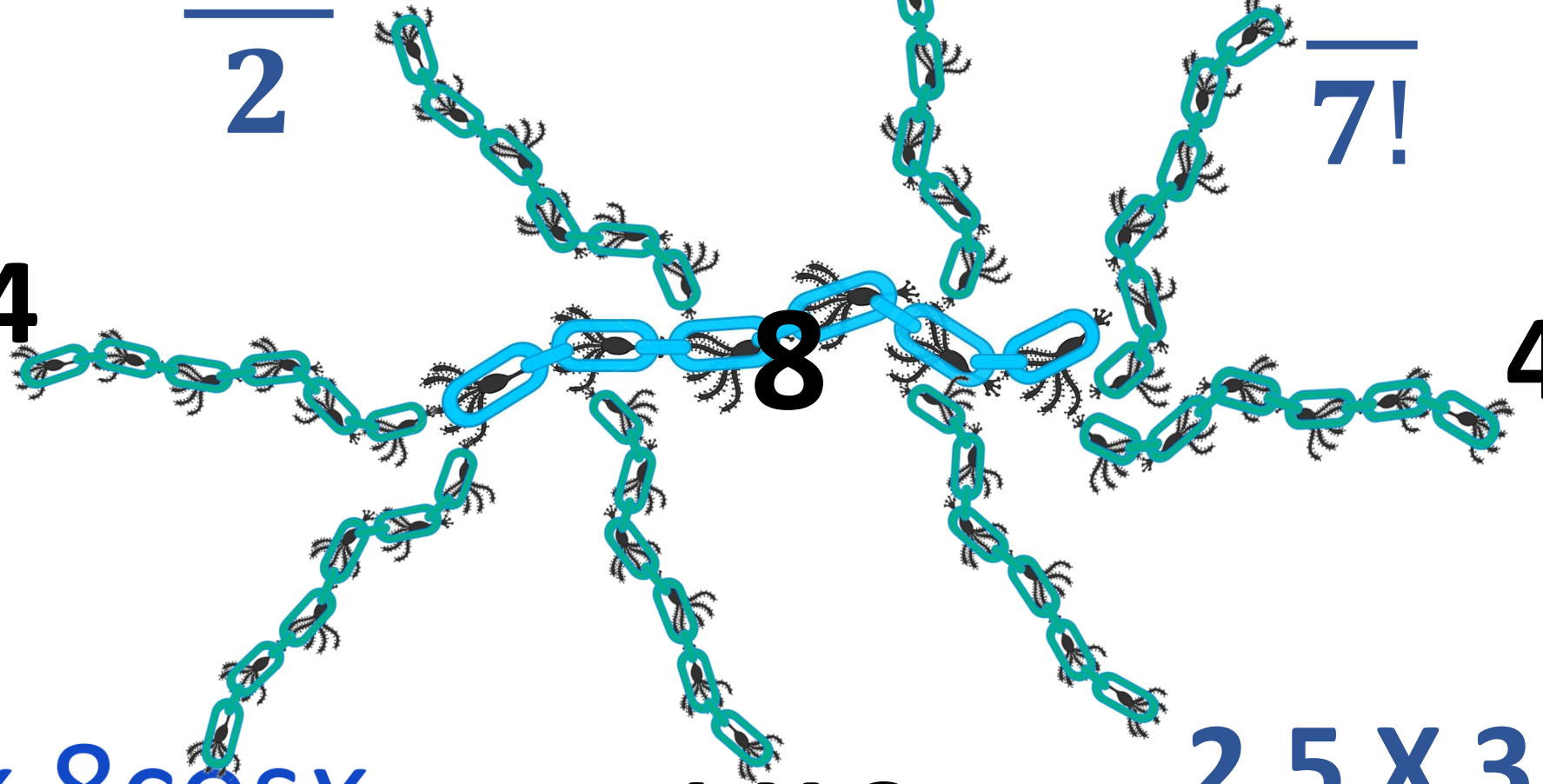
2.5 X 3.2

$\frac{16}{2}$

2^3

$\frac{8!}{7!}$

2 X 4

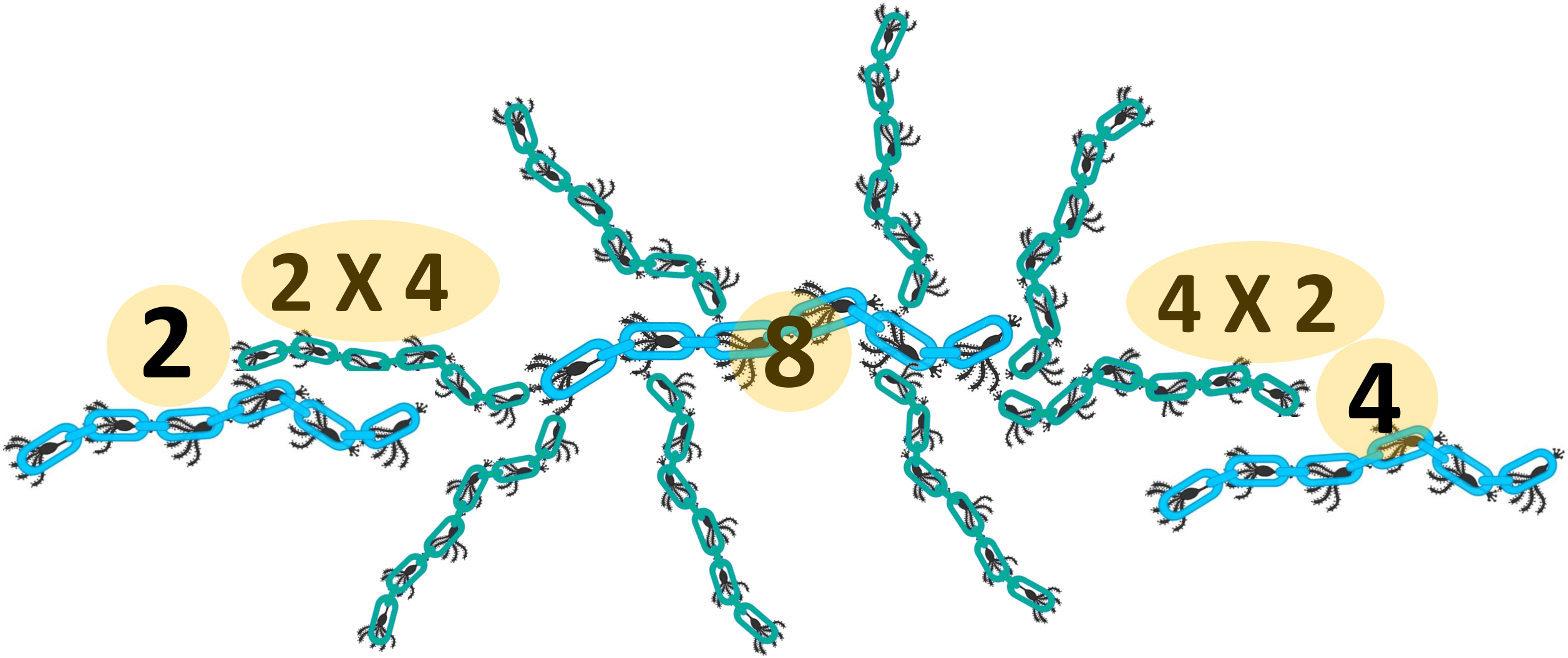


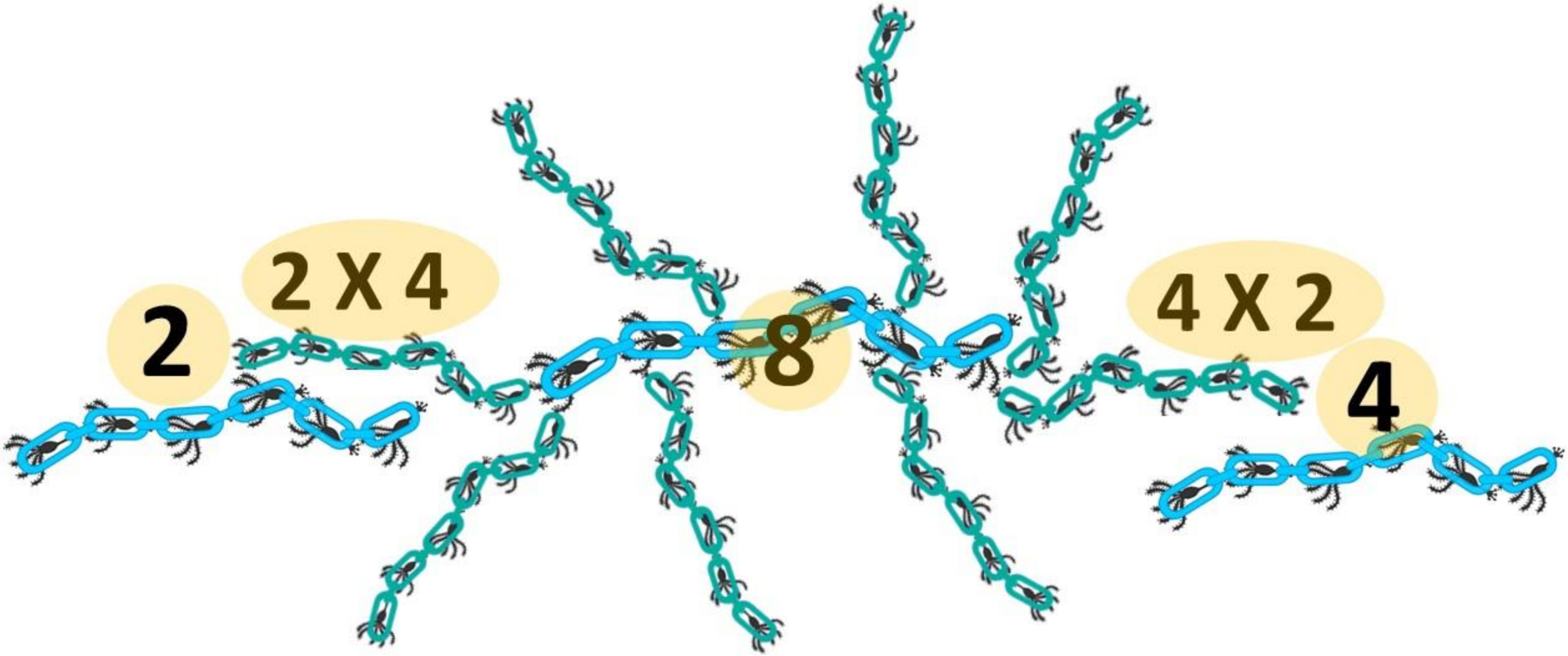
4 X 2

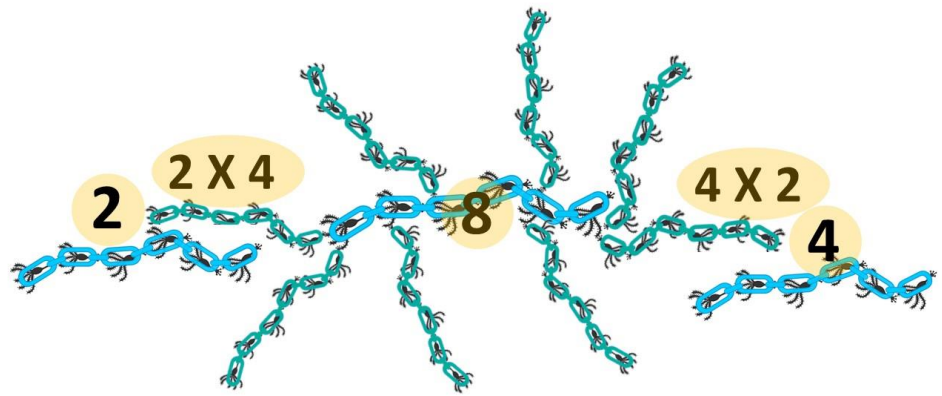
$\int_{\pi/2}^{-\pi/2} dx \cdot 8\cos x$

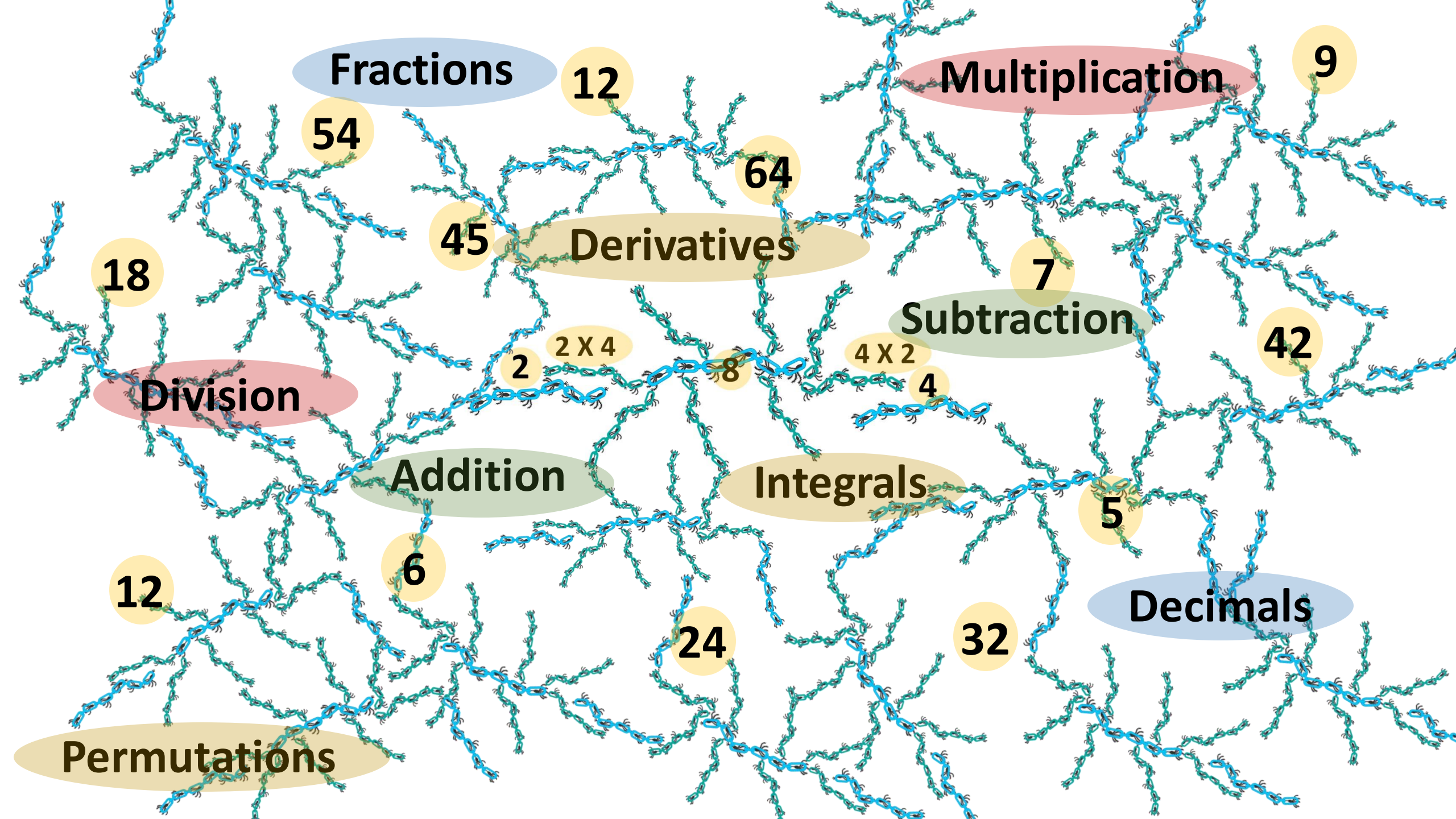
1 X 8

2.5 X 3.2


2
2 X 4
8
4 X 2
4

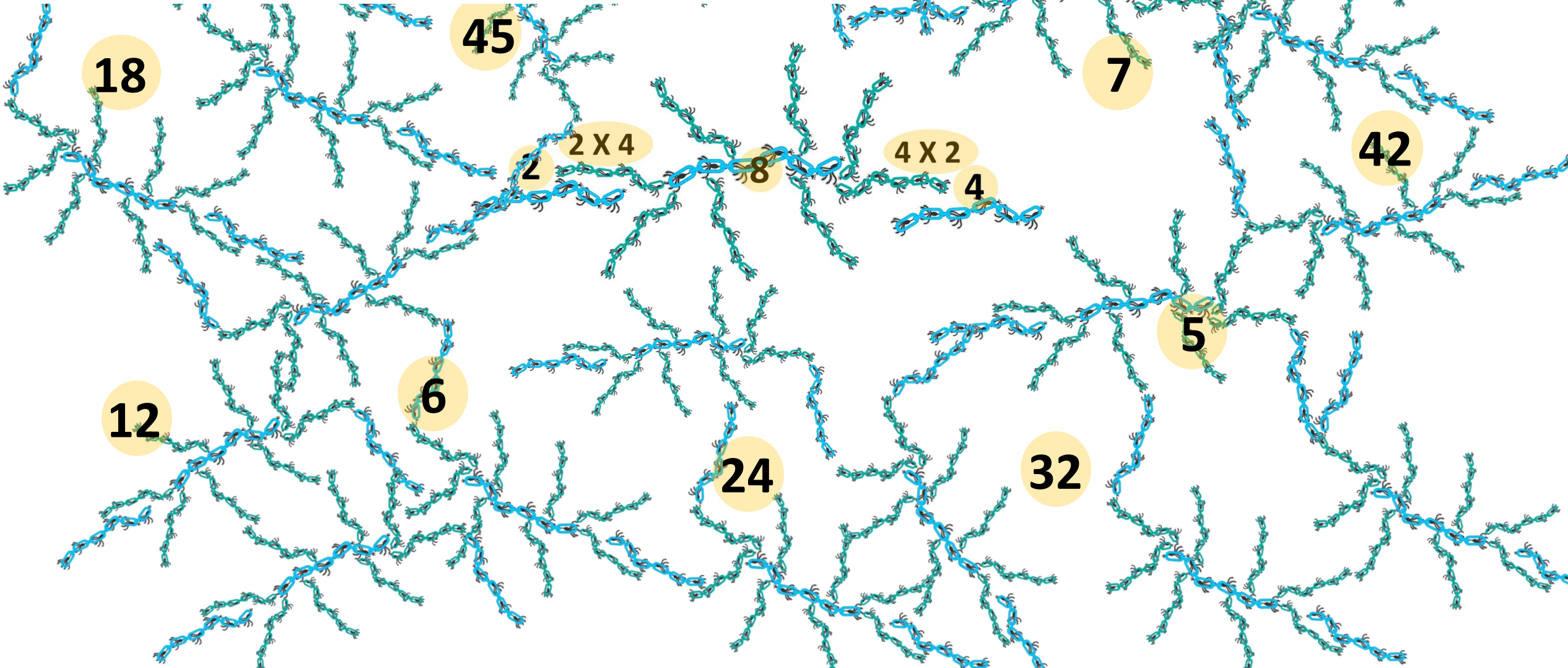

2
2 X 4
8
4 X 2
4

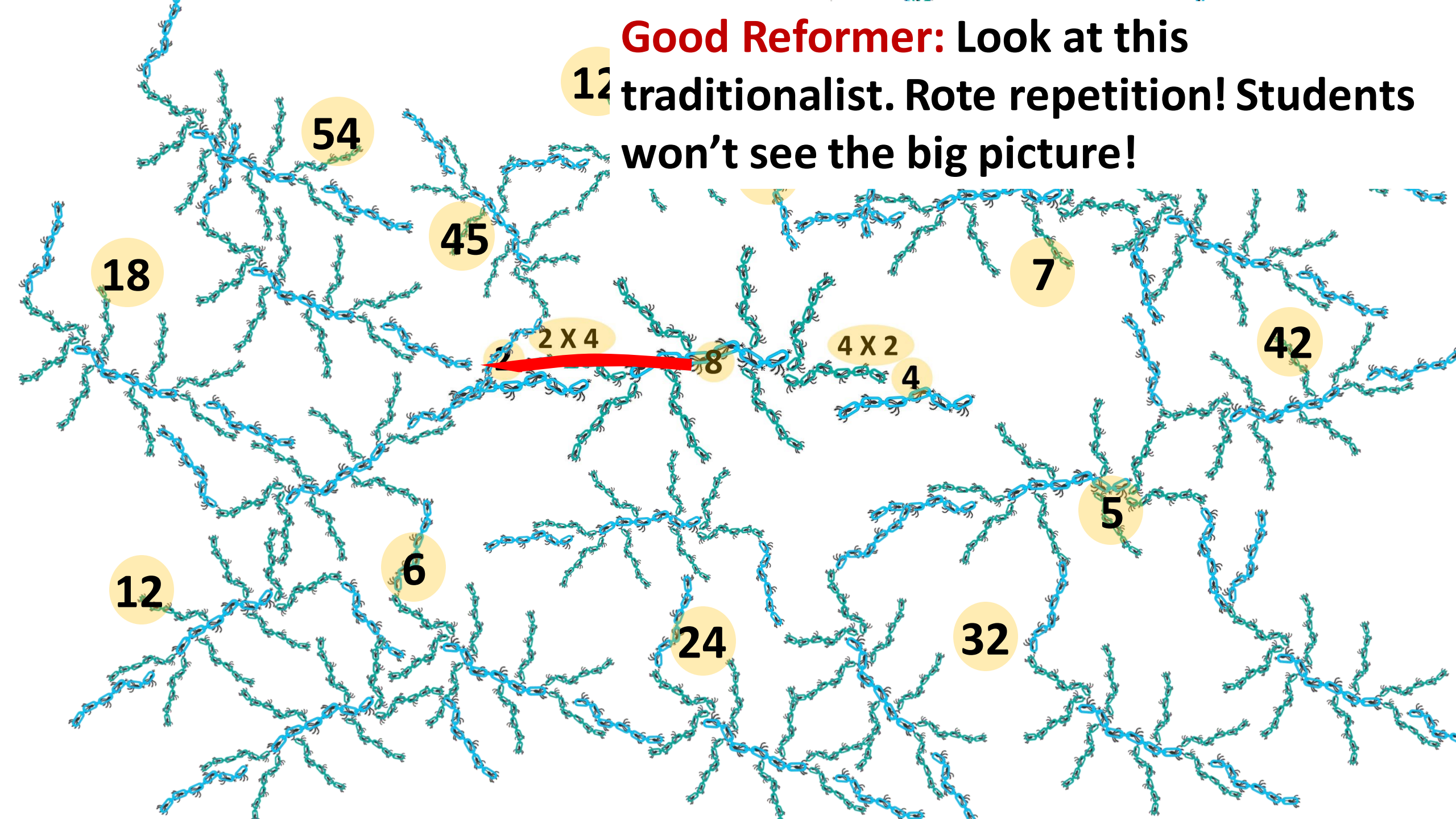

2
2 X 4
8
4 X 2
4


Fractions
12
Multiplication
9
54
64
45
Derivatives
18
7
Subtraction
2 X 4
4 X 2
42
2
8
4
Division
Addition
Integrals
5
6
12
Decimals
24
32
Permutations

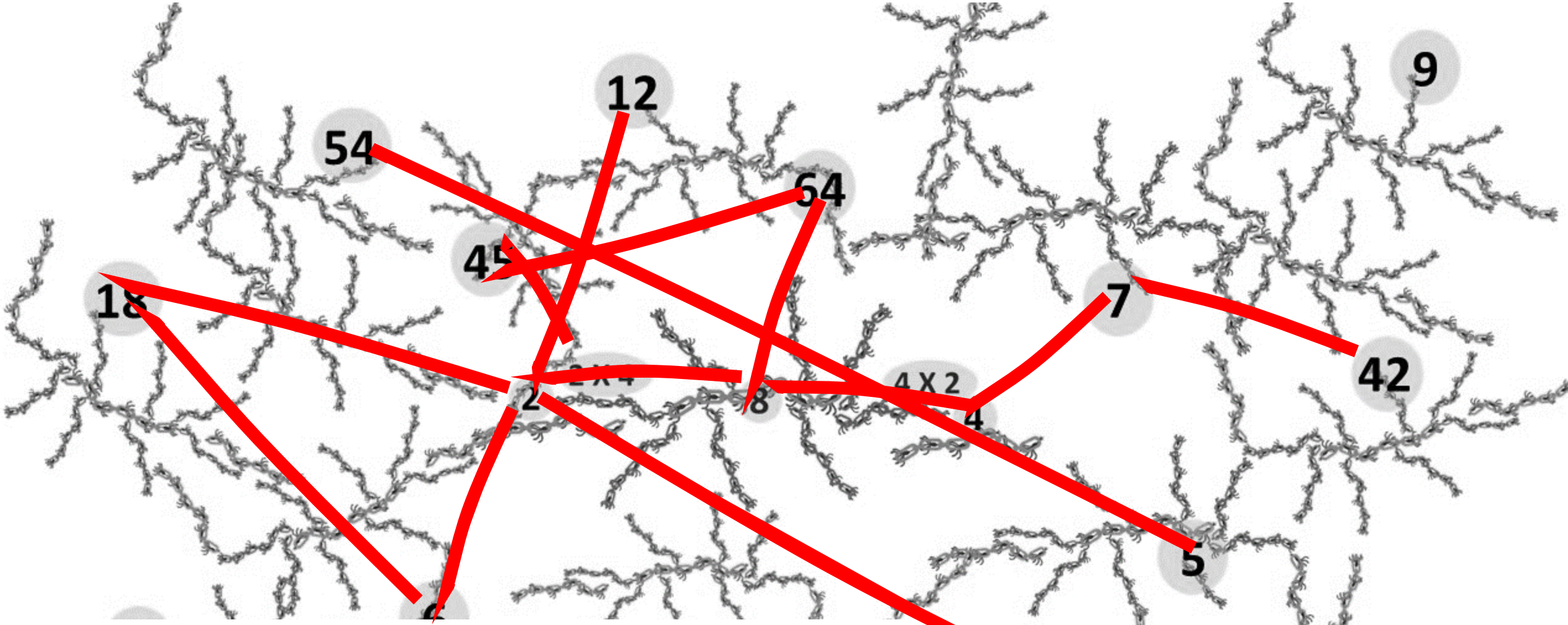
Good Reformer: See the big picture of the connections and relationships!

Transfer is important!

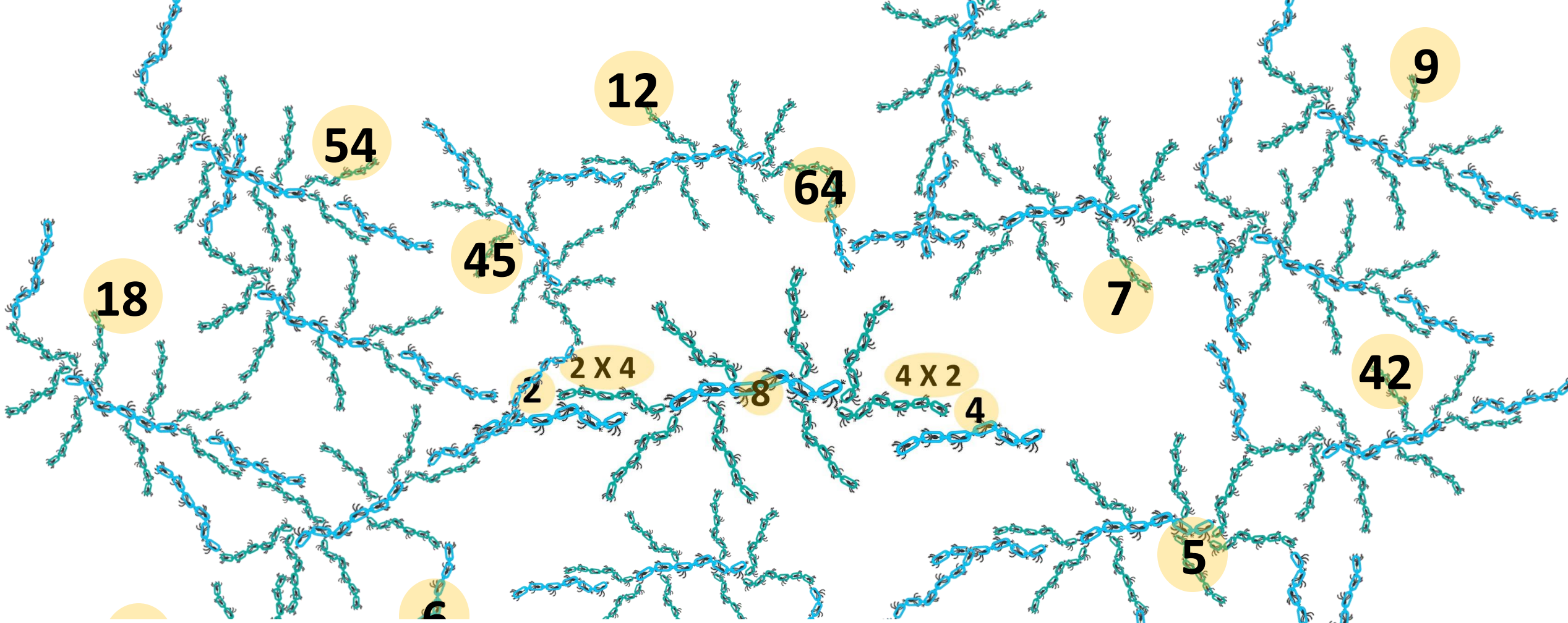



Good Reformer: Look at this traditionalist. Rote repetition! Students won't see the big picture!
12
54
45
18
2 X 4
8
4 X 2
4
7
42
5
6
12
24
32

Good Traditionalist: **Without practice, the connections and relationships won't gel inside the brain! Transfer becomes more difficult to accomplish.**



Good Traditionalist: We don't just sit there repeating 2 X 4 = 8. We are interleaving our practice so that the big picture, as well as the details, become deeply embedded.

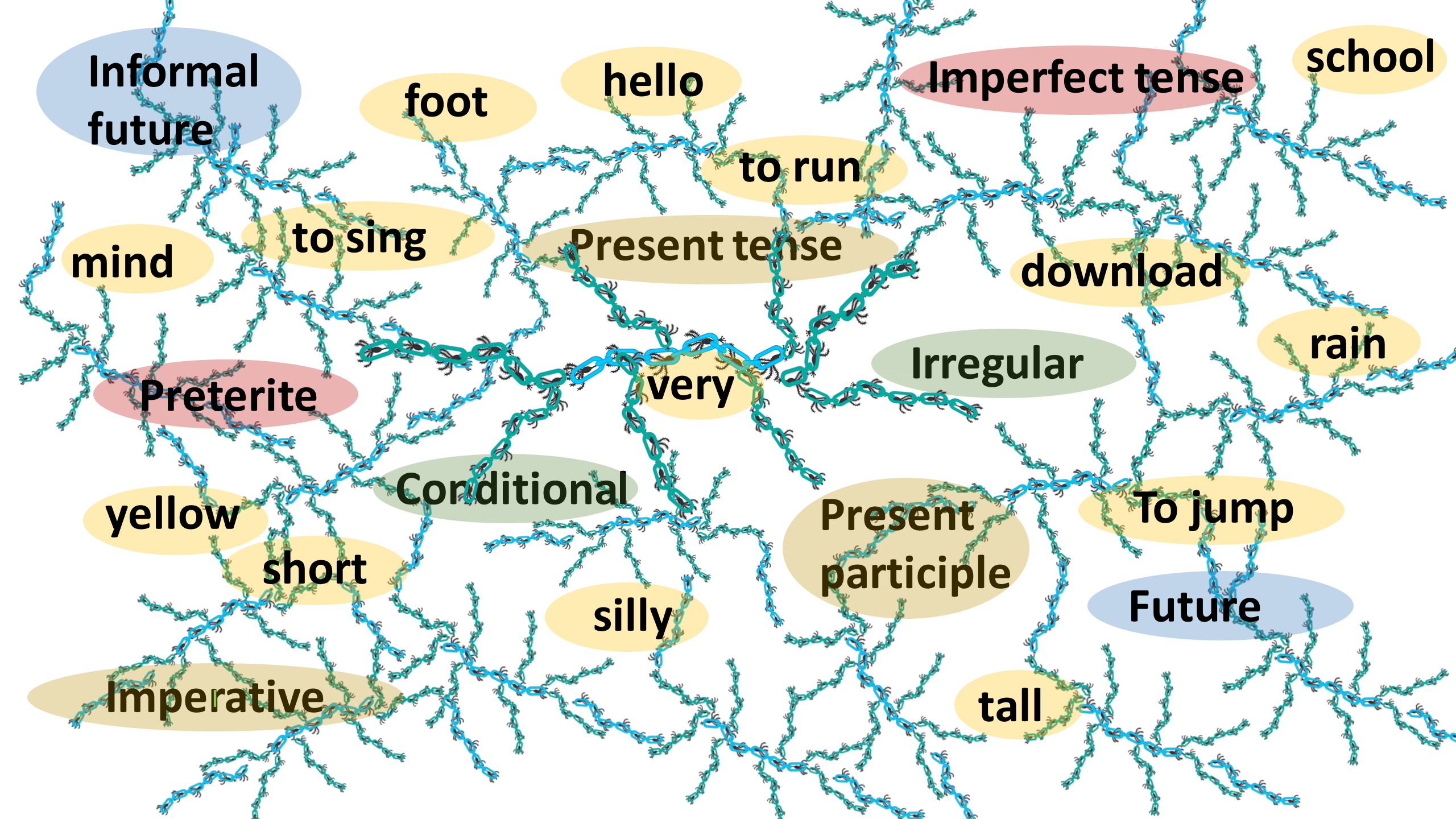


Good Traditionalist: We don't just sit there repeating 2 X 4 = 8. We are interleaving our practice so that the big picture, as well as the details, become deeply embedded.

Wu, Shelley Yijung, and Dan Battey. "The Cultural Production of Racial Narratives About Asian Americans in Mathematics." *Journal for Research in Mathematics Education* 52, no. 5 (01 Nov. 2021 2021): 581-614.

- Victor Pan put it this way: “When I was in elementary school, I was pretty bad at math. . . . But after I learned the multiplication tables, I did pretty great. All of [a] sudden, I knew what happened, and I started getting 100 on the tests.”

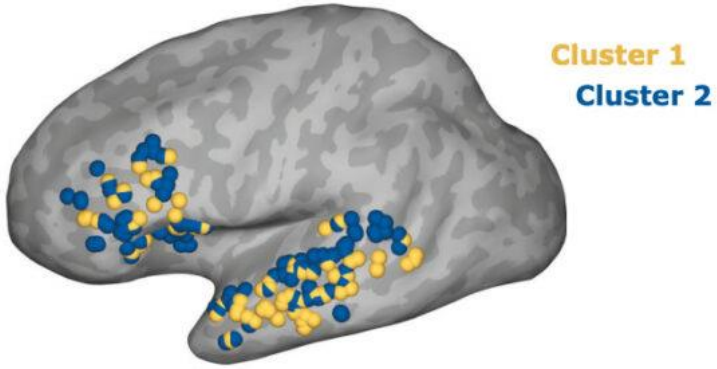
- “If you memorize the multiplication table, you are pretty much at the fourth- or fifth-grade level. You can almost get everything.” The students acknowledged that the memorization work positioned them to be successful in the upper elementary grades.


Informal future
foot
hello
Imperfect tense
school
to run
to sing
Present tense
mind
download
rain
Irregular
Preterite
very
Conditional
yellow
To jump
Present participle
short
Future
silly
Imperative
tall

It seems that order matters

Phonics ➡ words

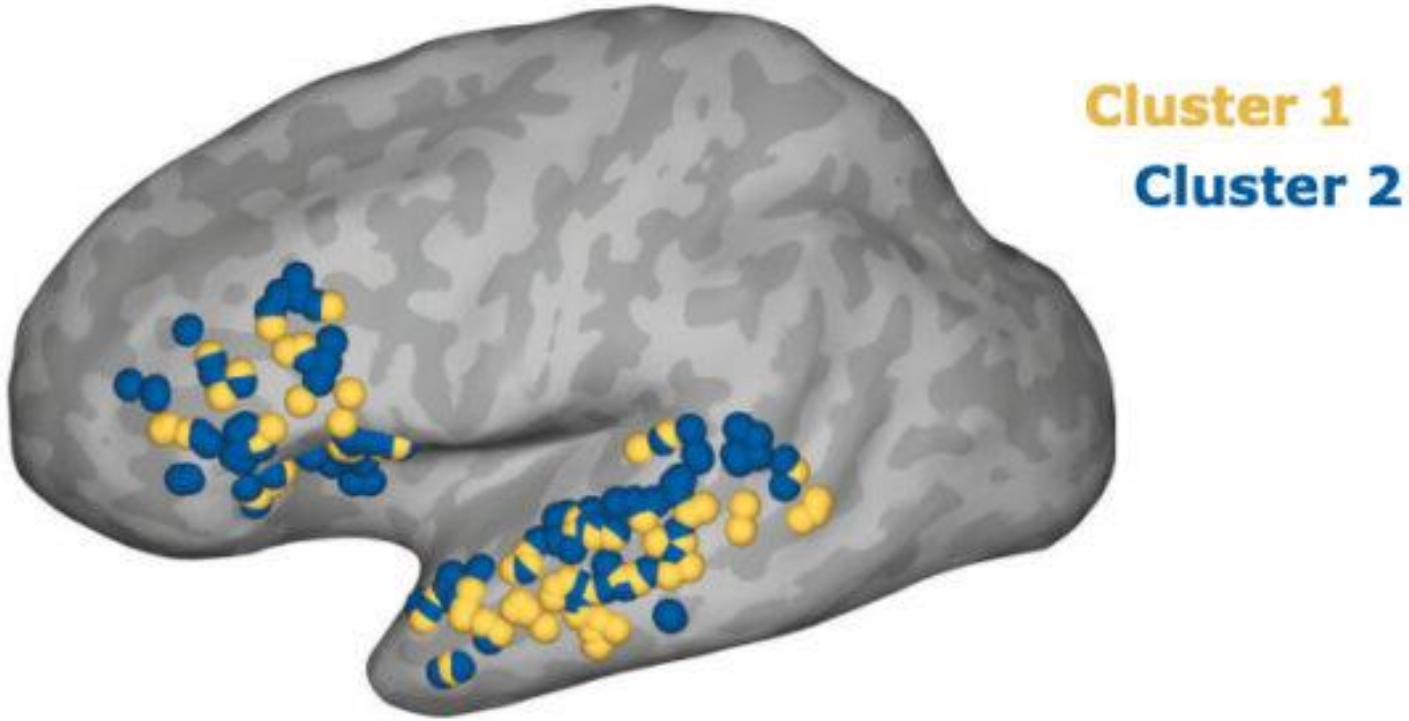
words ➡ sentences



You can’t skip this part!

But this isn’t all you do to teach reading!

- Woolnough, O., C. Donos, E. Murphy, P. S. Rollo, Z. J. Roccaforte, S. Dehaene, and N. Tandon. "Spatiotemporally Distributed Frontotemporal Networks for Sentence Reading." *Proceedings of the National Academy of Sciences of the United States of America 120, no. 17 (Apr 25 2023): e2300252120. https://dx.doi.org/10.1073/pnas.2300252120.*
- McDonald, Fiona. "Scientists Show 2 Distinct Brain Networks Are Activated While Reading." *Science Alert (20 Apr 2023). https://www.sciencealert.com/scientists-show-2-distinct-brain-networks-are-activated-while-reading.*



Cluster 1 is activated as we gain meaning from sentences, and **cluster 2** is activated as we understand the meaning of individual words. (Woolnough et al., *PNAS*, 2023)

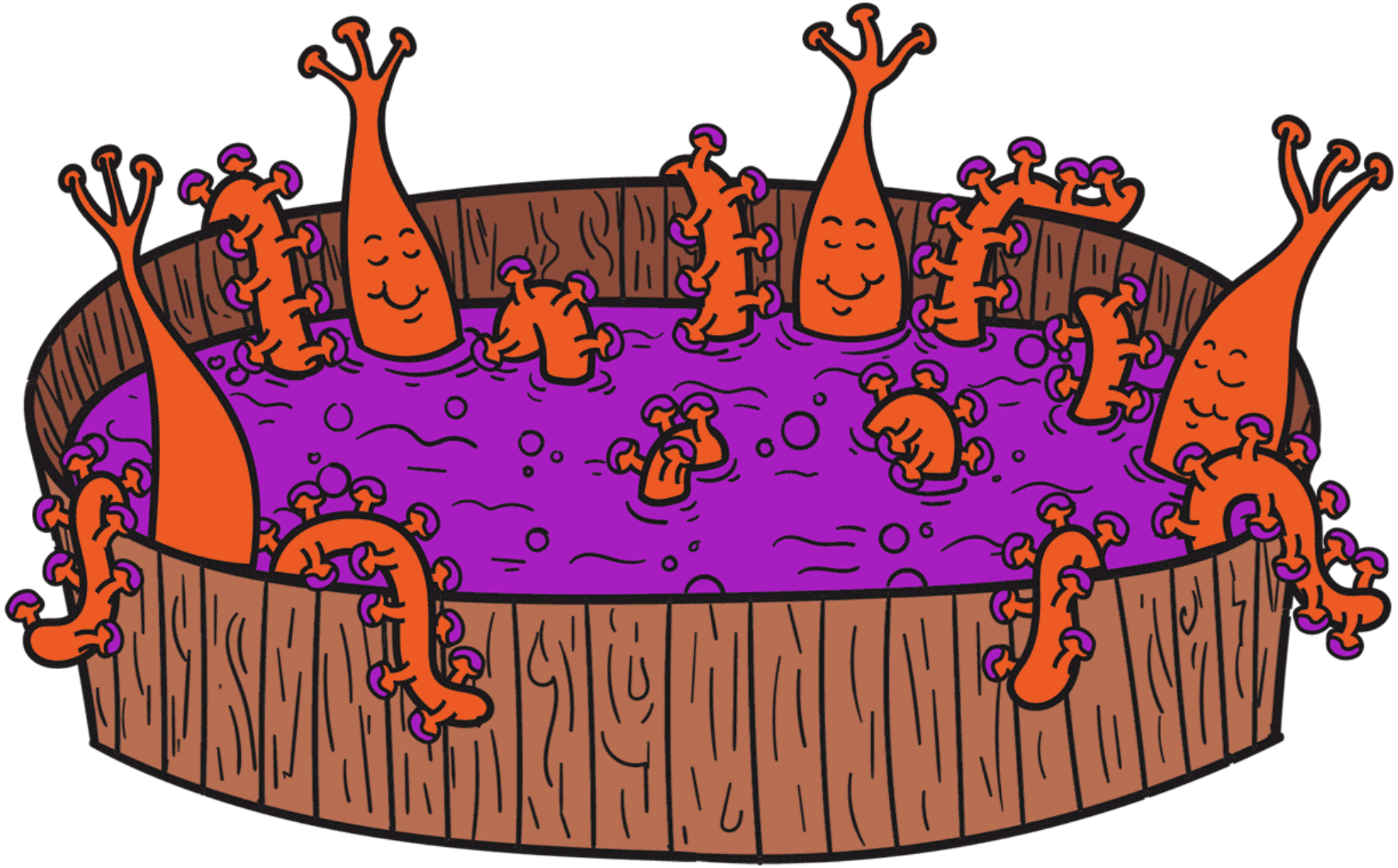
Reformers and traditionalists are *both* right

- Students need to see the big picture.
- But this happens only bit by bit.
- With interleaved practice, the patterns develop, thickening and enriching understanding.
- With procedural (basal ganglia) learning, students know without being conscious of how they know.
- Bottom line—the leap forward happens AFTER memorization. Memorization allows for internalization of important numerical relationships in ways that aren't obvious.

Just as with language, for math

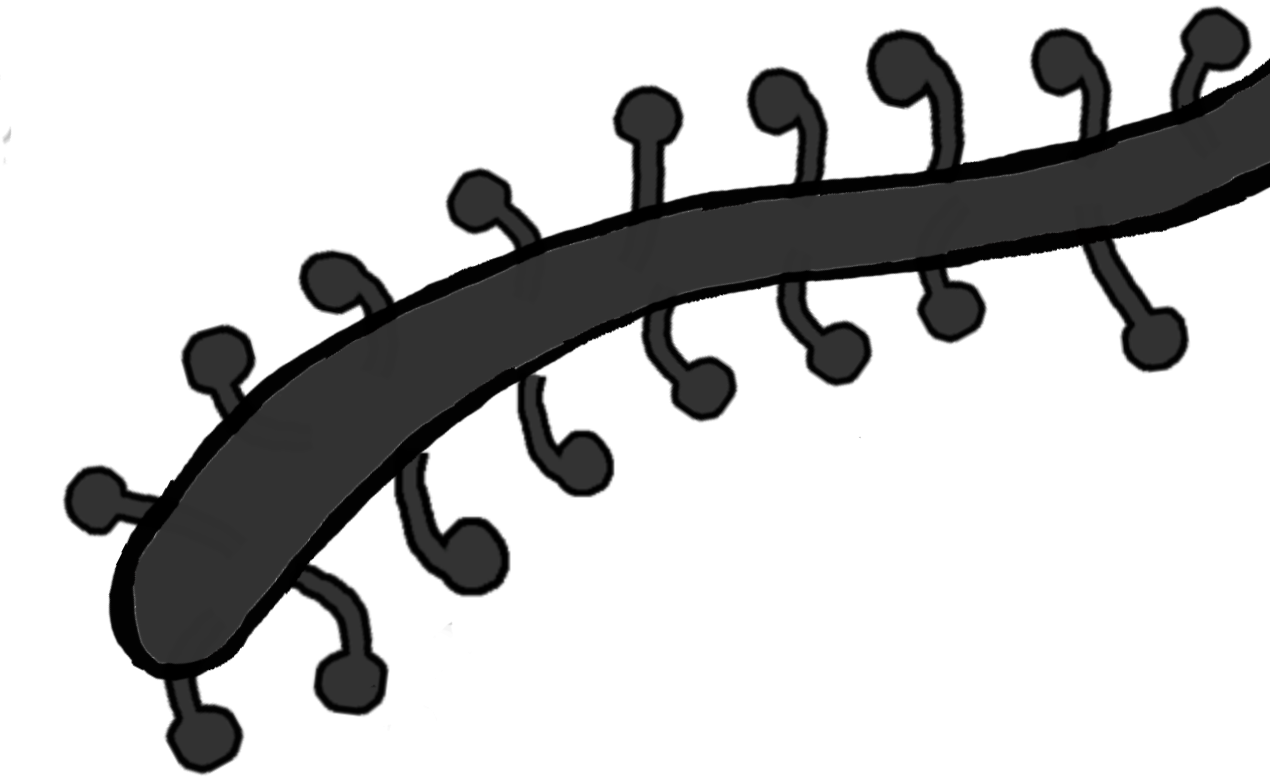
- The big picture of constructivist approaches matters. (The patterns of math; the patterns of reading.)
- But internalization of simplistic ideas

  (eg, 2 X 4 = 8; *k* = "*k*" sound) matters *first.*

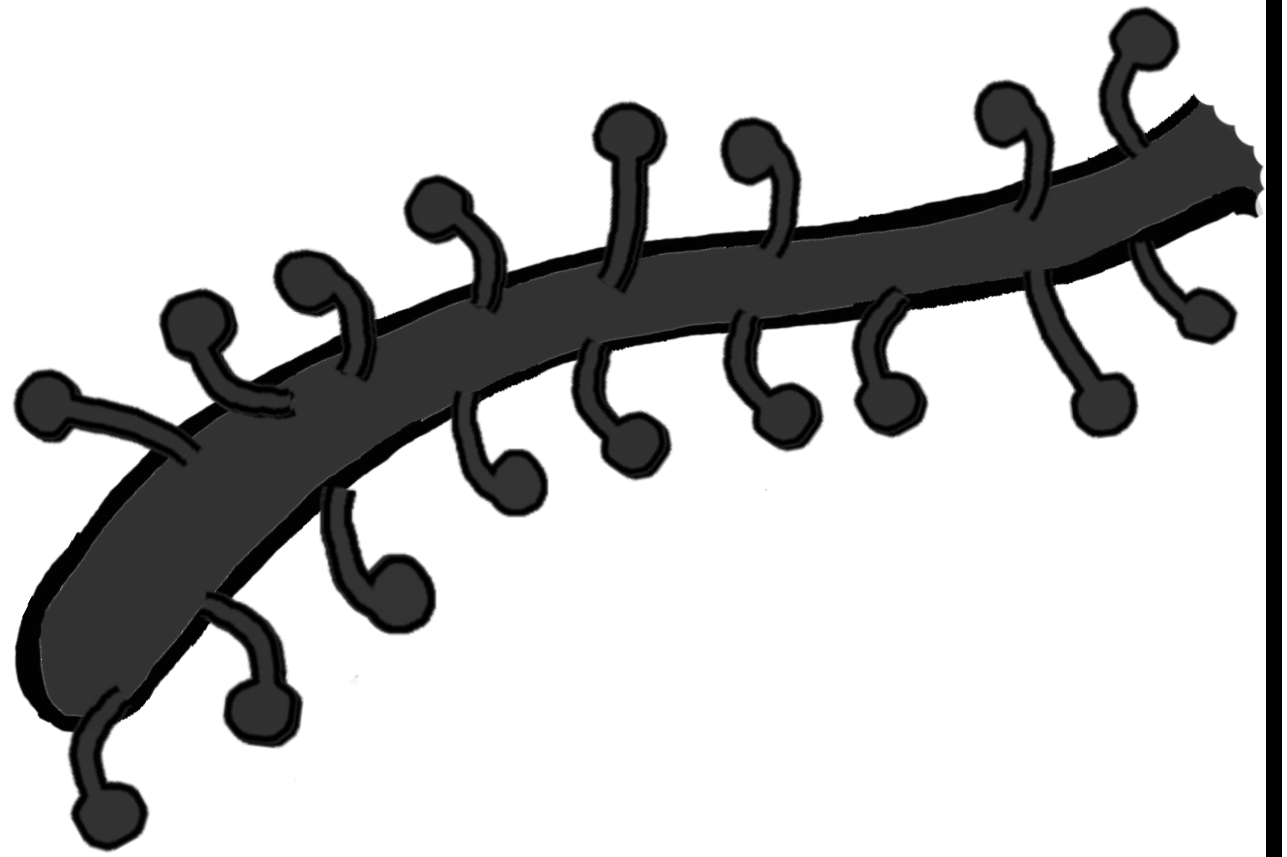


Fast learner—doesn't forget

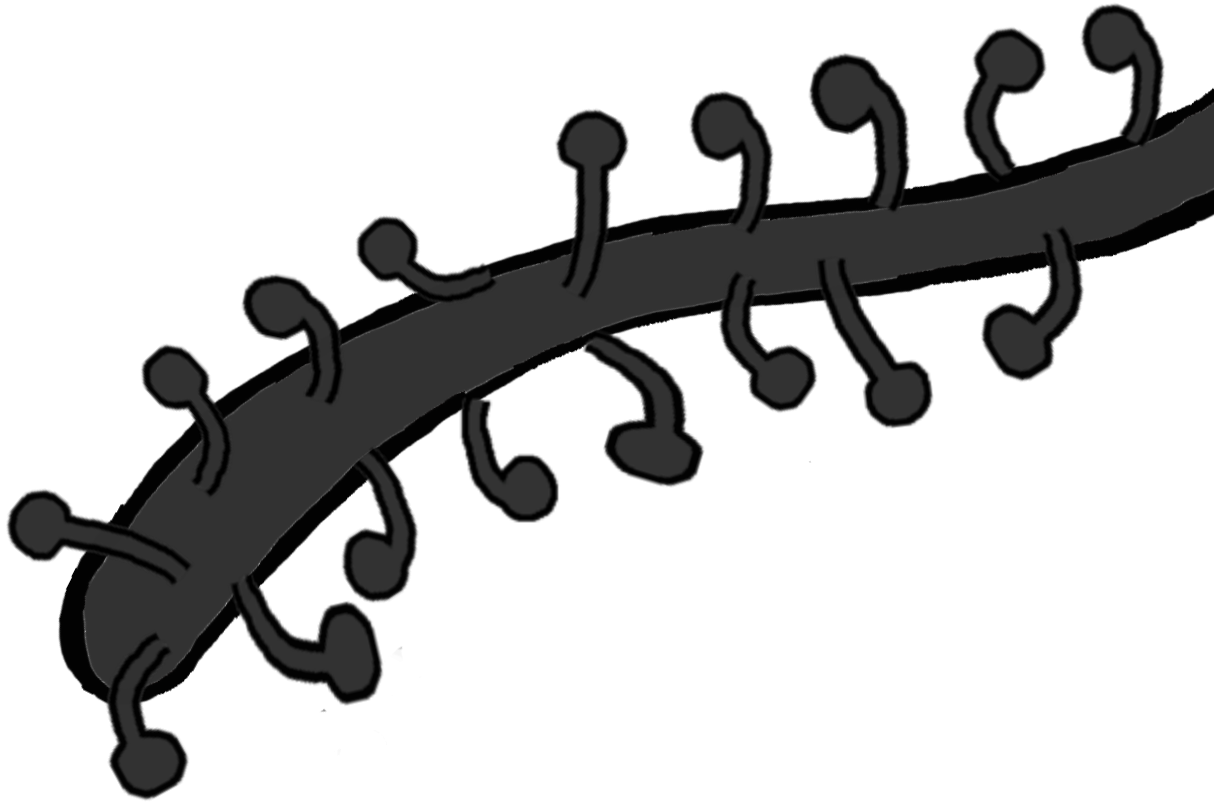
Slow Learner—forgets



Fast learner—doesn't forget



Slow Learner—forgets & relearns



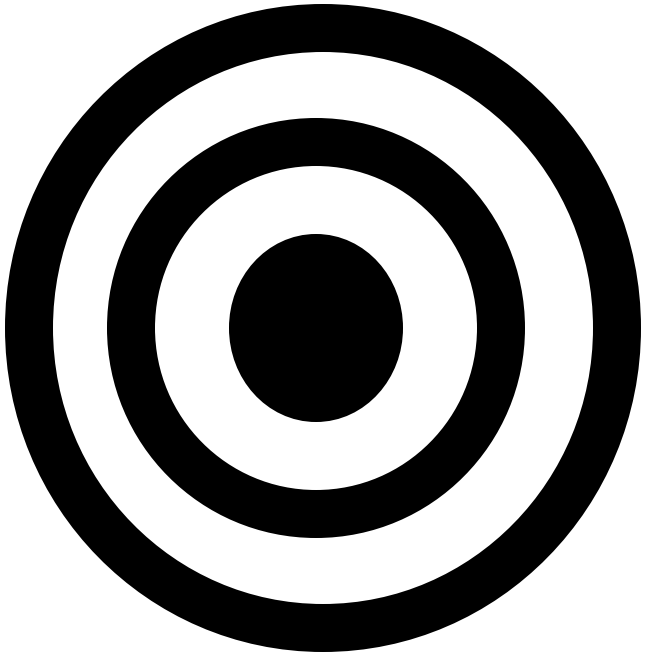
Race car learners

THE WORLD NEEDS BOTH KINDS OF LEARNERS!

Hiker learners

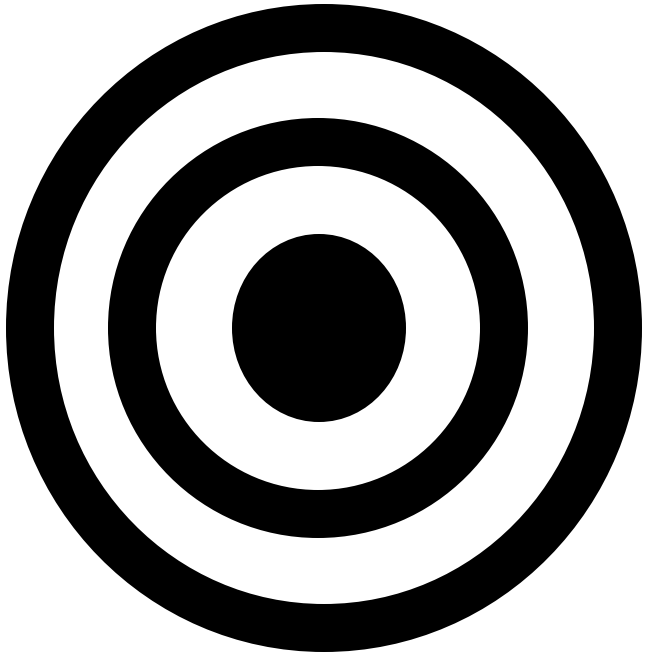
Characteristics of fast versus slow learners

- Fast but often inaccurate



Inflexible

- Slow but more accurate

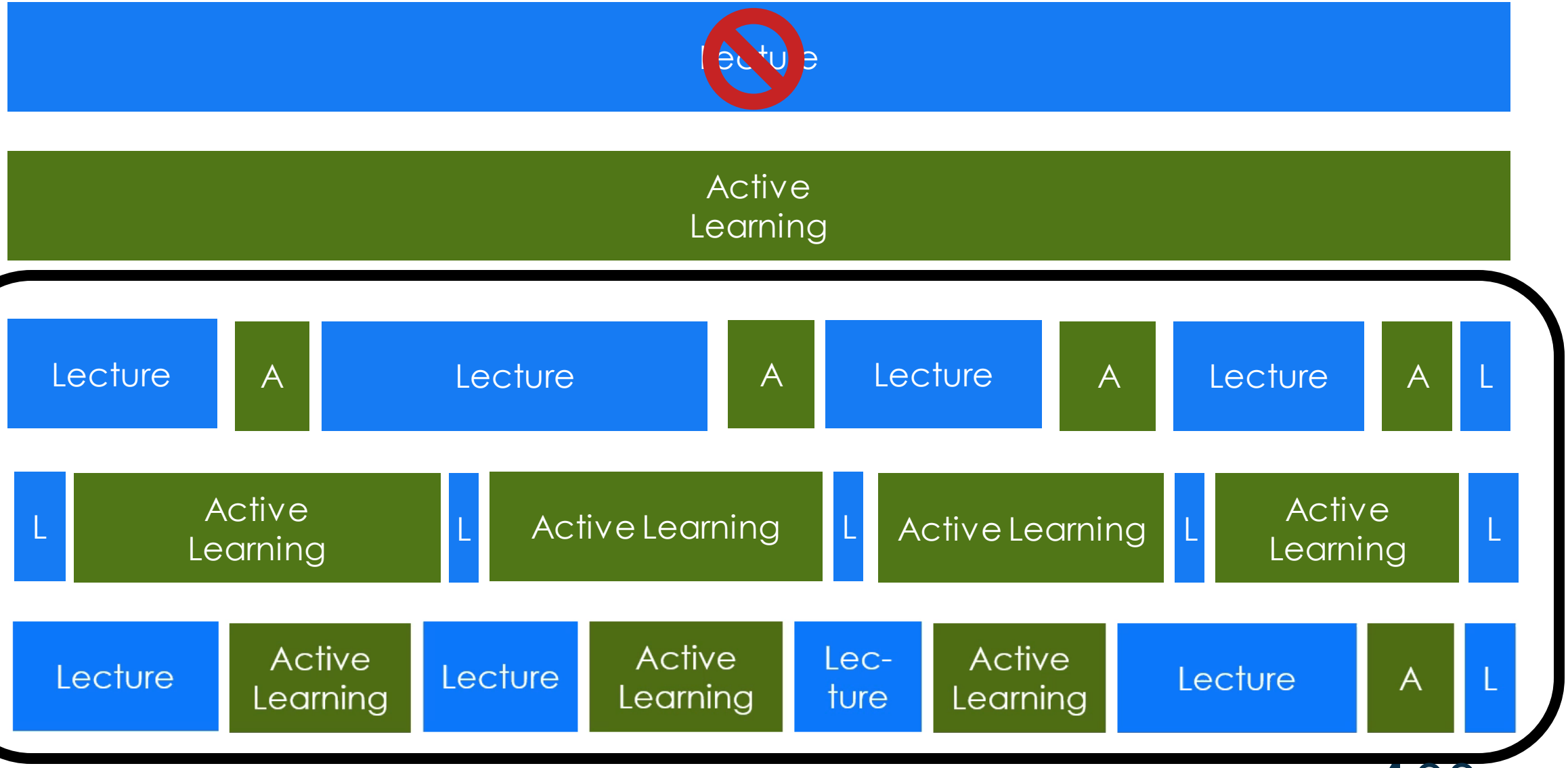


Flexible

Supplemental schooling our two daughters in math from ages 3 to 15.

KUMON

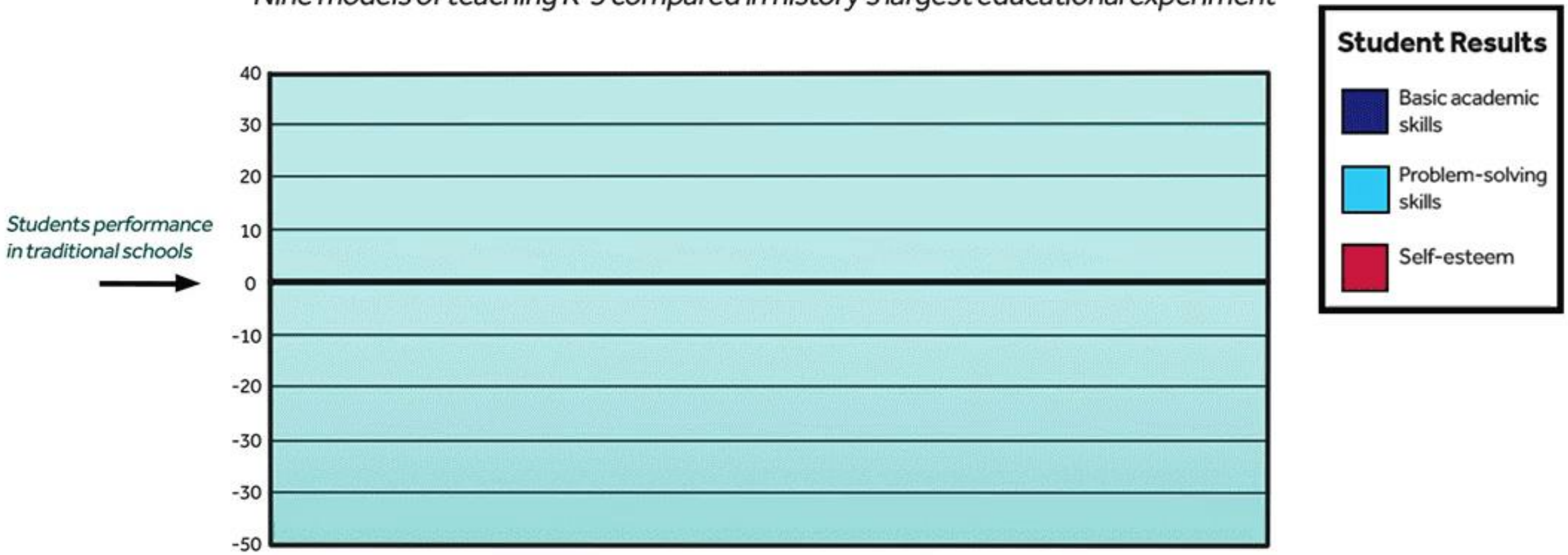
Smartick

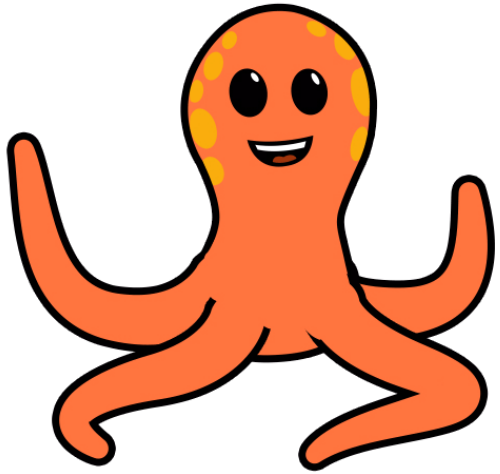


Direct instruction

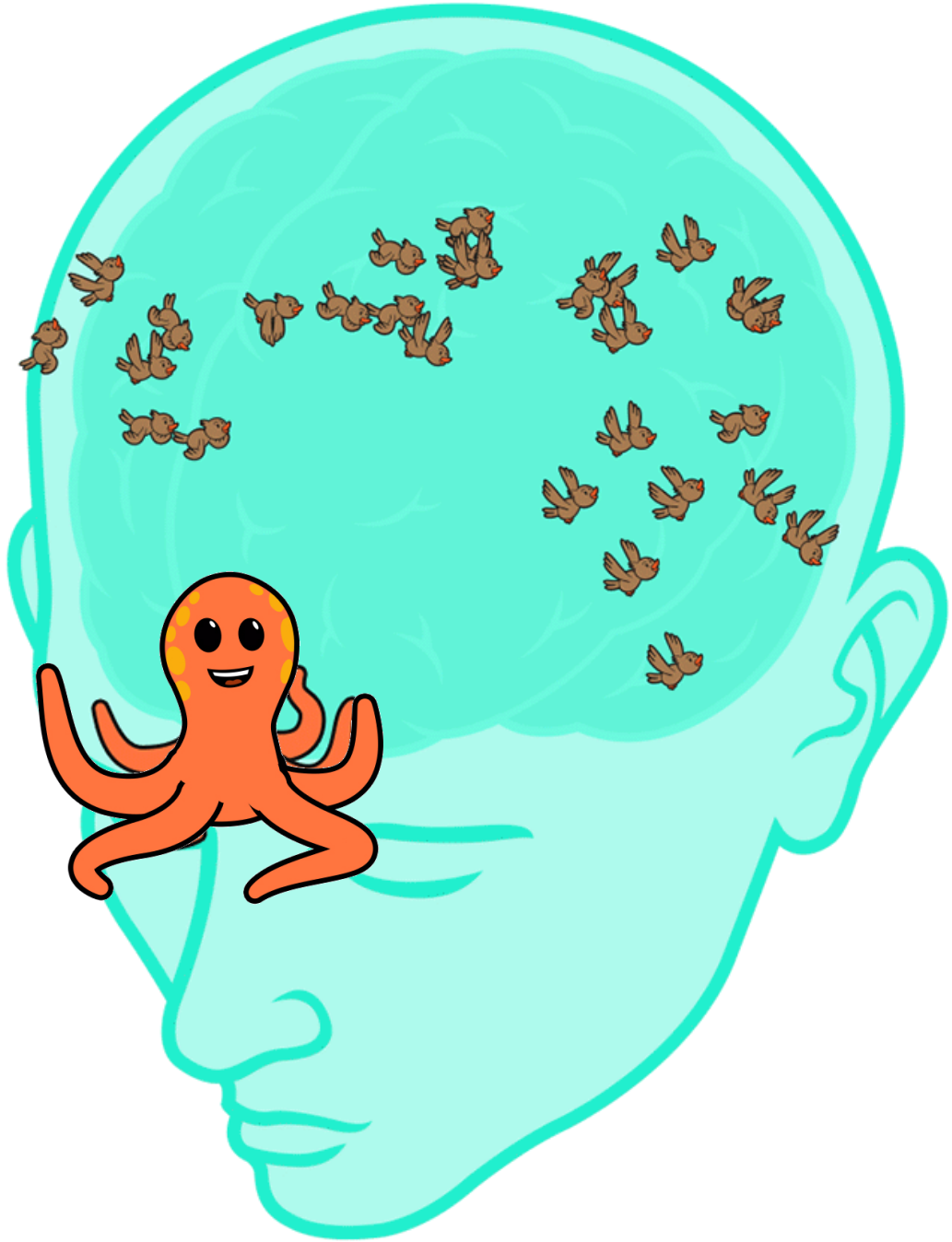
Project Follow Through, 1967 - 1977

Nine models of teaching K-3 compared in history's largest educational experiment

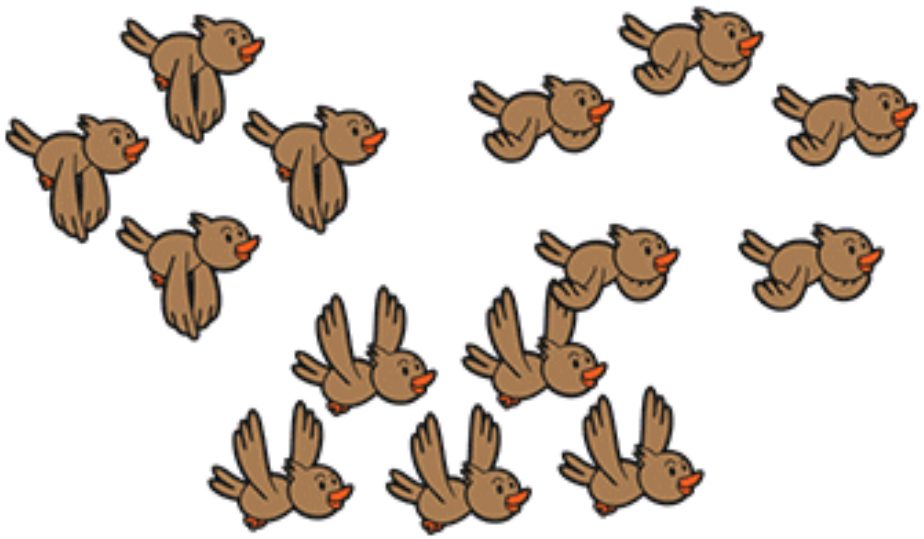




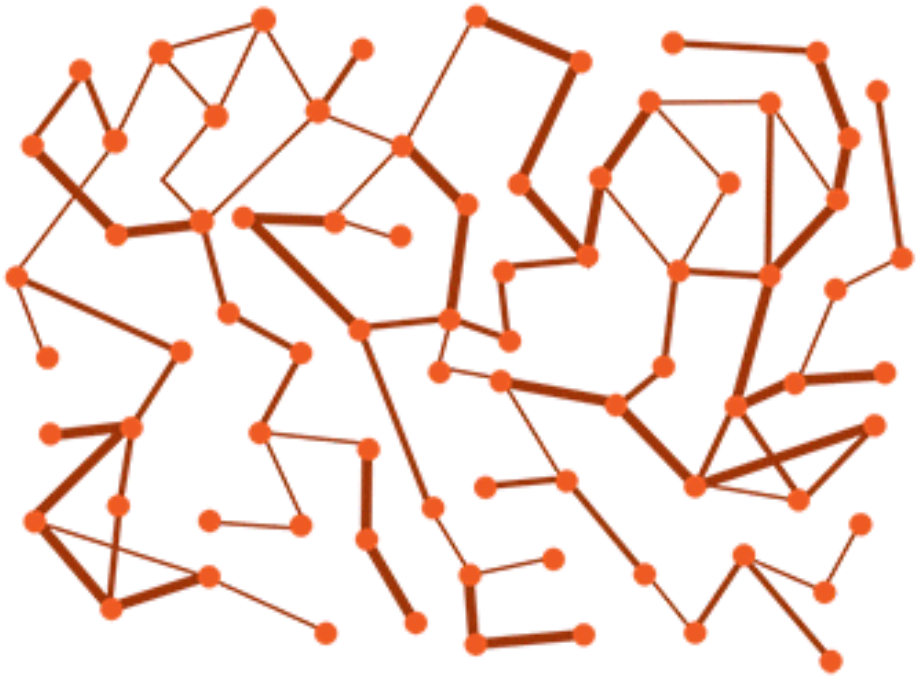
Insights from movie making!

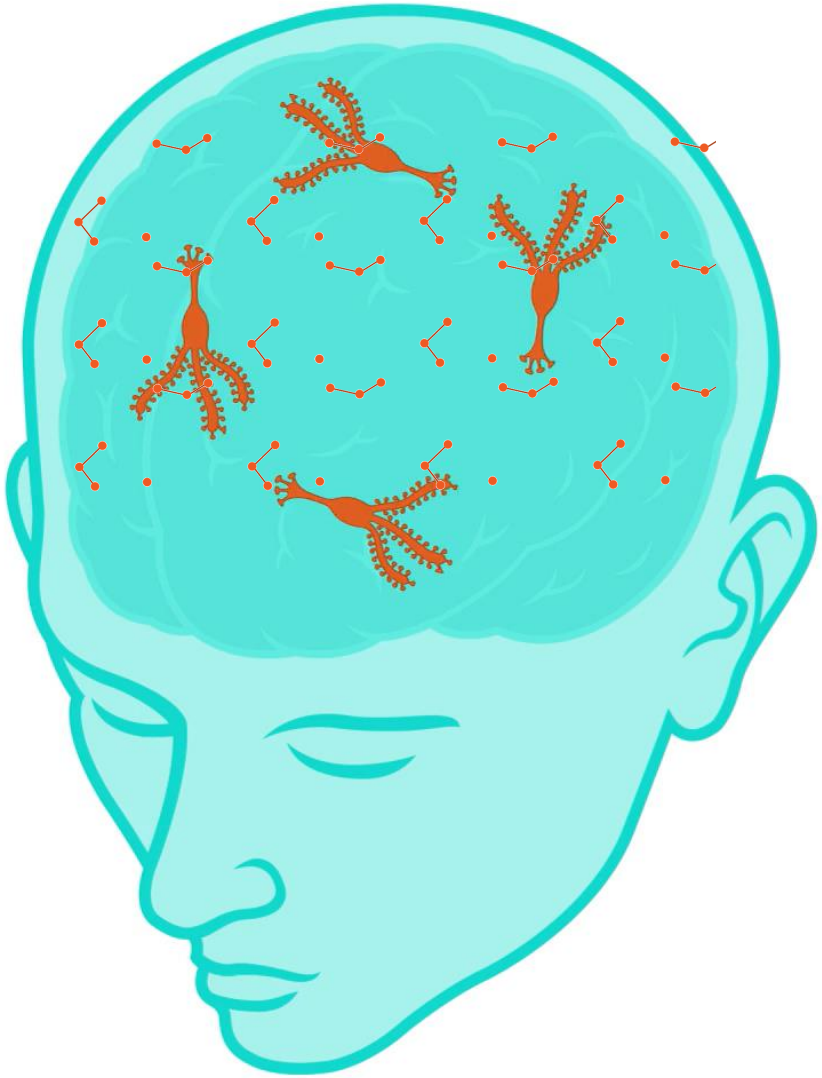


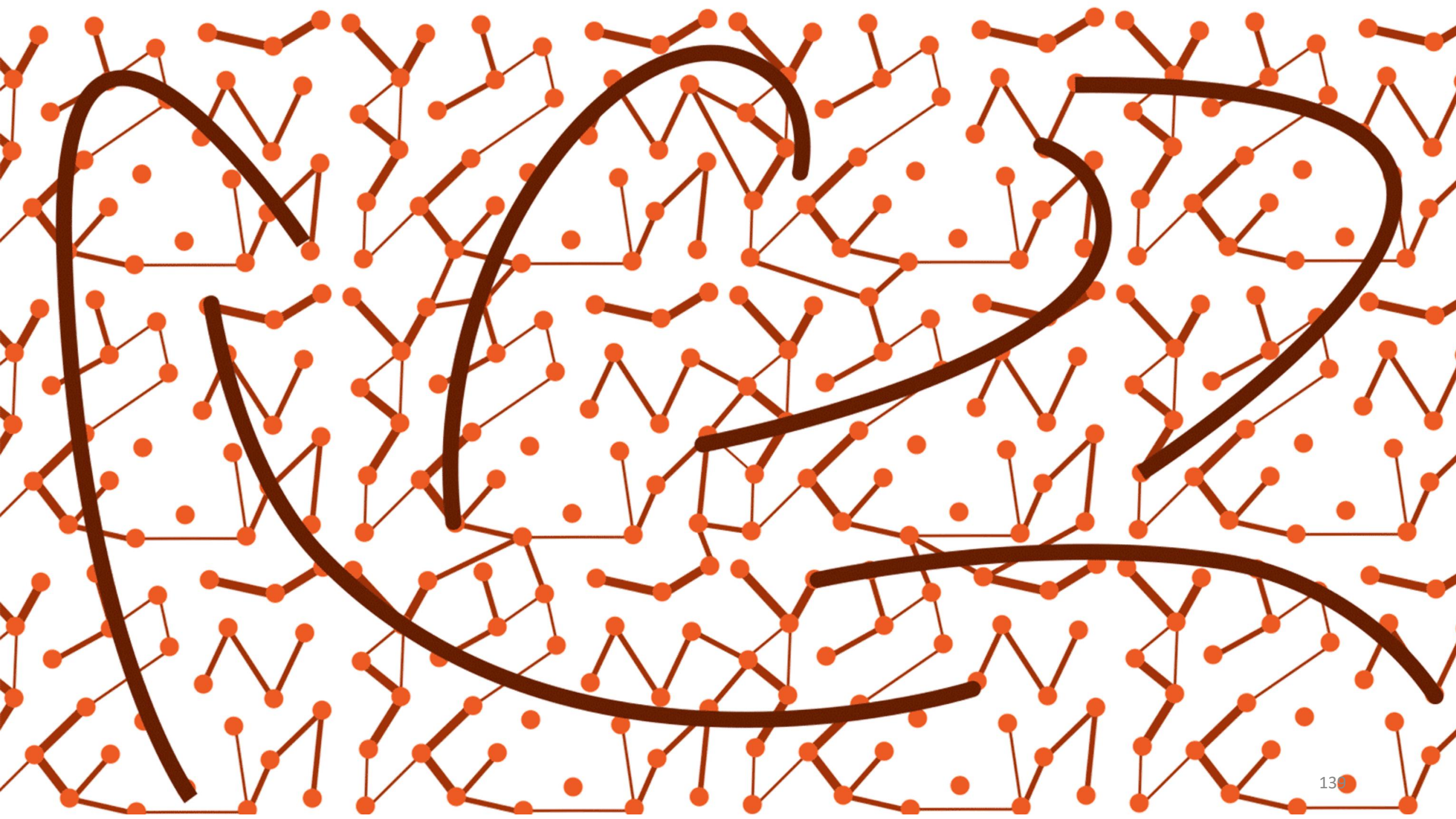
Mental models



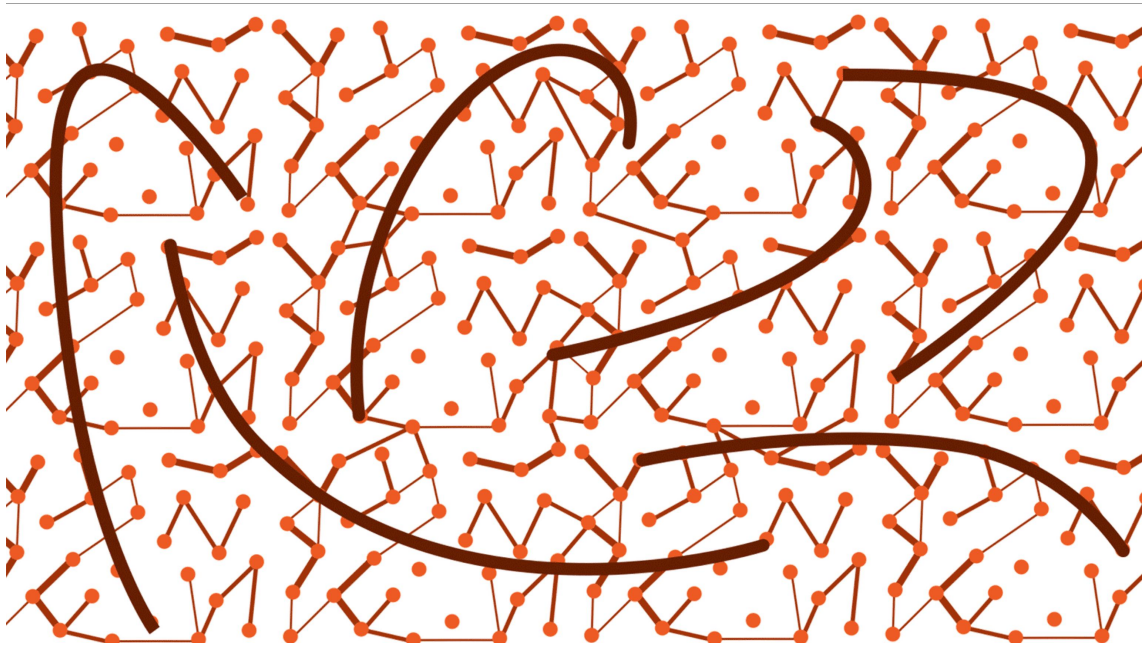
Schema



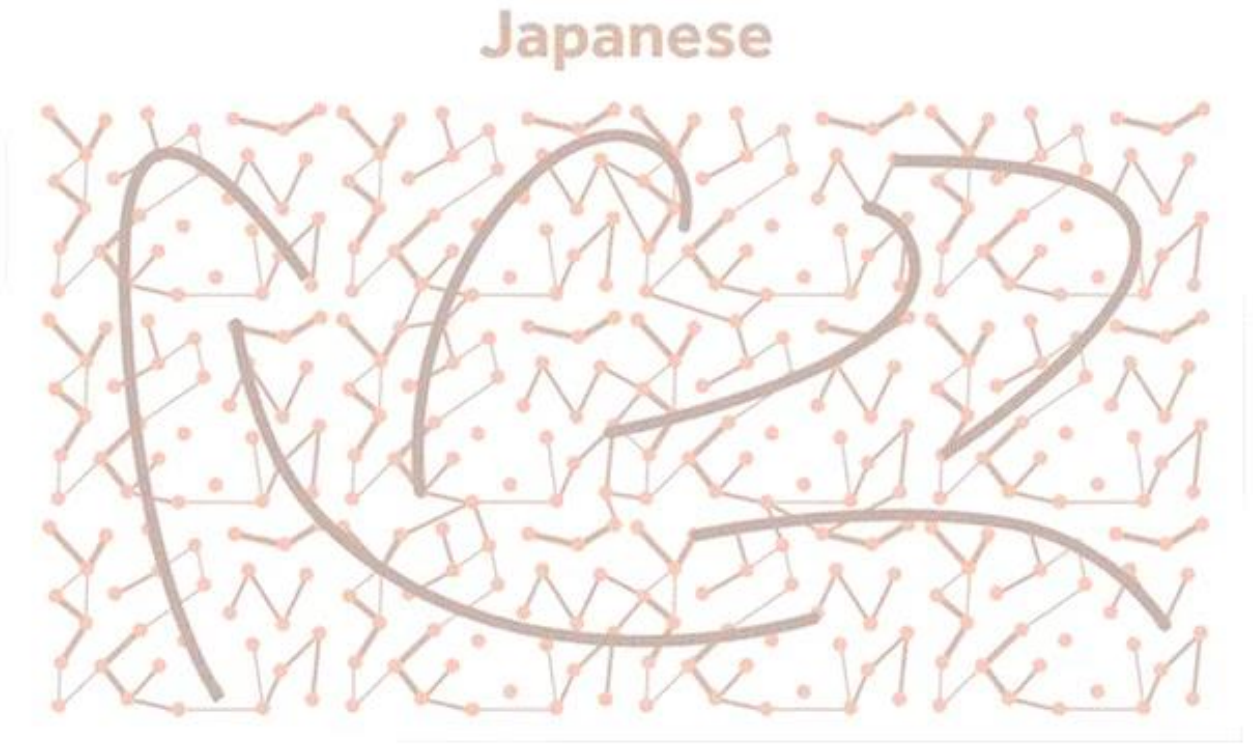


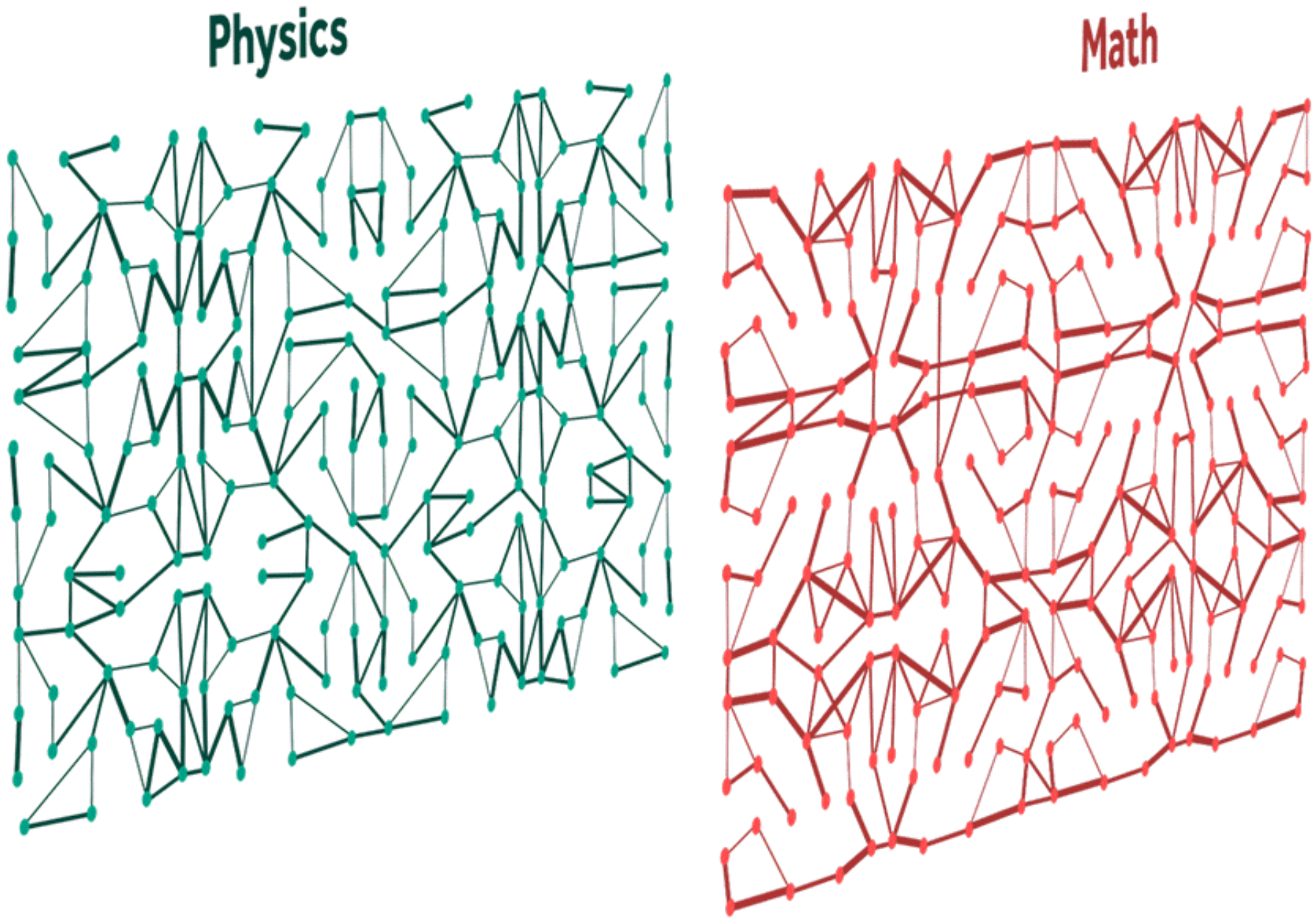


Schemas

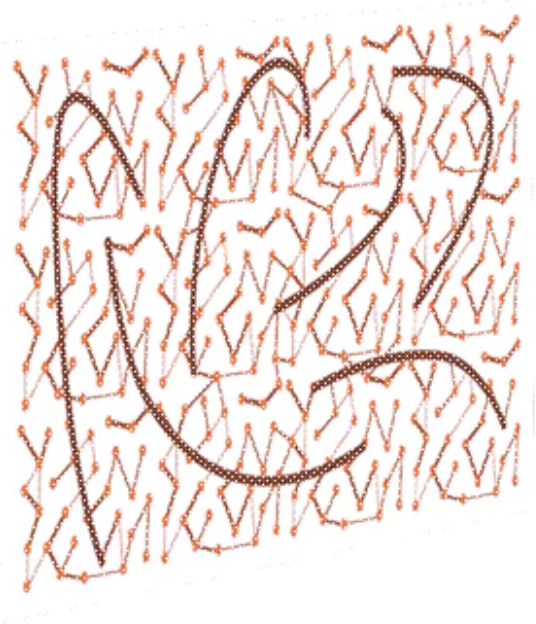


Schemas

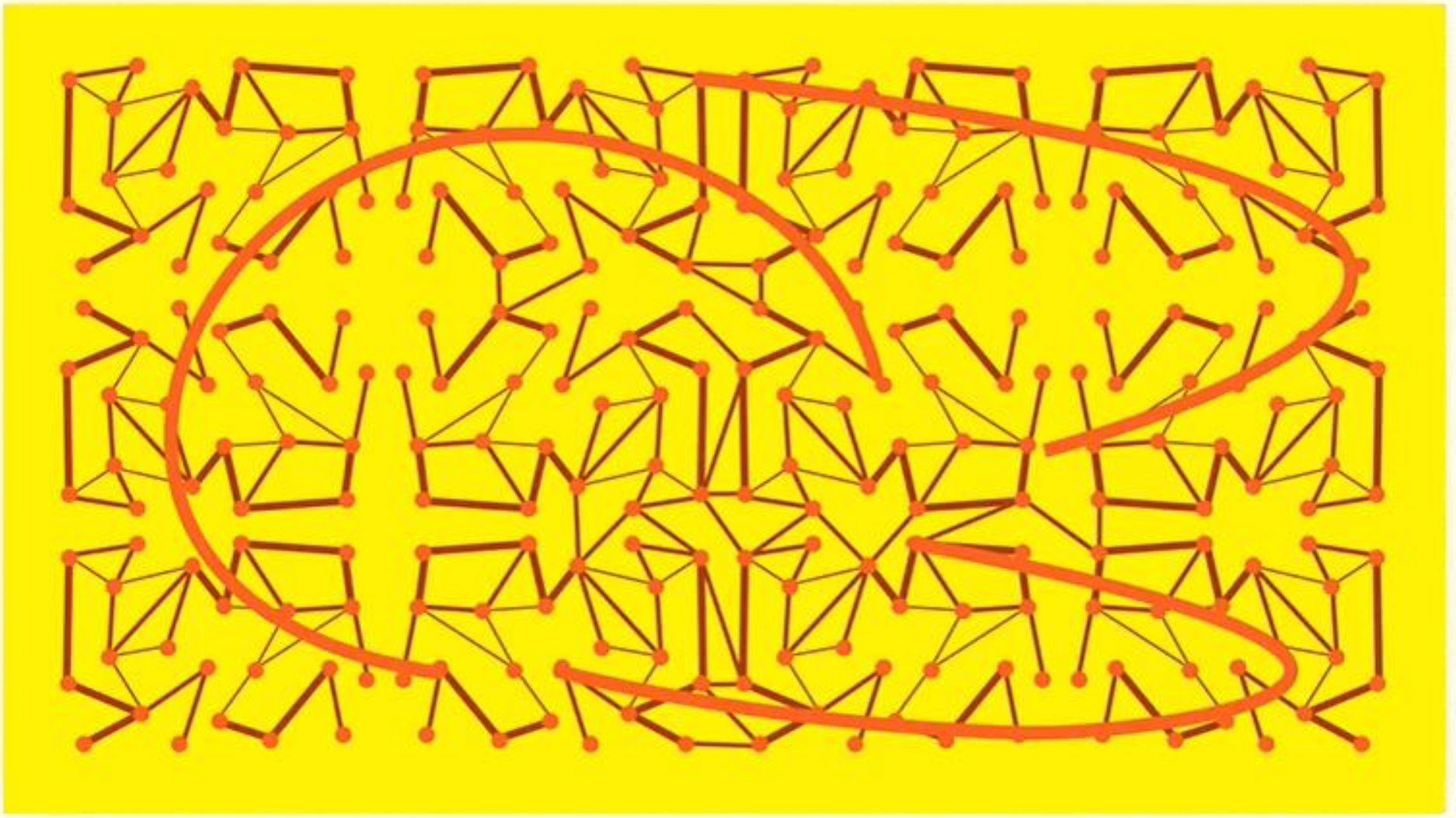


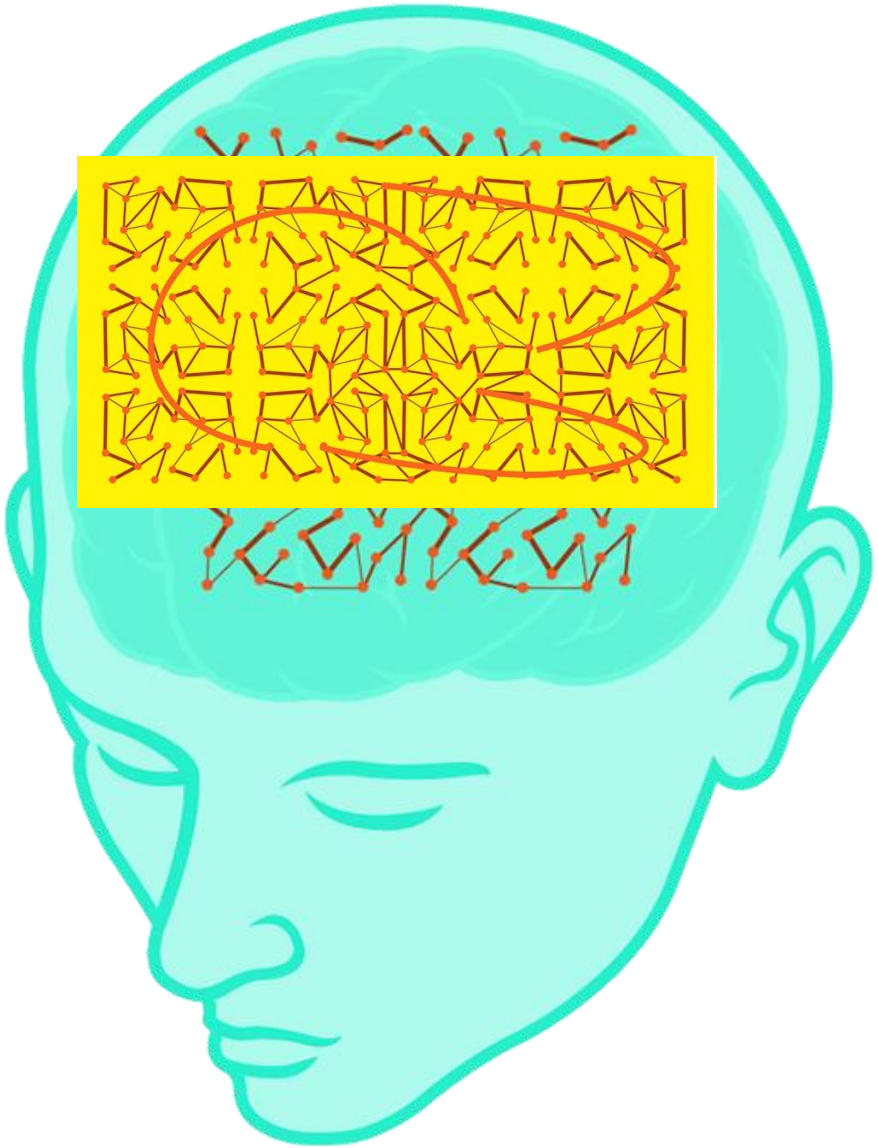

Physics
Math

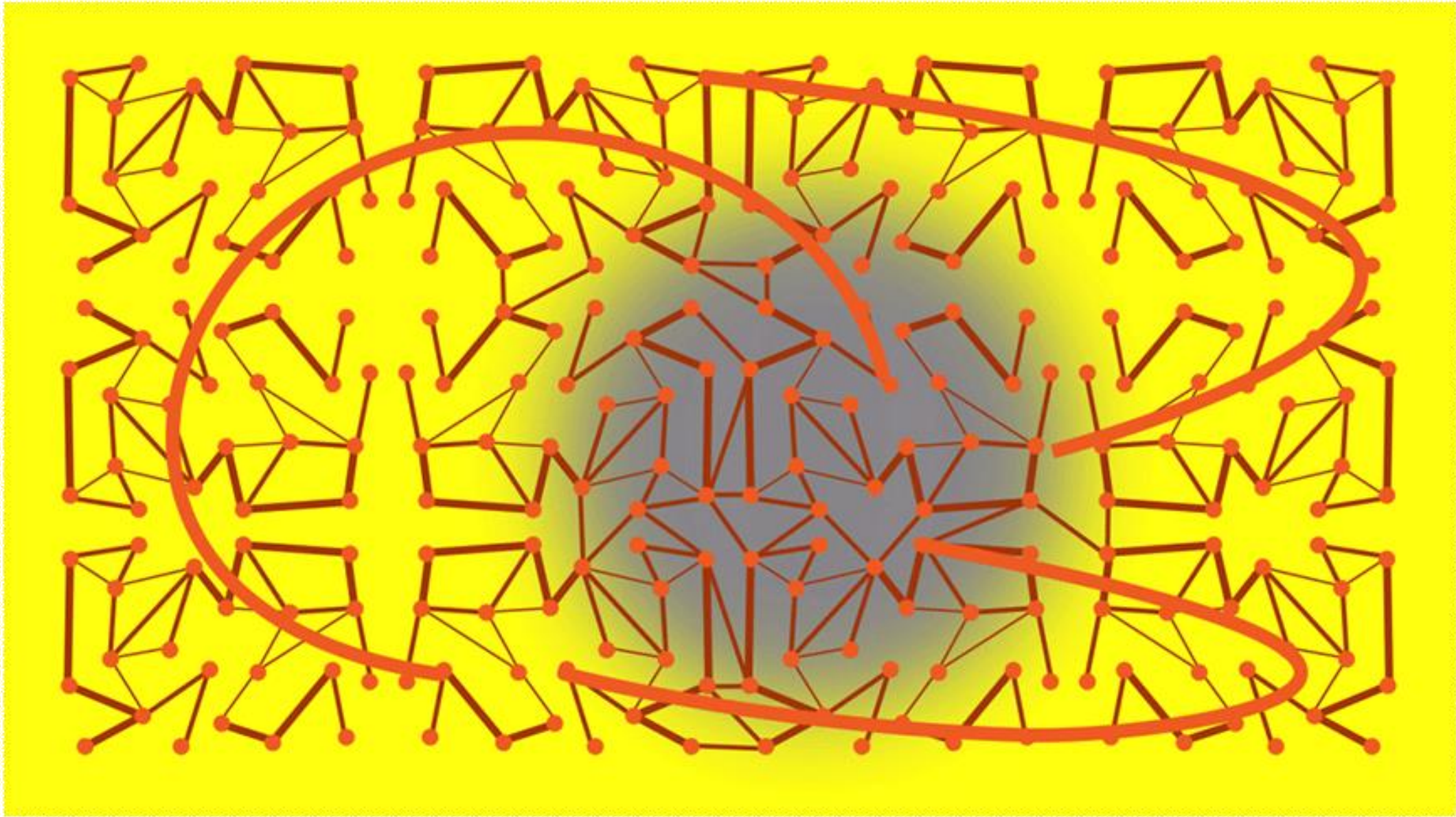
Identity Schema



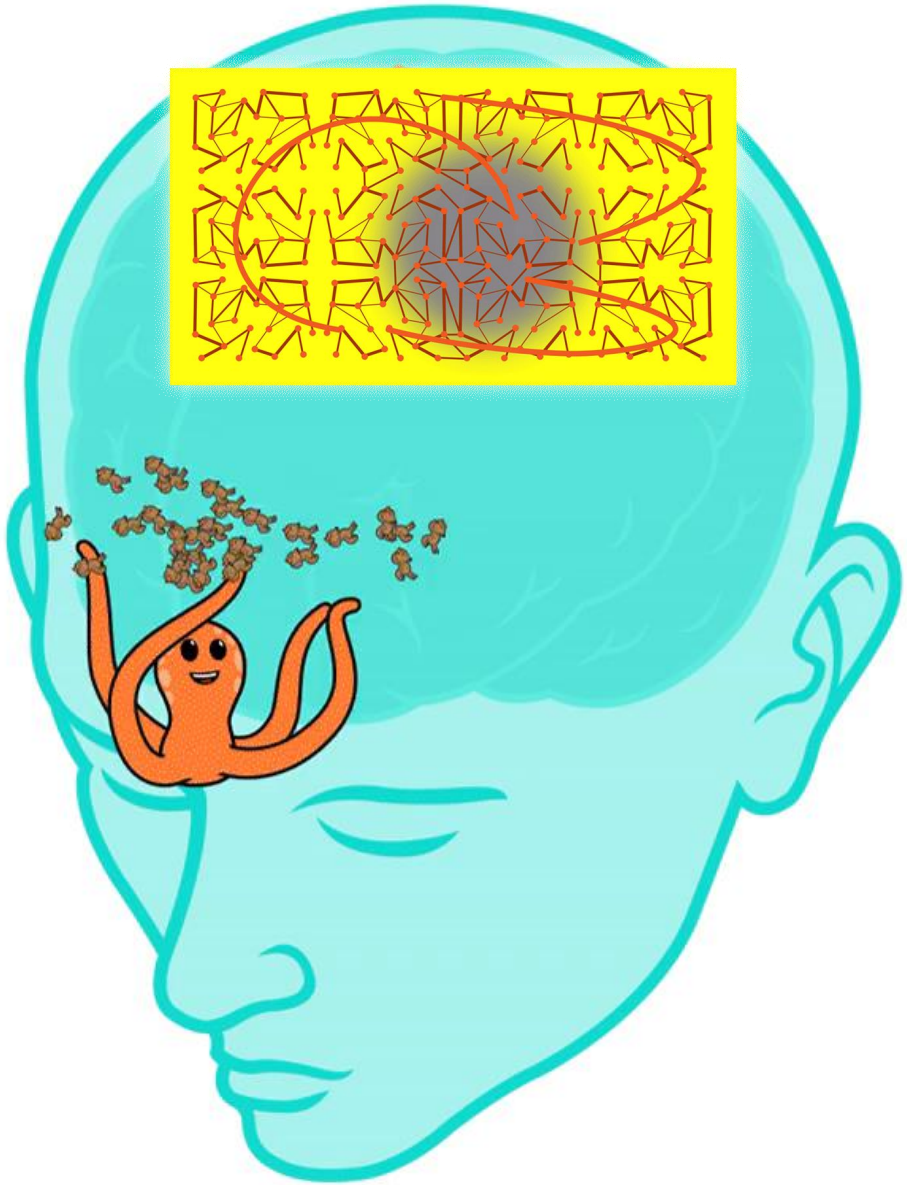
Identity Schema



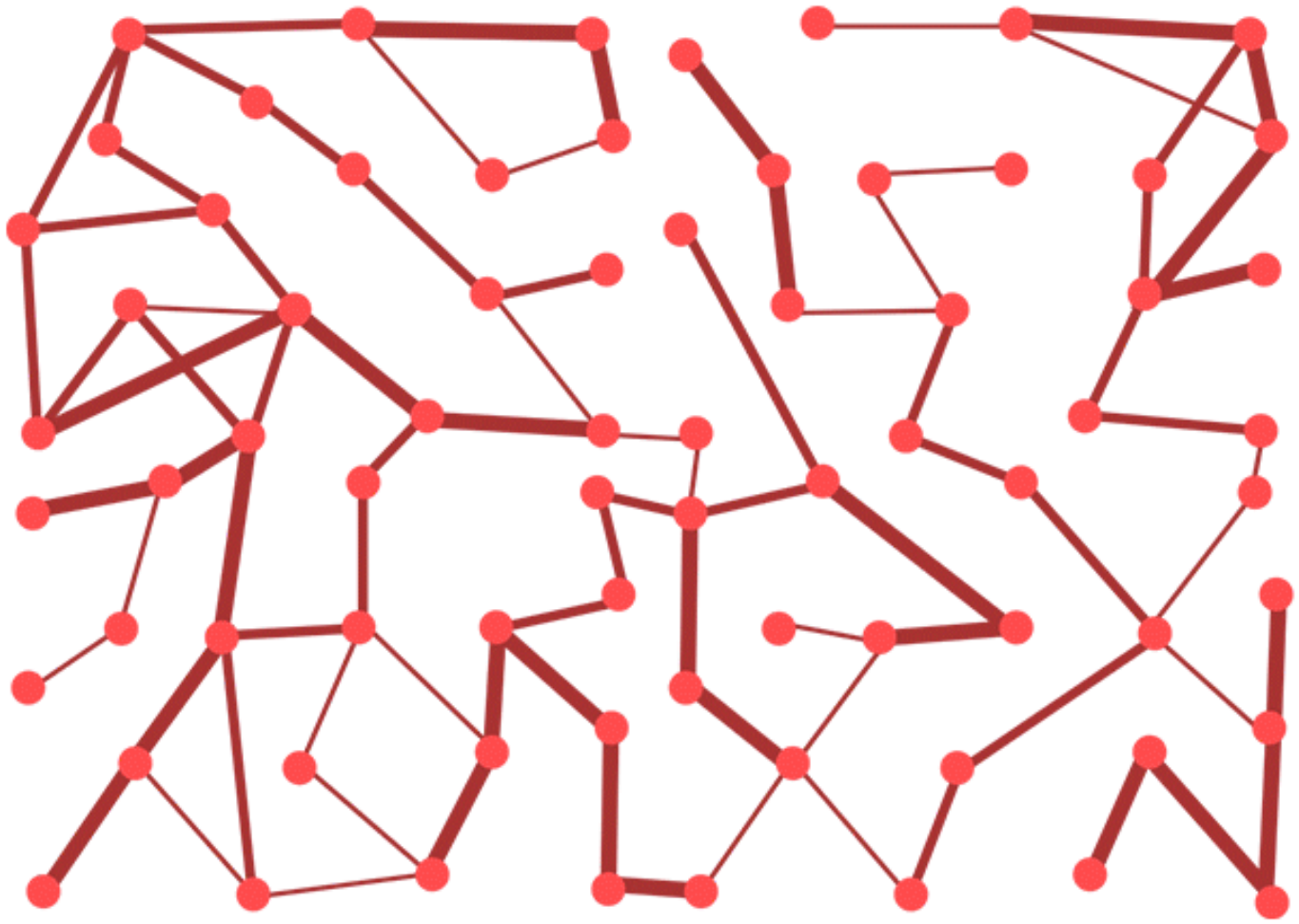




Student



“When we hear the words of the Buddha… we have to think about their meaning and apply that meaning to our own lives. And when we do this, we generate changes in the structure and functions of our brains..”
The Joy of Living, Yongey Mingyur Rinpoche, Page 17



NEUROCASE
2020, VOL. 26, NO. 2, 79–90
https://doi.org/10.1080/13554794.2020.1731553

Routledge
Taylor & Francis Group

BrainAGE and regional volumetric analysis of a Buddhist monk: a longitudinal MRI case study

Nagesh Adluru [a], Cole H. Korponay [b], Derek L. Norton [c], Robin I. Goldman [d] and Richard J. Davidson [d,e]

[a]Waisman Center, UW-Madison, USA; [b]McLean Hospital, Harvard Medical School, USA; [c]Department of Biostatistics and Medical Informatics, UW-Madison, USA; [d]Center for Healthy Minds, UW-Madison, USA; [e]Departments of Psychology and Psychiatry, UW-Madison, USA

ABSTRACT

Yongey Mingyur Rinpoche (YMR) is a Tibetan Buddhist monk, and renowned meditation practitioner and teacher who has spent an extraordinary number of hours of his life meditating. The brain-aging profile of this expert meditator in comparison to a control population was examined using a machine learning framework, which estimates "brain-age" from brain imaging. YMR's brain-aging rate appeared slower than that of controls suggesting early maturation and delayed aging. At 41 years, his brain resembled that of a 33-year-old. Specific regional changes did not differentiate YMR from controls, suggesting that the brain-aging differences may arise from coordinated changes spread throughout the gray matter.

ARTICLE HISTORY
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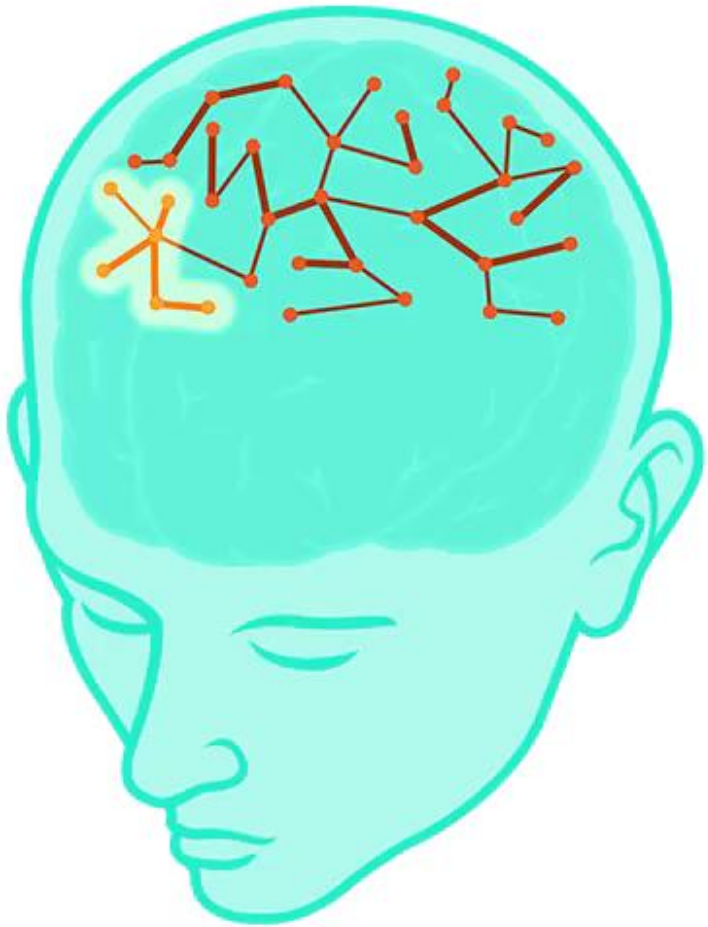
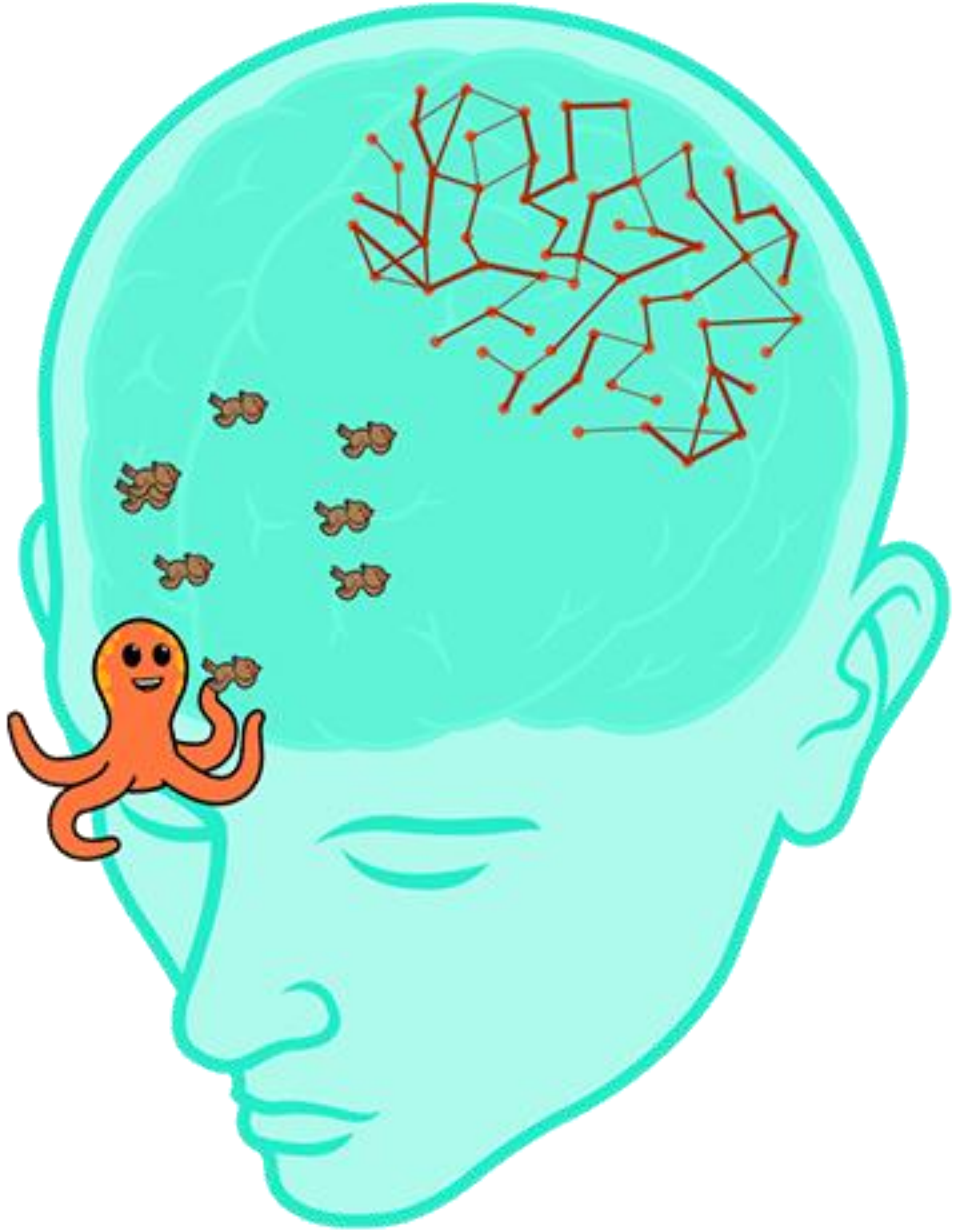
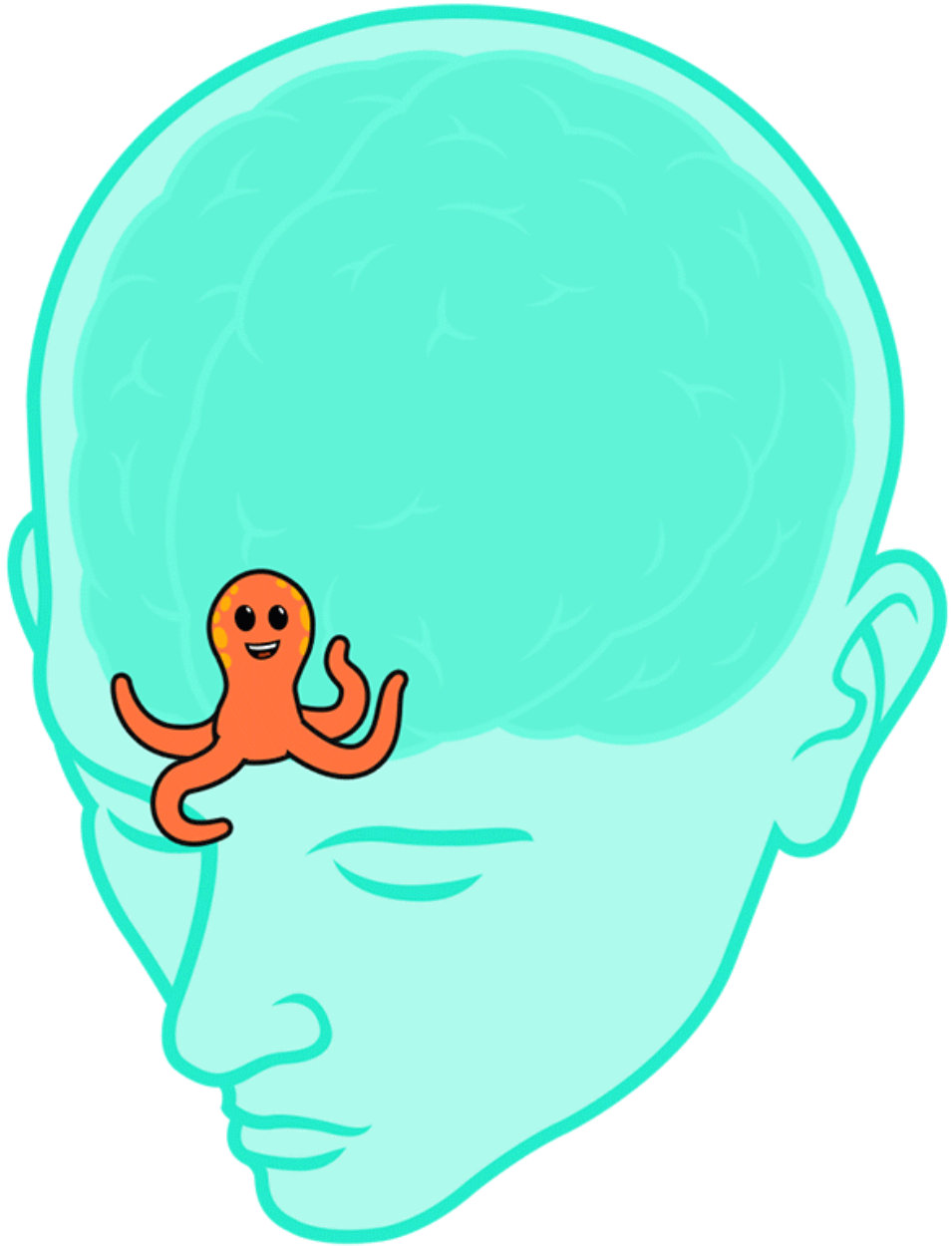
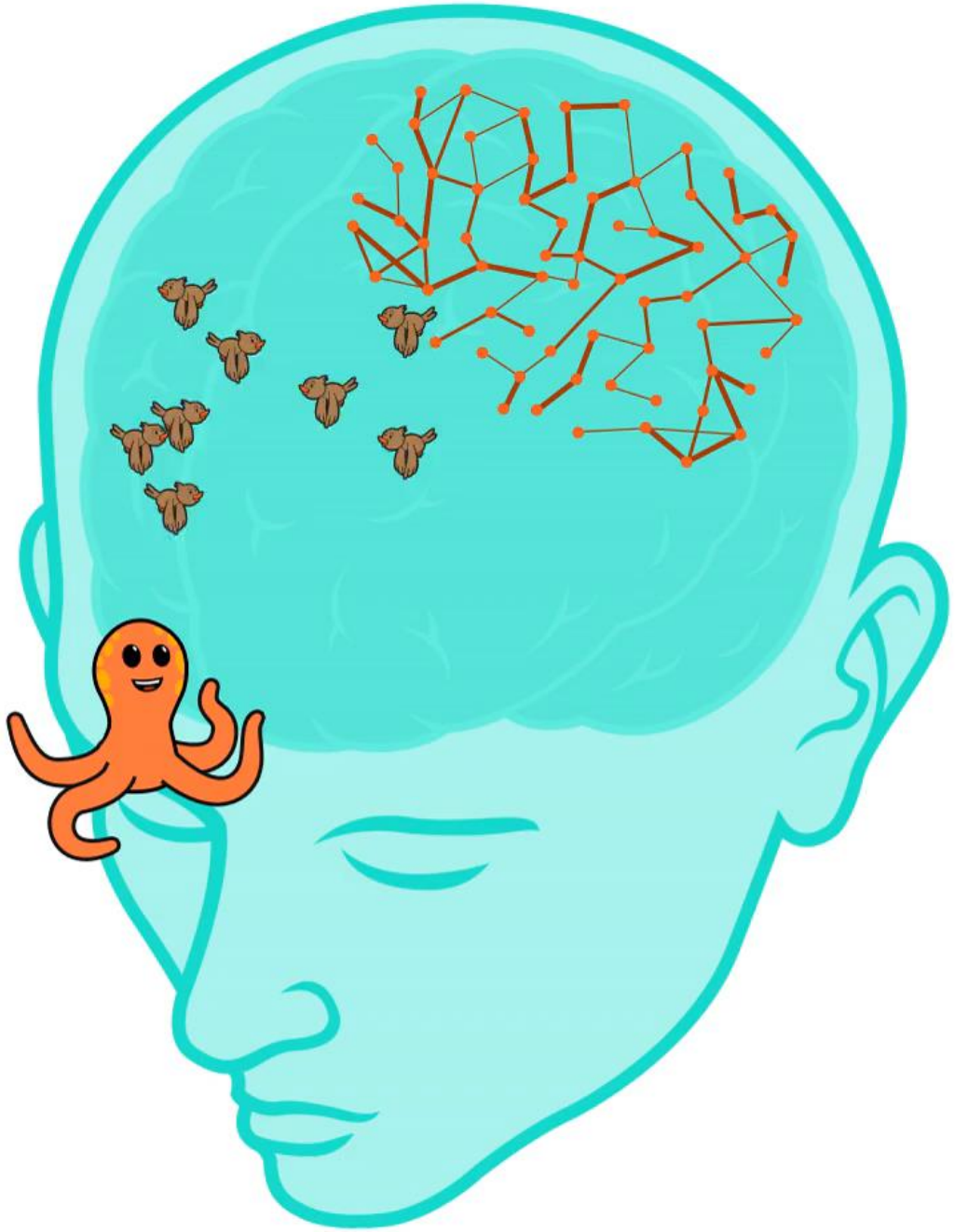
KEYWORDS
MRI case study; machine learning; long-term meditator; Buddhist monk



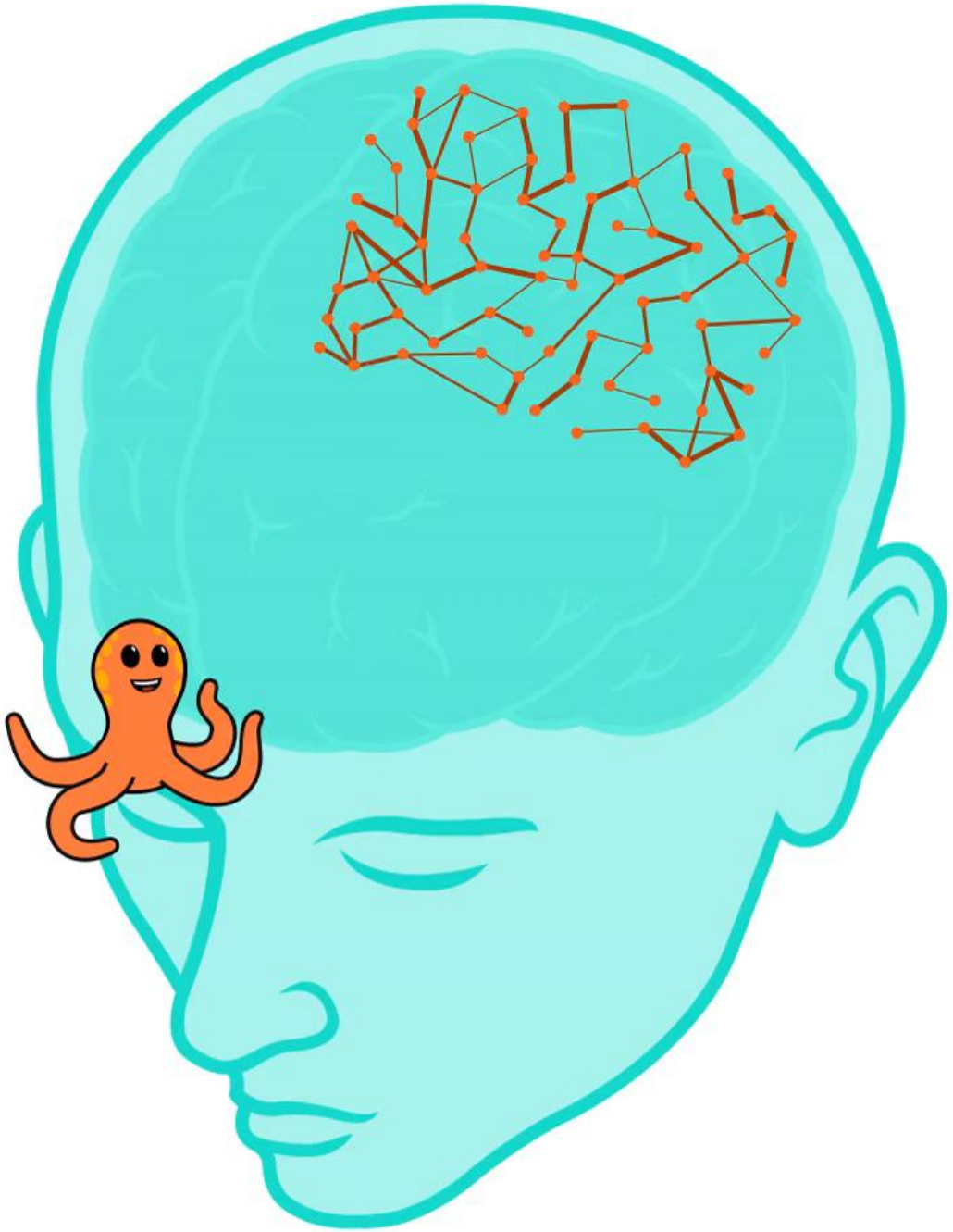




Events ⟷ Mental models



Practice putting the mental model into long-term memory (schema)



Practice pulling the mental model OUT of long-term memory

Student

Teacher

Teaching means getting in neural synchrony

Teaching means getting in neural synchrony

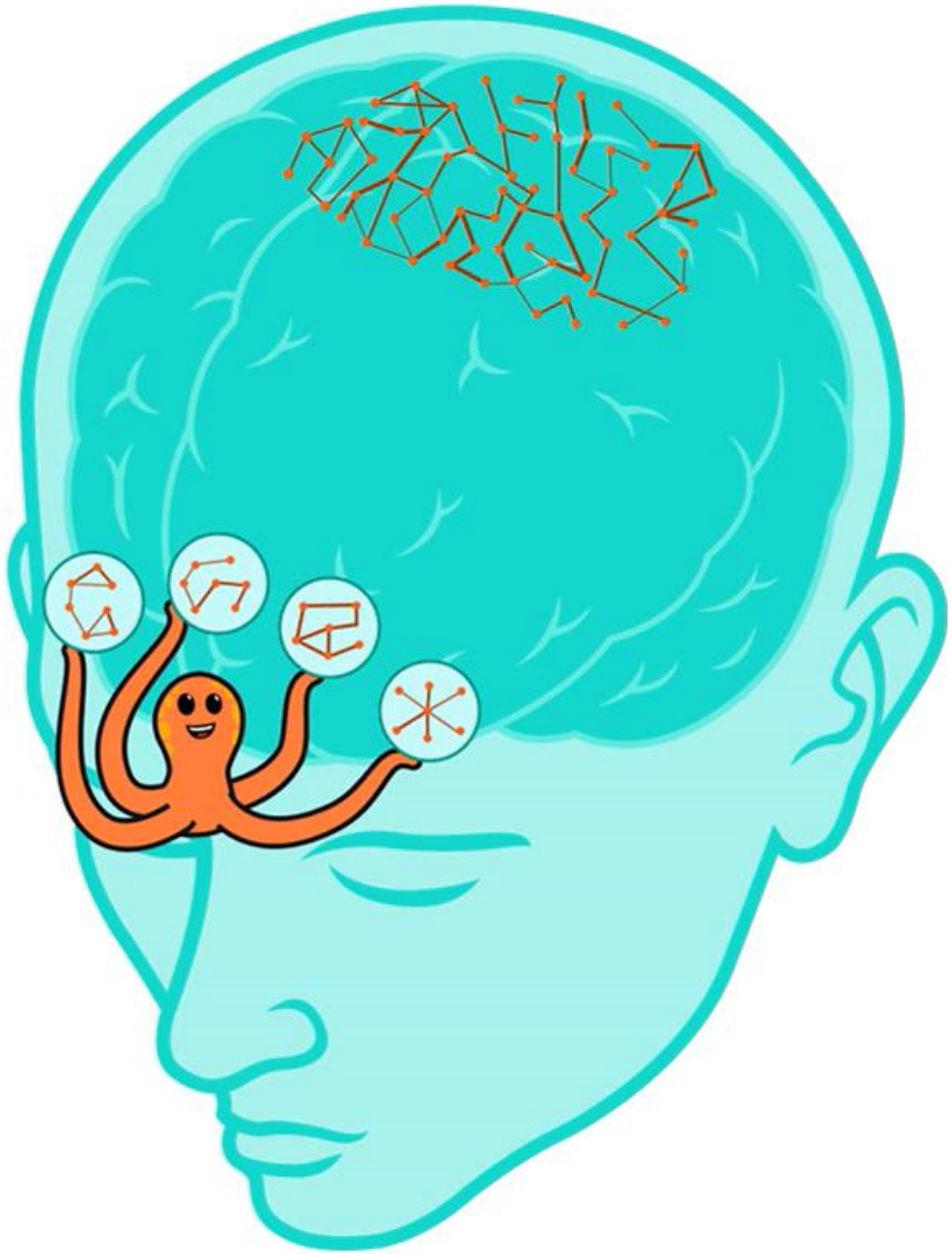
Social learning

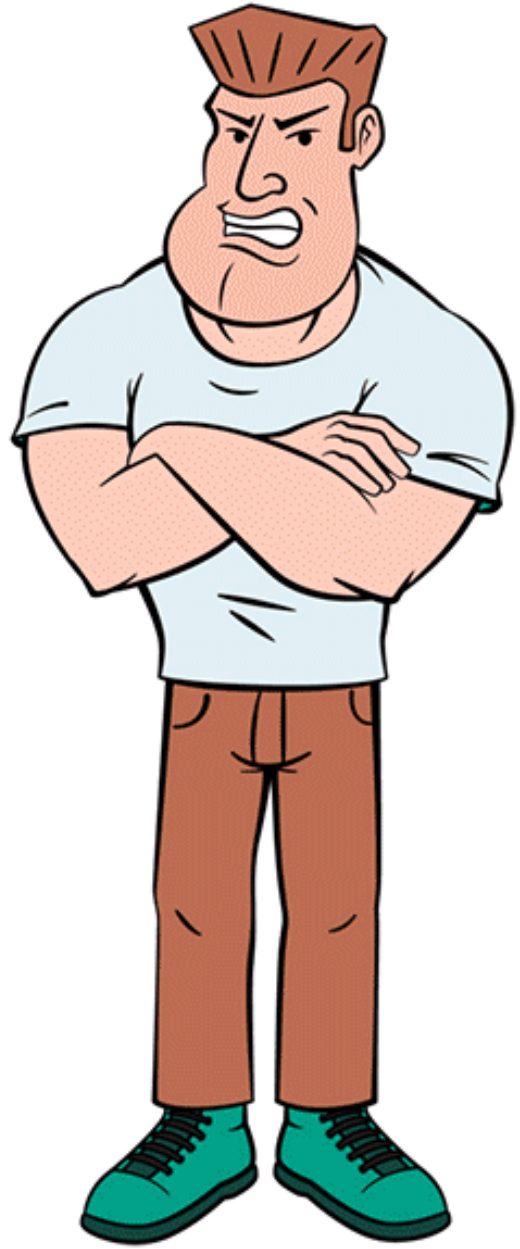
The challenge of discussion forums

The “tyranny of film”

Hutson, J. P., P. Chandran, J. P. Magliano, T. J. Smith, and L. C. Loschky. "Narrative Comprehension Guides Eye Movements in the Absence of Motion." *Cogn Sci* 46, no. 5 (May 2022): e13131. https://dx.doi.org/10.1111/cogs.13131.

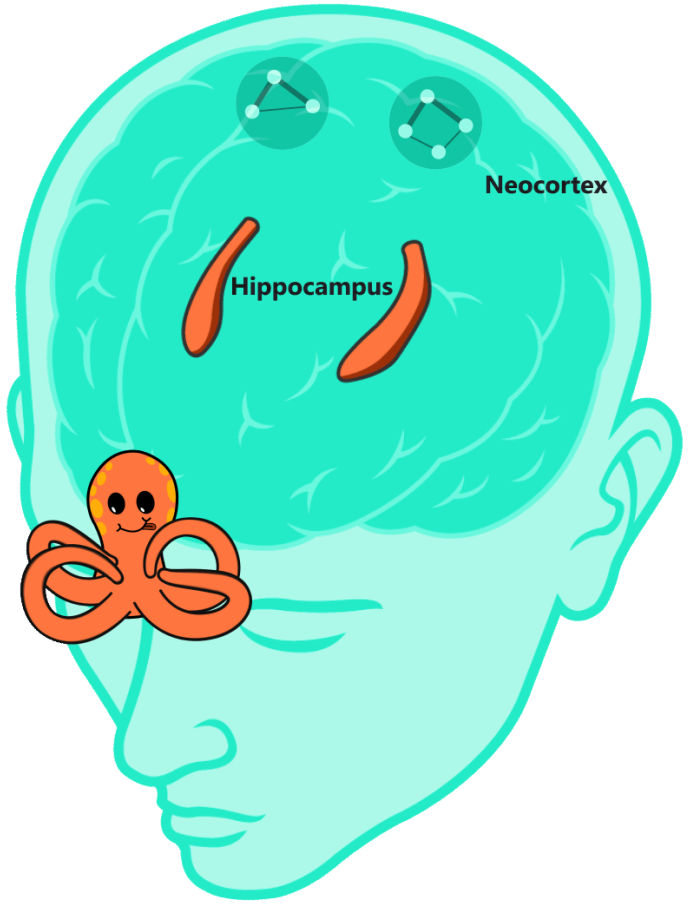
The hippocampus in declarative learning





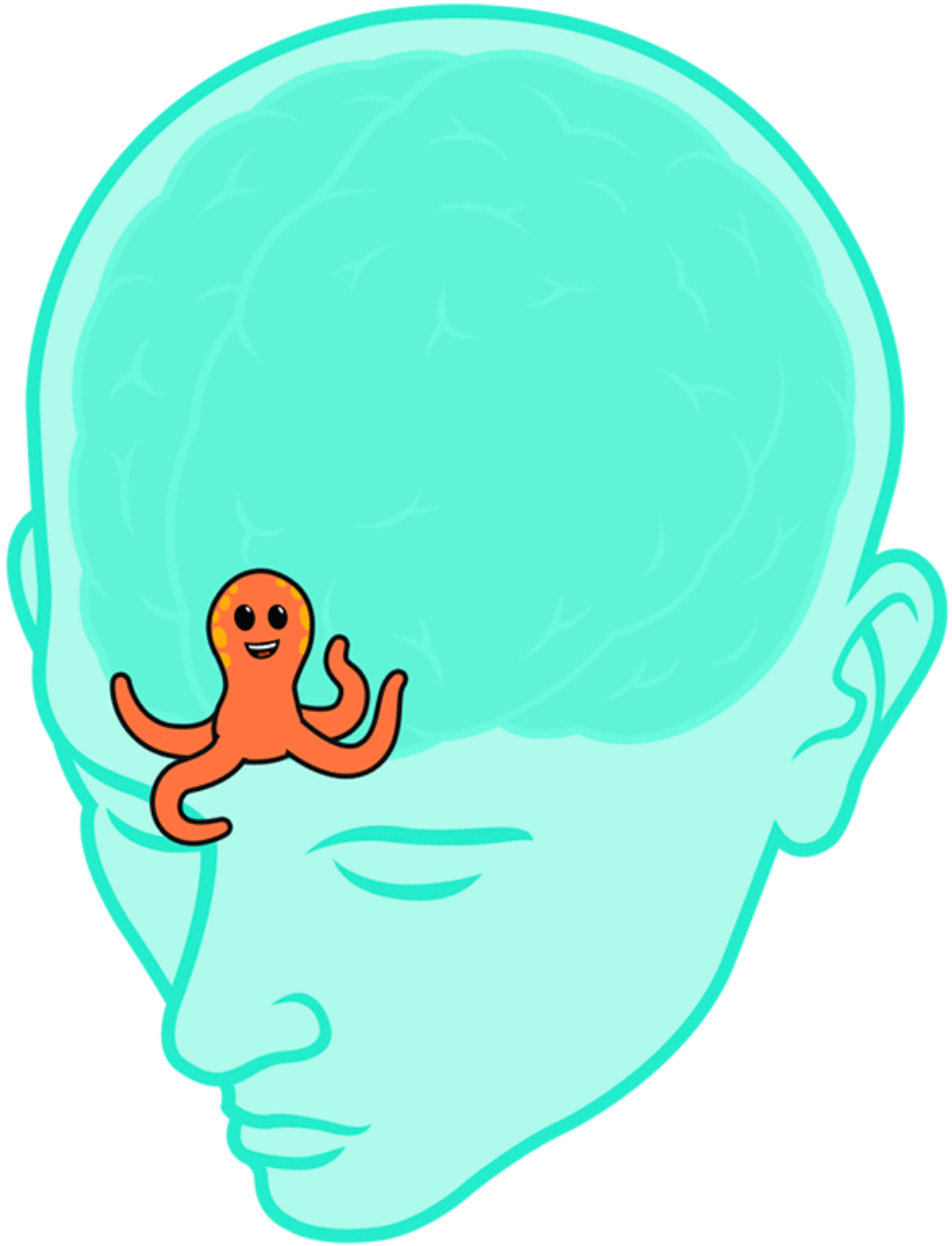
Short breaks or lighter tasks

Allow the hippocampus to strengthen links in the neocortex

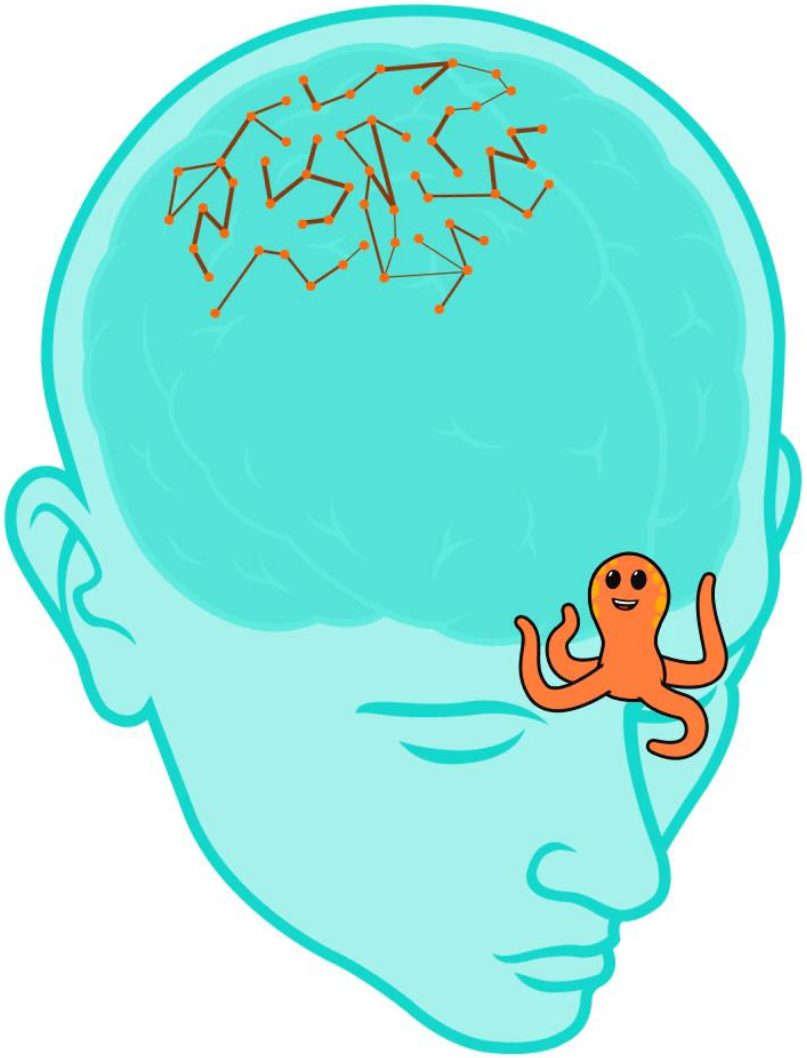


Think-pair-share

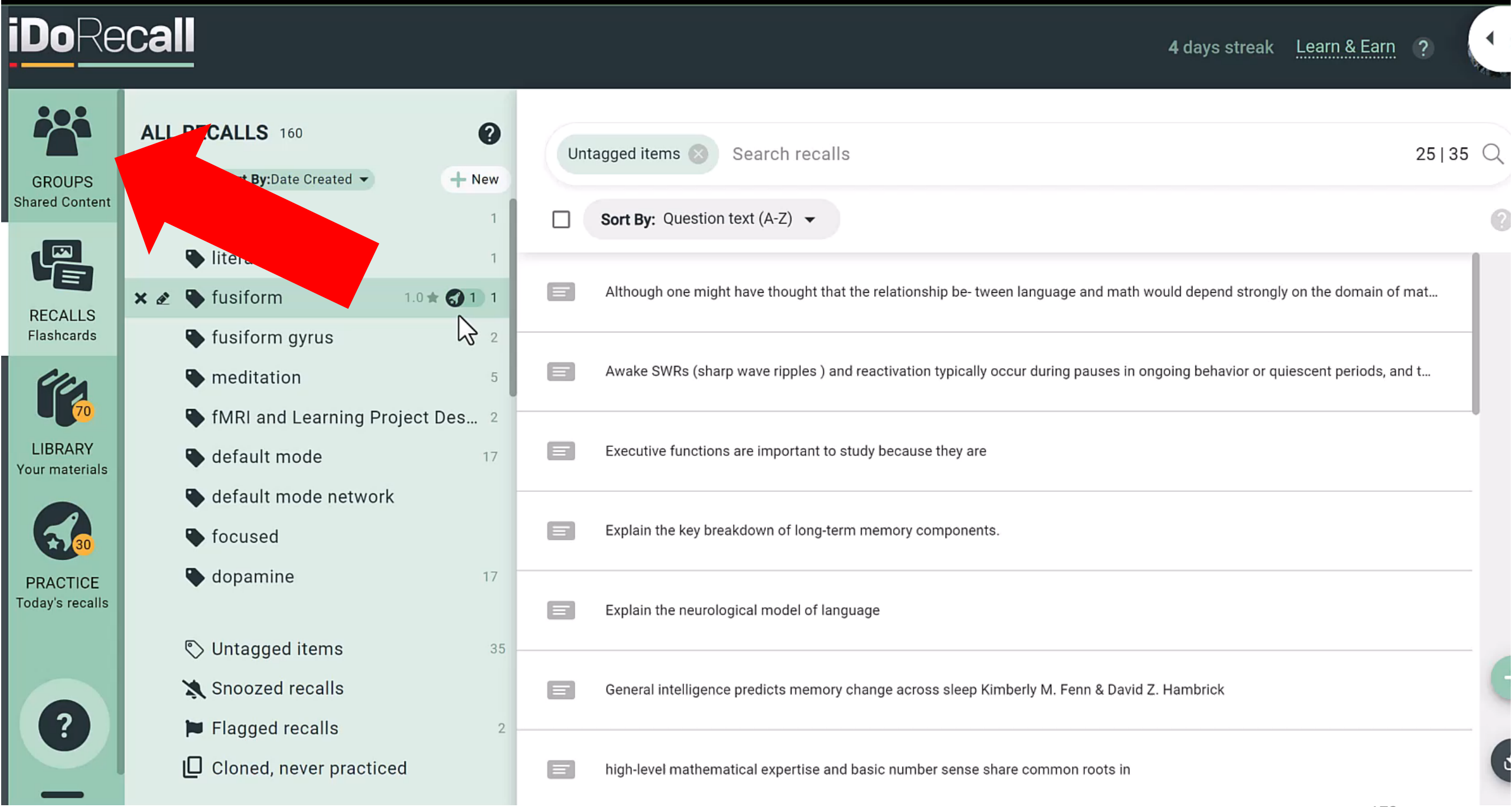
Why cramming works—but only temporarily



TWEAKING *YOUR* SCHEMAS



- Add retrieval practice apps to your teaching repertoire!


iDoRecall
4 days streak
Learn & Earn
GROUPS
Shared Content
RECALLS
Flashcards
70
LIBRARY
Your materials
30
PRACTICE
Today's recalls
ALL RECALLS 160
By:Date Created
New
1
1
fusiform 1.0 1 1
fusiform gyrus 2
meditation 5
fMRI and Learning Project Des... 2
default mode 17
default mode network
focused
dopamine 17
Untagged items 35
Snoozed recalls
Flagged recalls 2
Cloned, never practiced
Untagged items
Search recalls
25 | 35
Sort By: Question text (A-Z)
Although one might have thought that the relationship be- tween language and math would depend strongly on the domain of mat...
Awake SWRs (sharp wave ripples) and reactivation typically occur during pauses in ongoing behavior or quiescent periods, and t...
Executive functions are important to study because they are
Explain the key breakdown of long-term memory components.
Explain the neurological model of language
General intelligence predicts memory change across sleep Kimberly M. Fenn & David Z. Hambrick
high-level mathematical expertise and basic number sense share common roots in

Retrieval Practice Apps

Teacher can facilitate creation of decks in classes

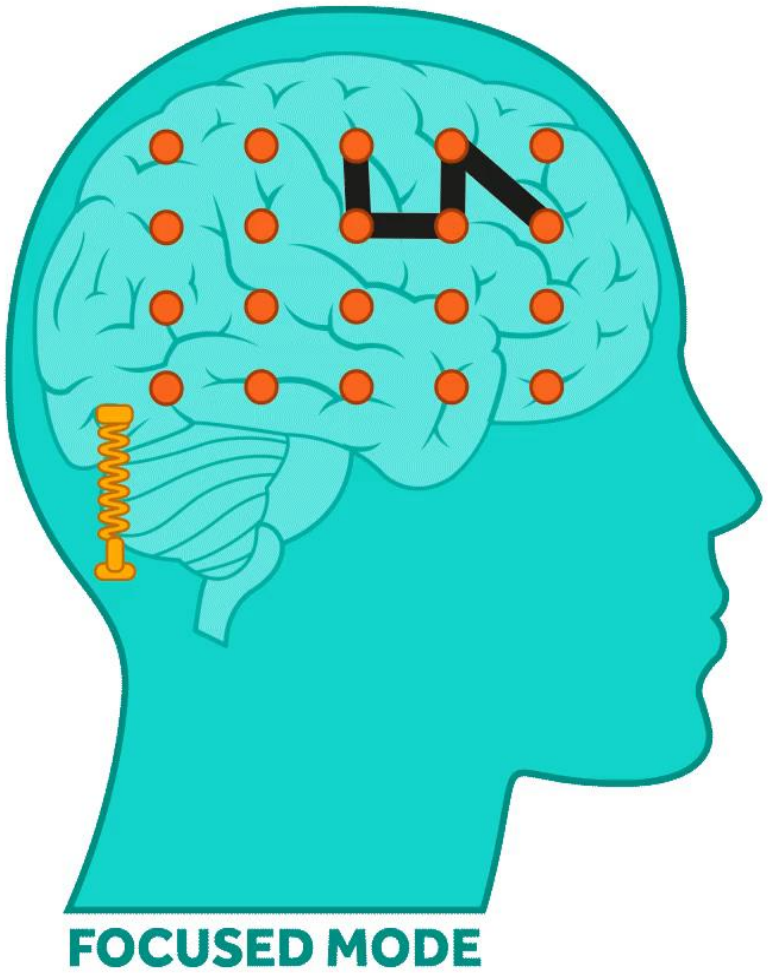
- iDoRecall
- Quizlet
- Kahoot!
- Anki

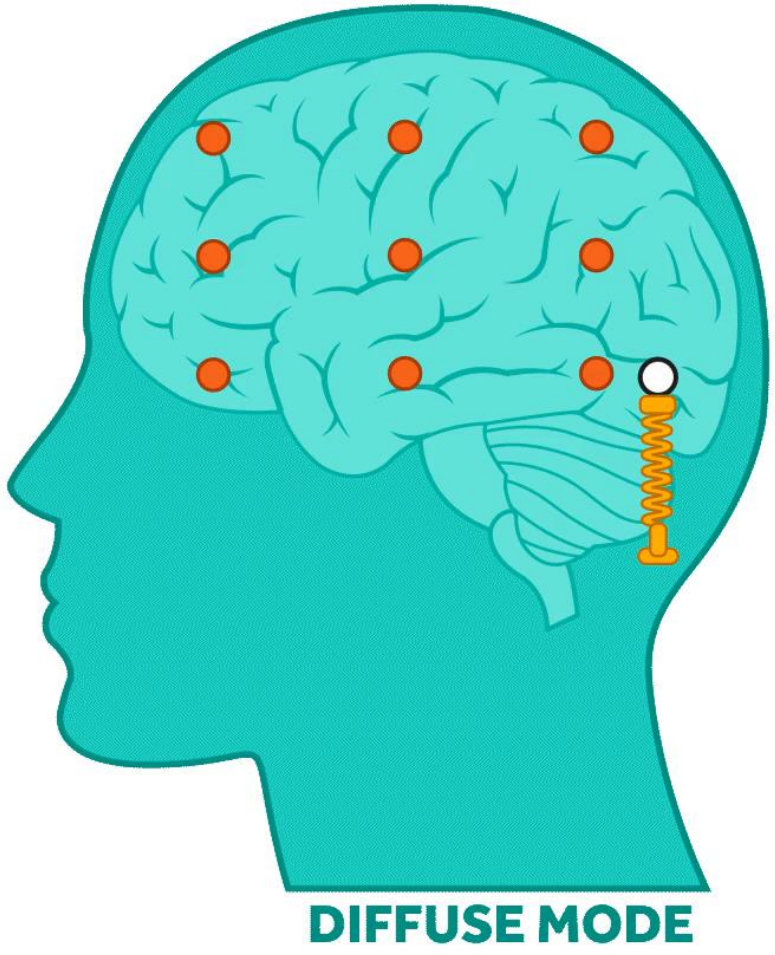
Live, in-class

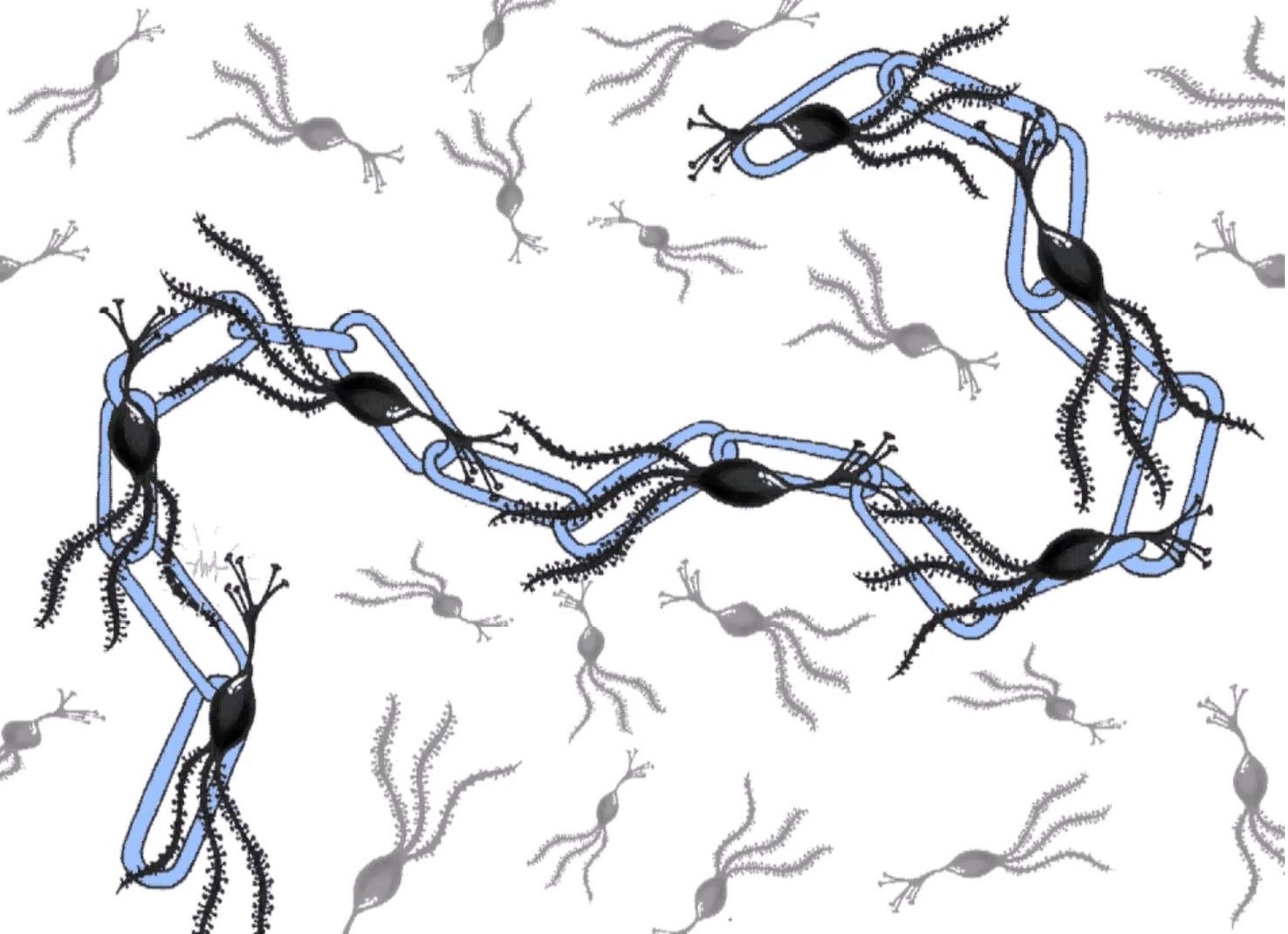
- PearDeck
- NearPod

Making Learning a Habit

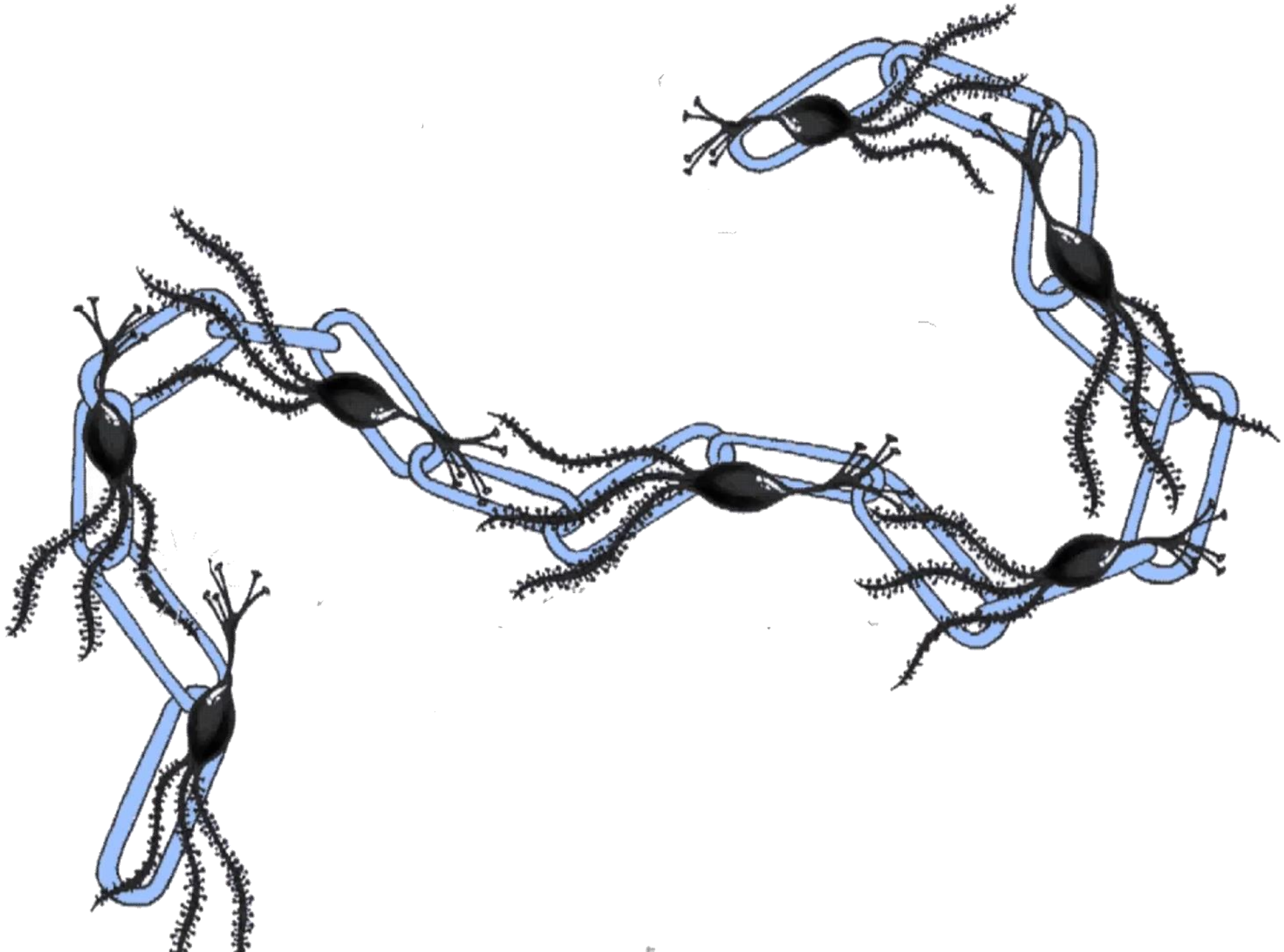
conjure.so


FOCUSED MODE


DIFFUSE MODE



These are like sets of links



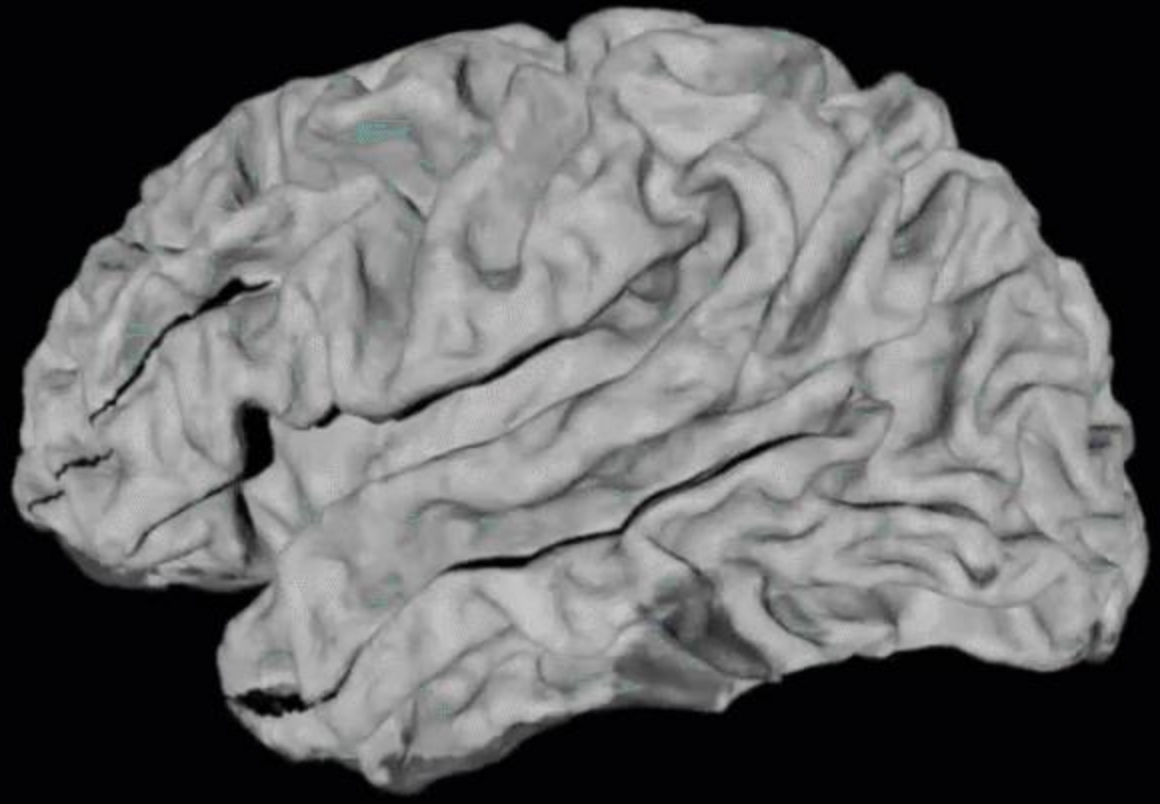
The Neocortex

Courtesy Alexander Huth

The Neocortex

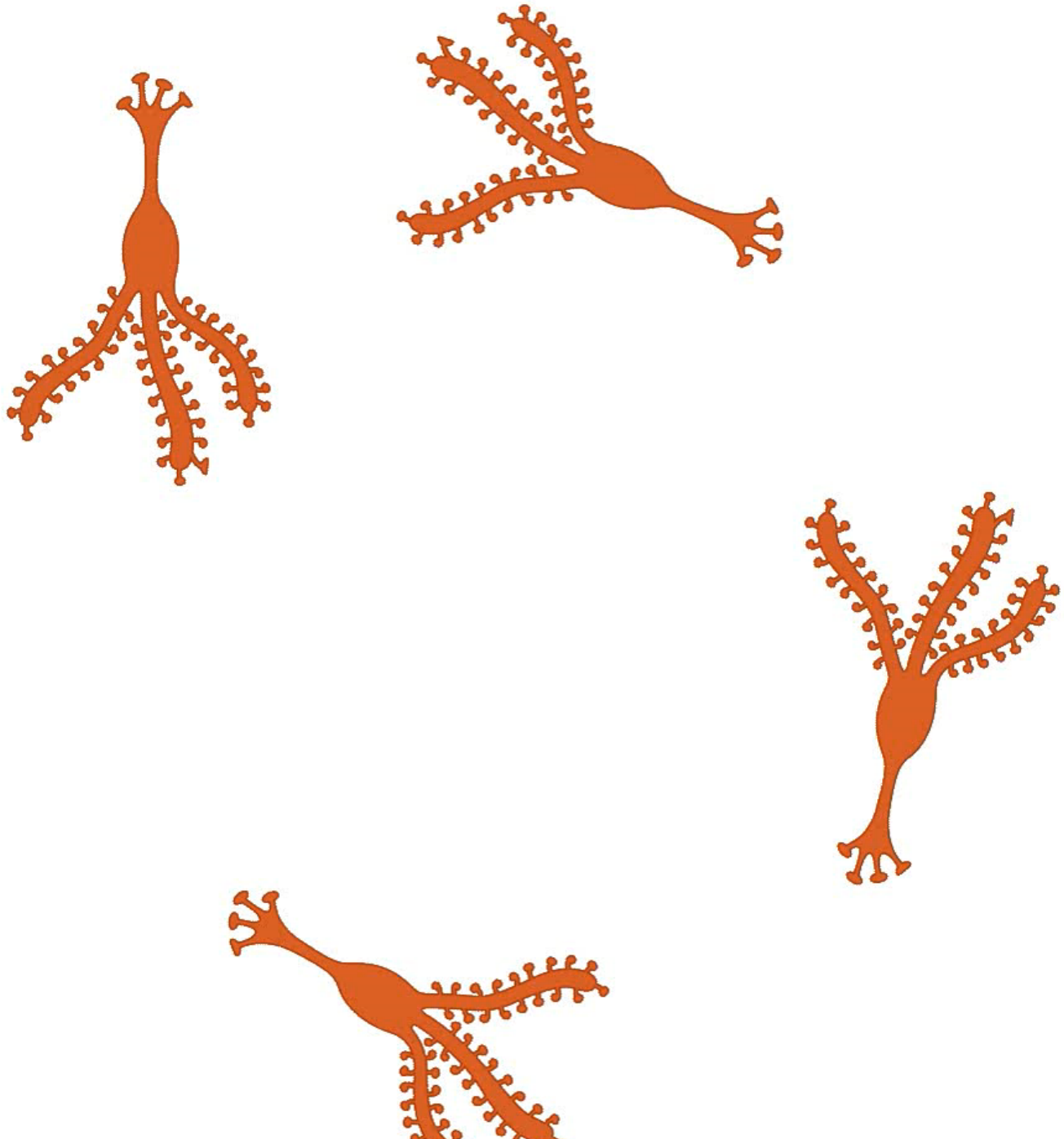
Courtesy Alexander Huth

The Neocortex

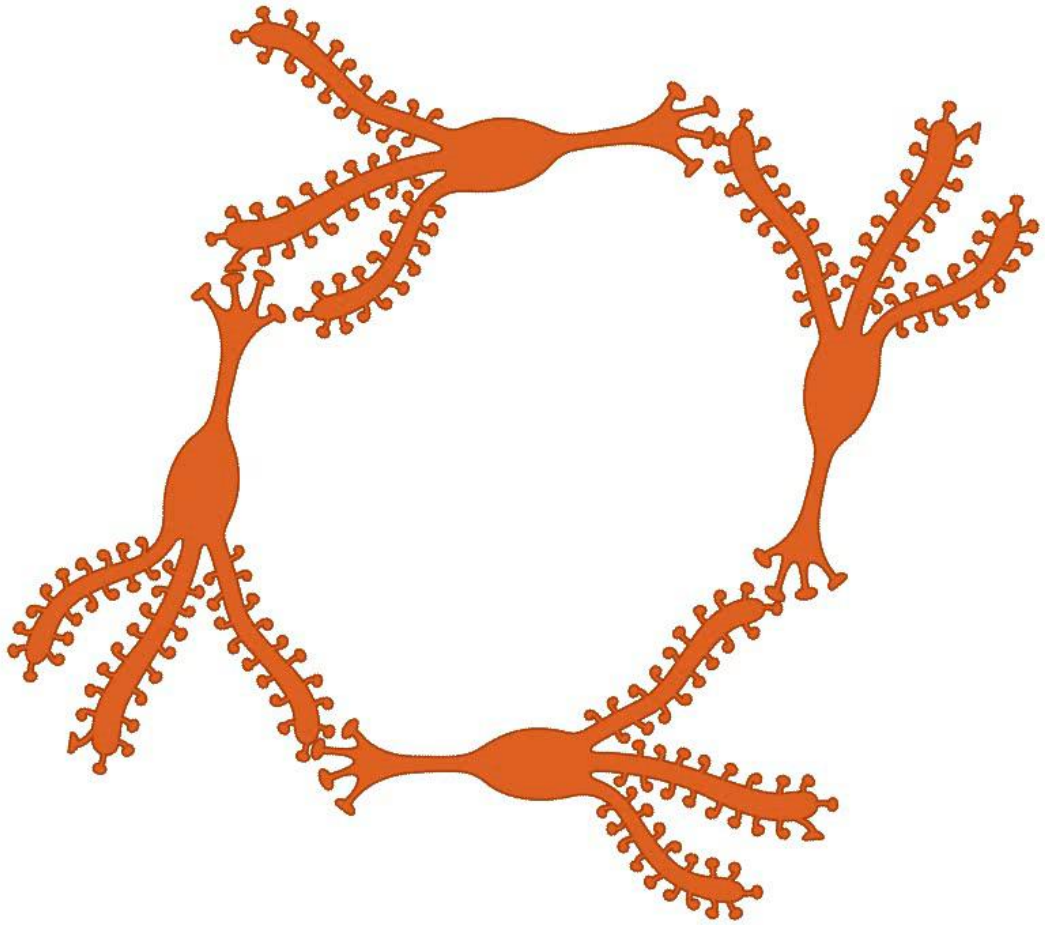


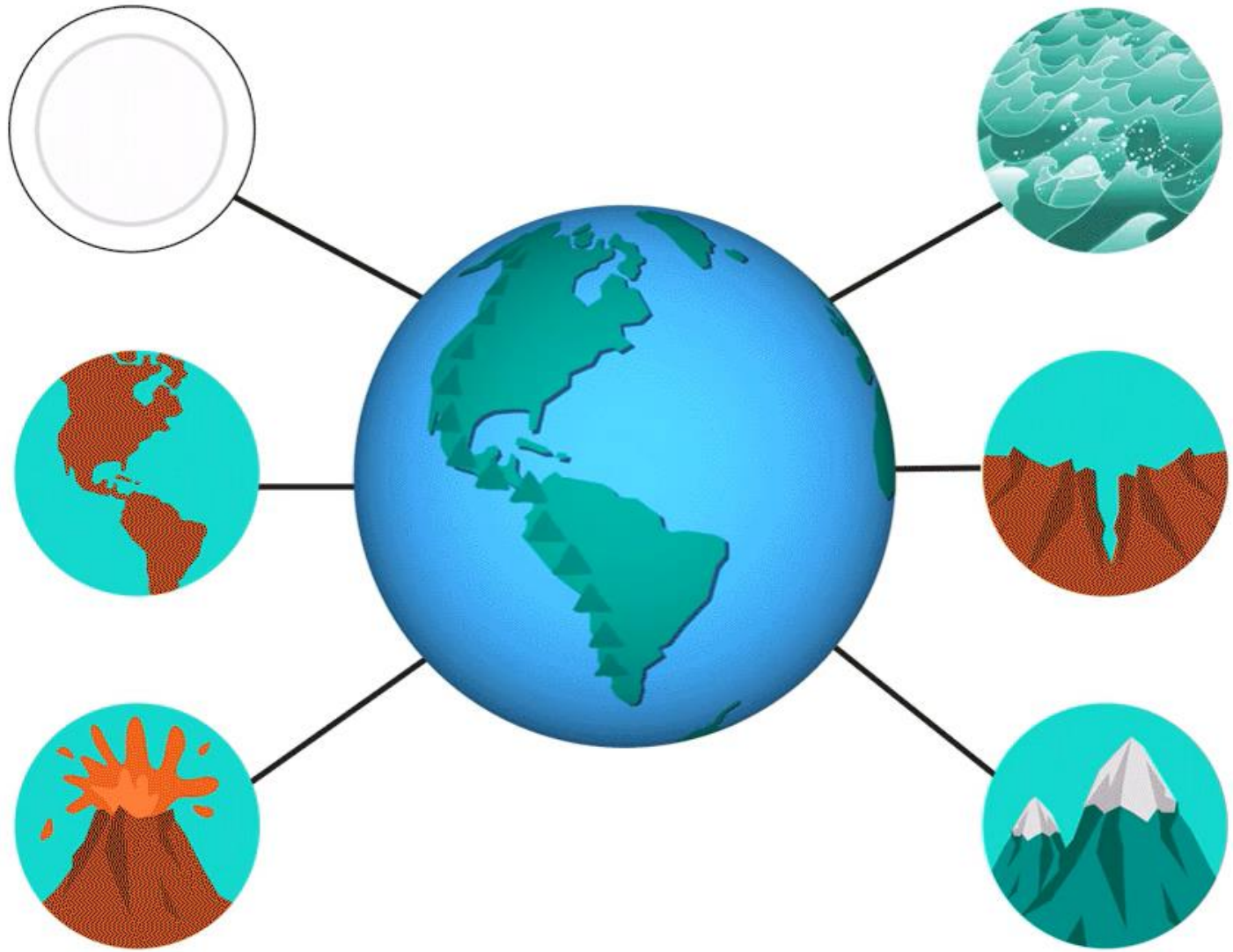
Courtesy Alexander Huth

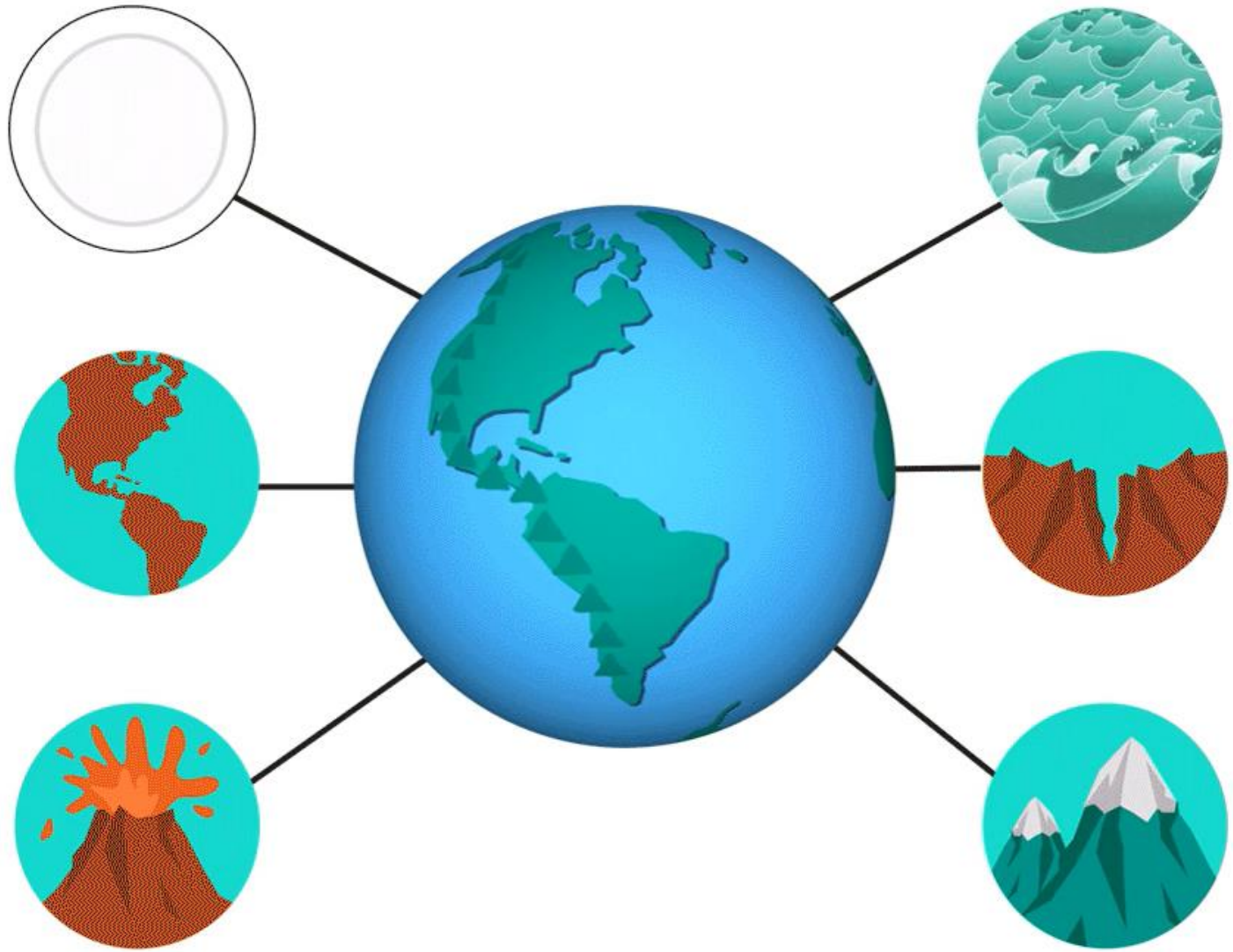
Neuron shorthand

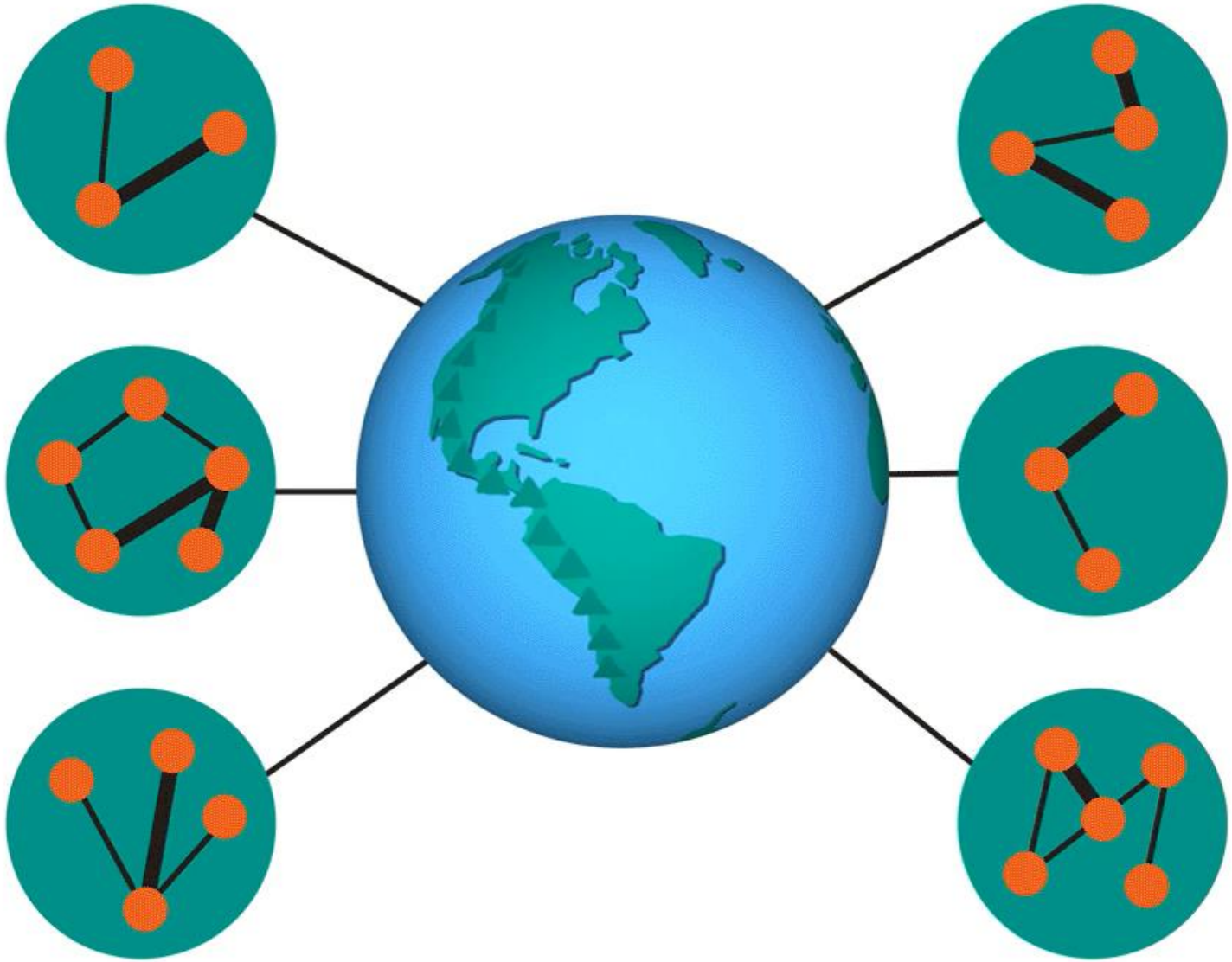


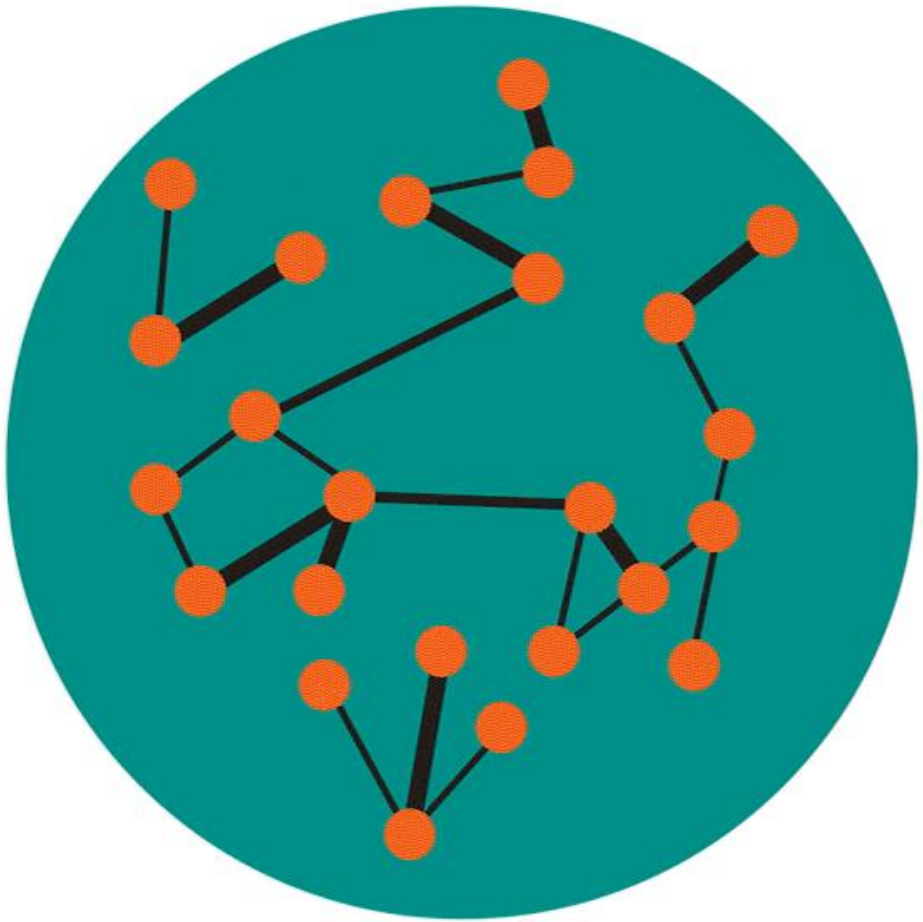
Neuron shorthand

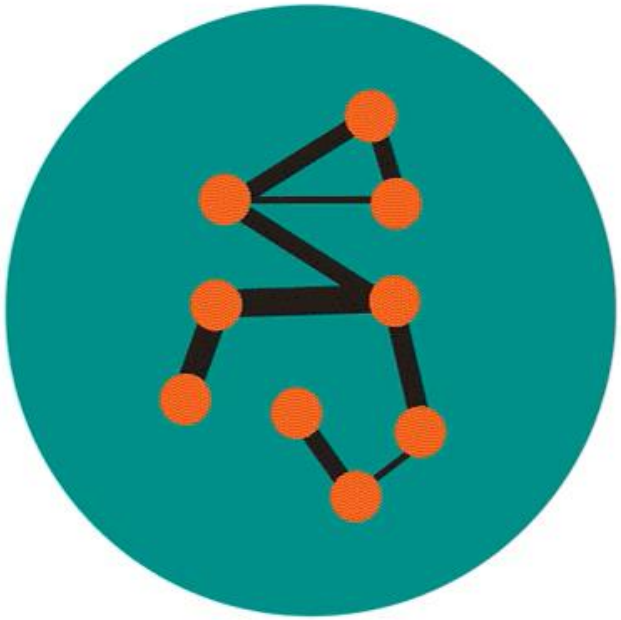






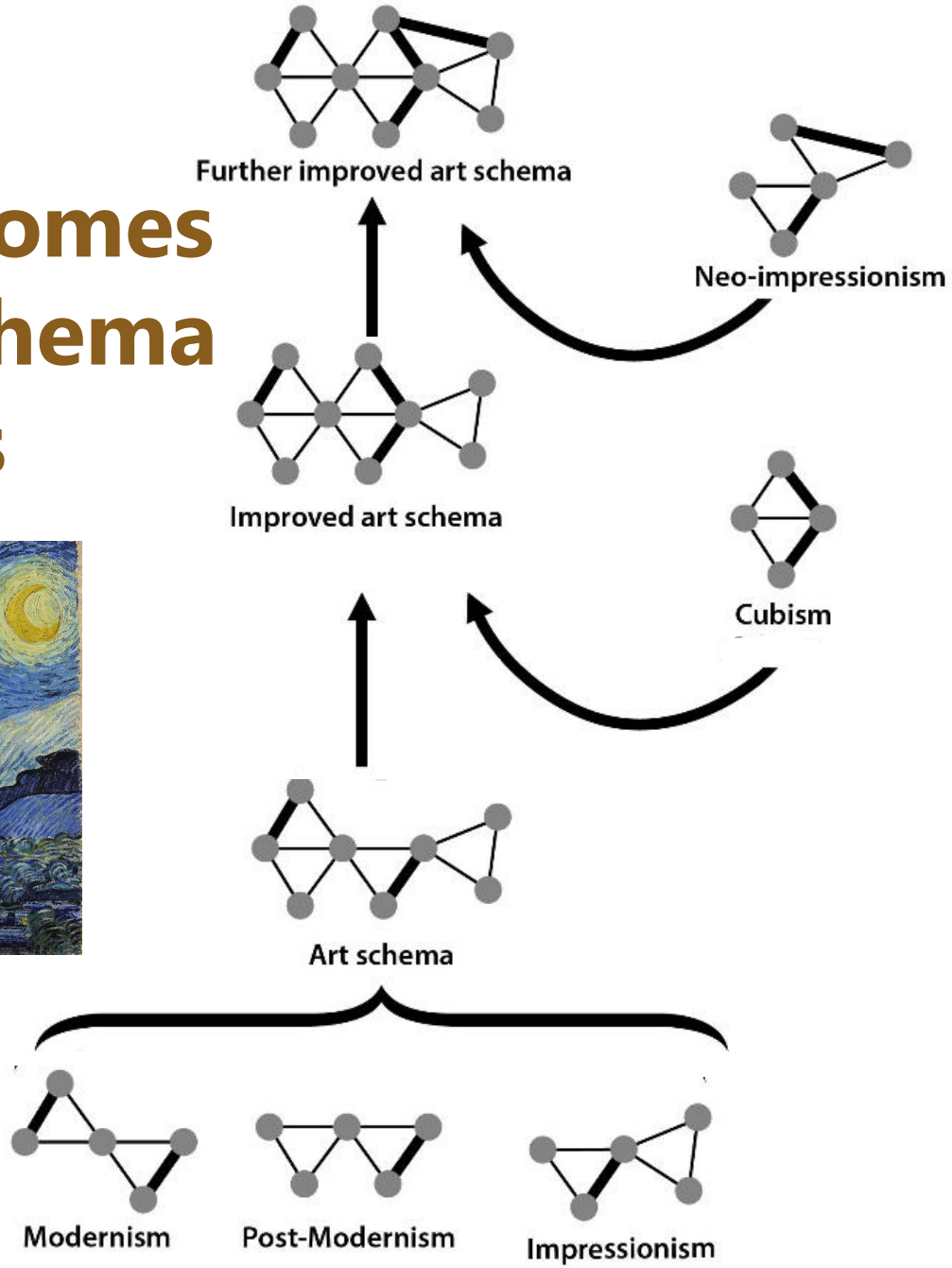


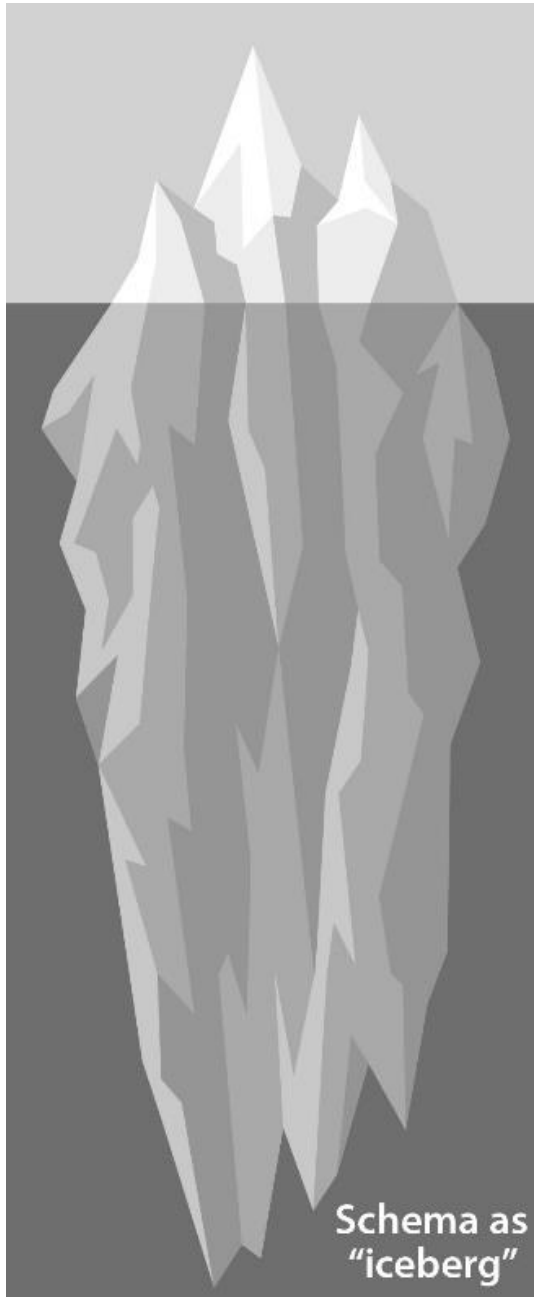


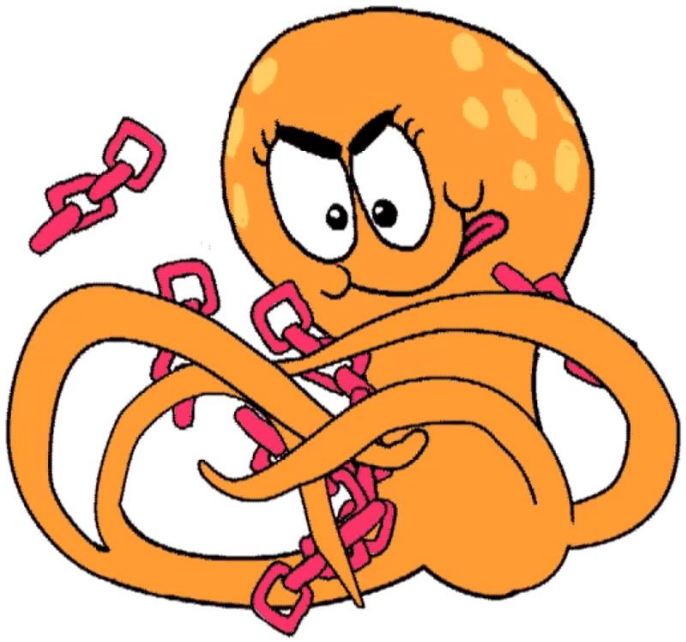


Metaphor & analogy

Learning becomes easier as a schema expands

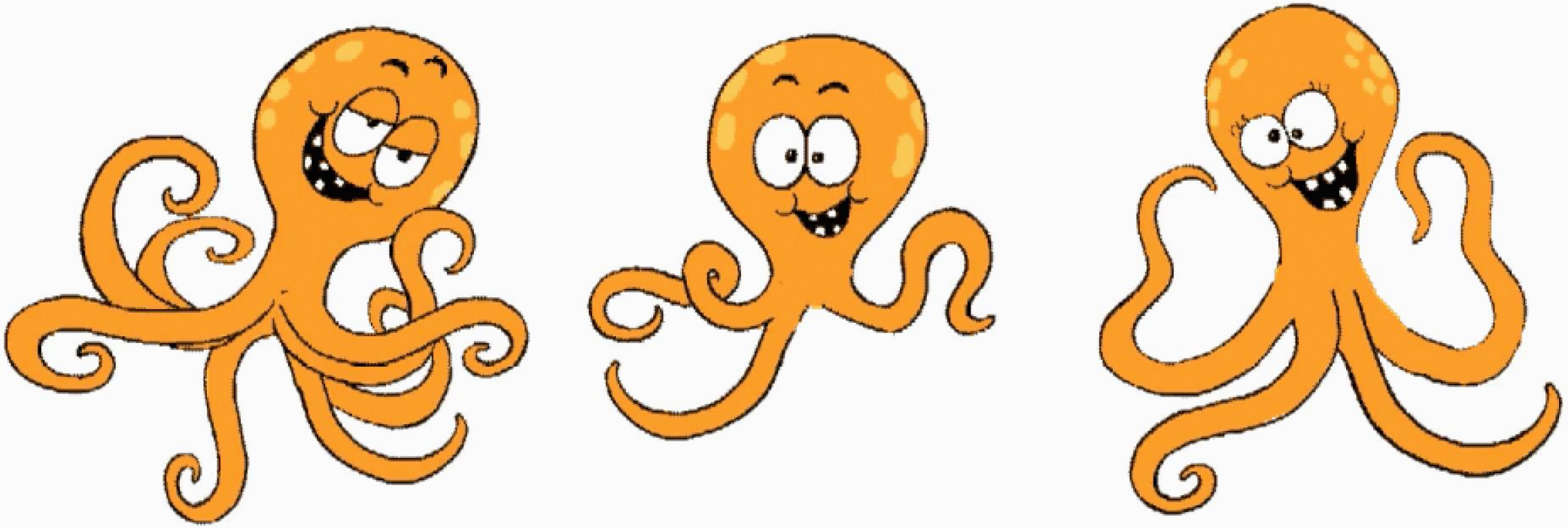


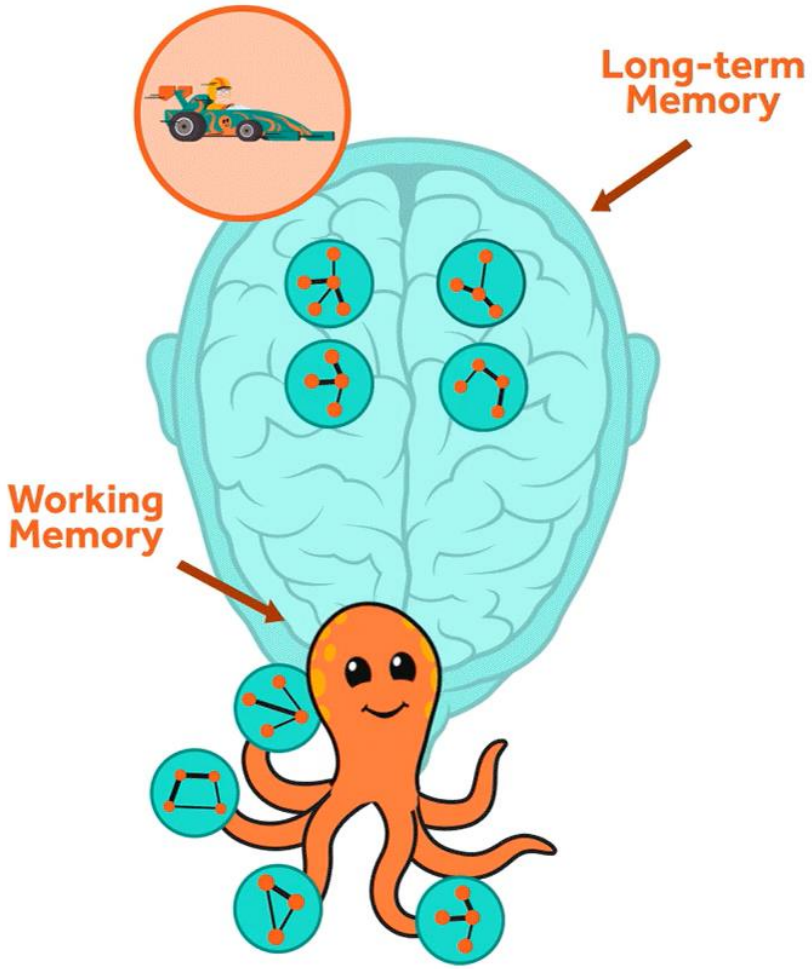


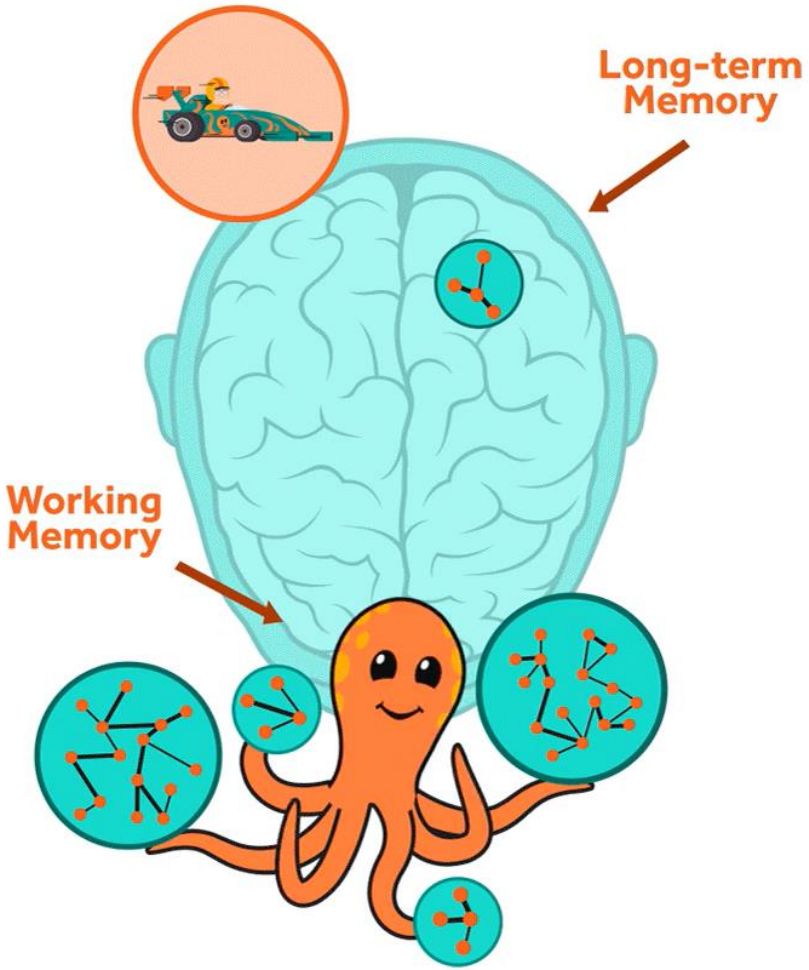


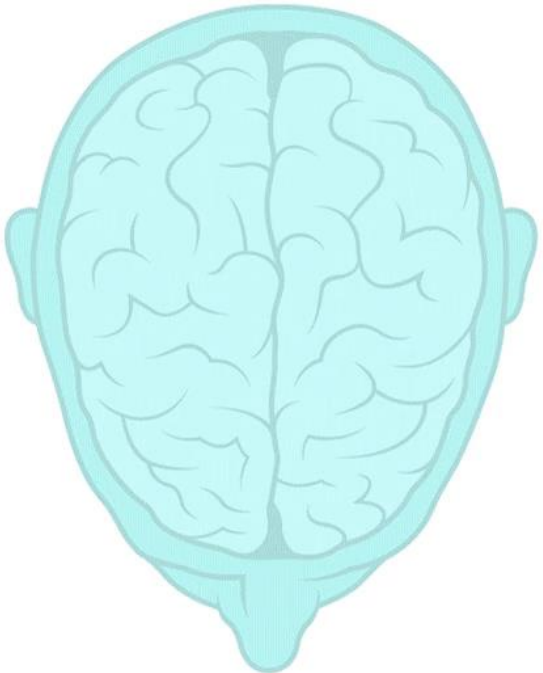
- Heavy cognitive load
- No working memory is available for anything else

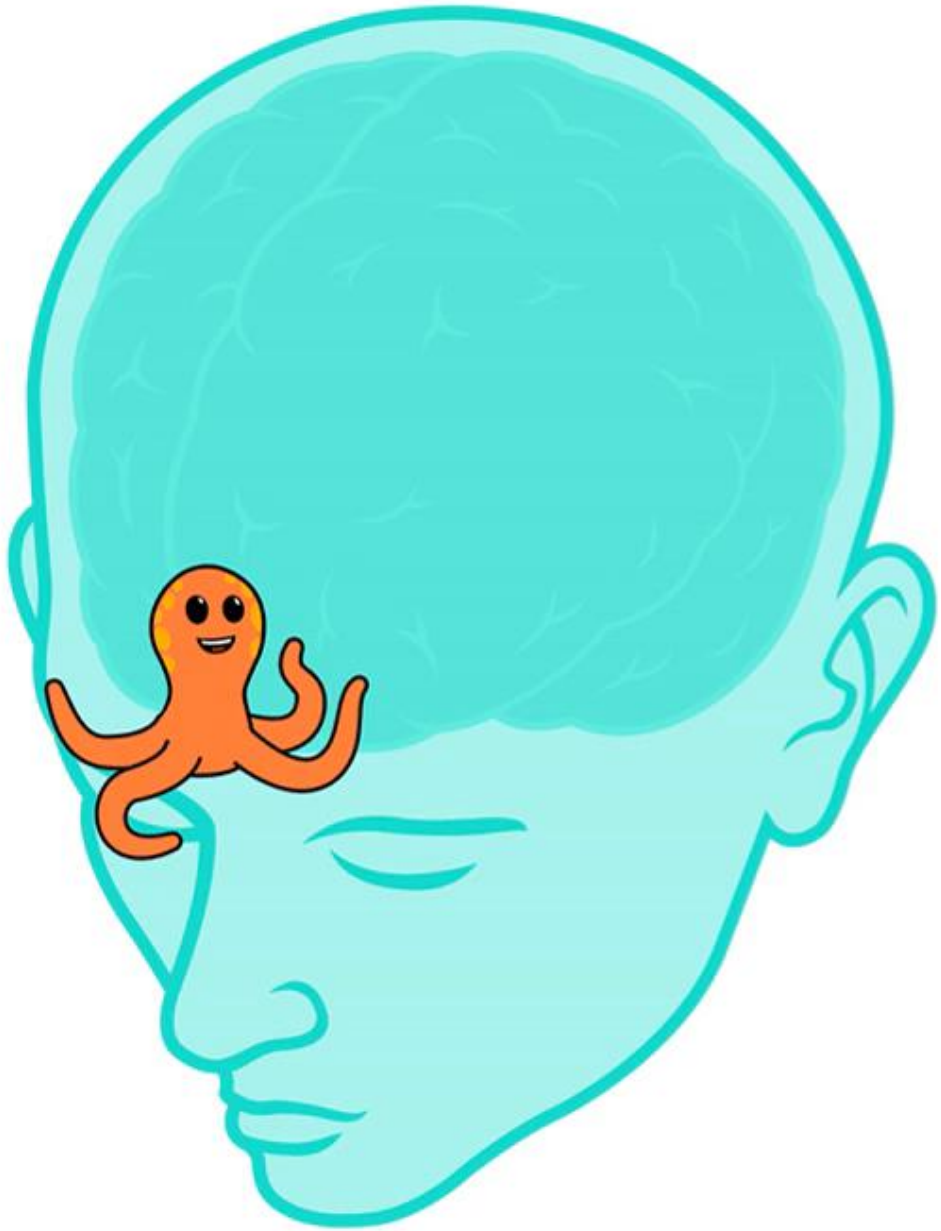
The lower the working memory capacity, the more the student is helped by their sets of links in long term memory!

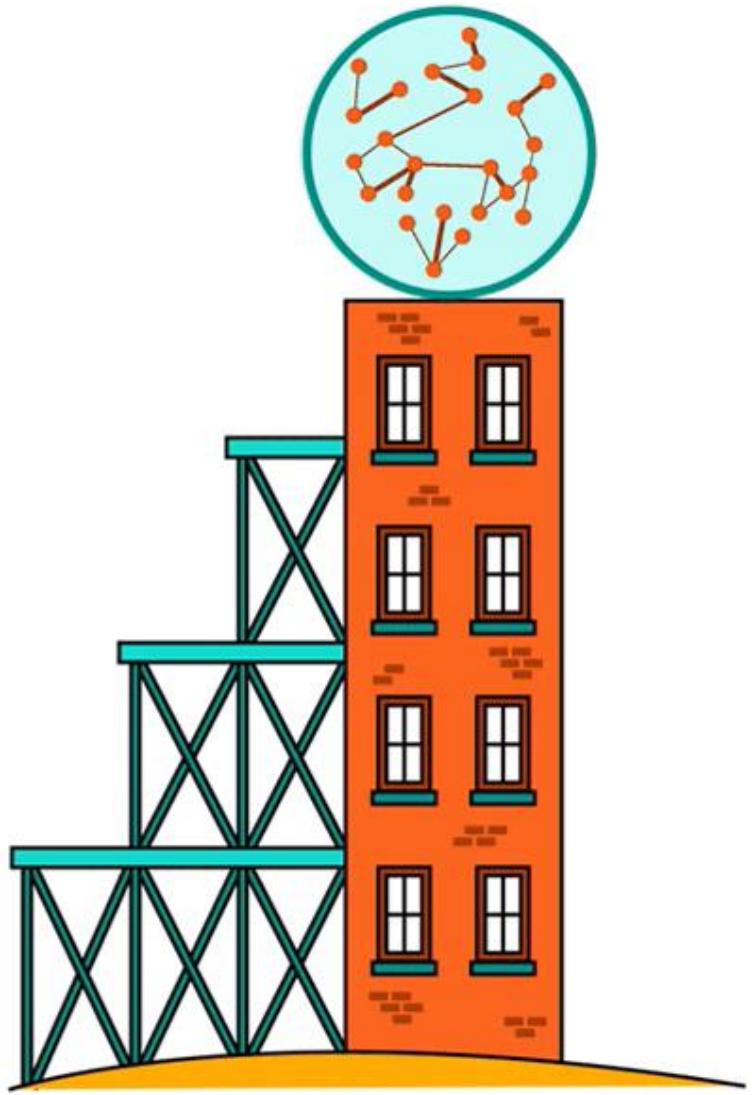



Long-term
Memory
Working
Memory

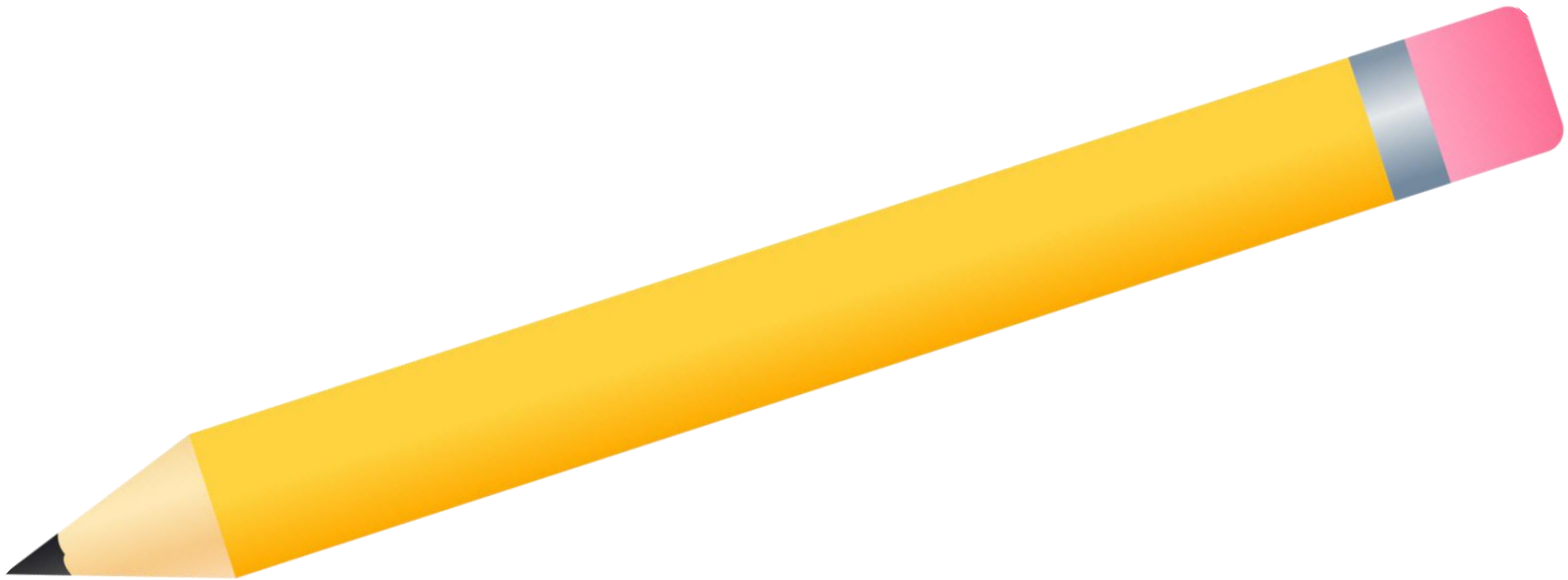

Long-term
Memory
Working
Memory








Mirroring and Motivation
Go



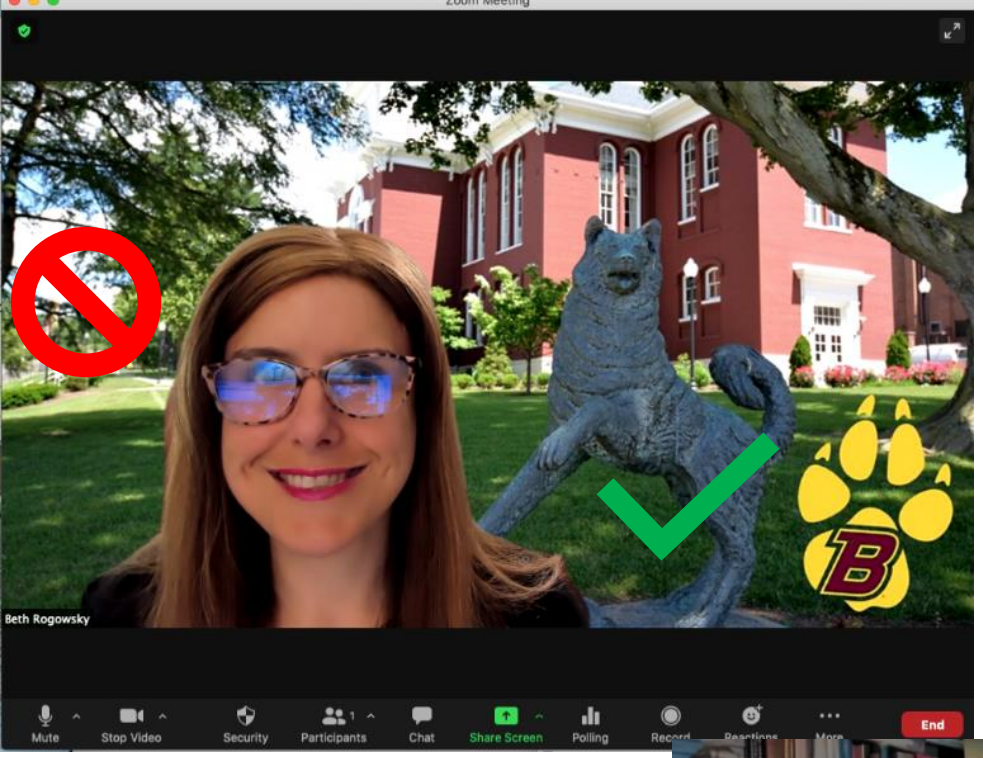
Student

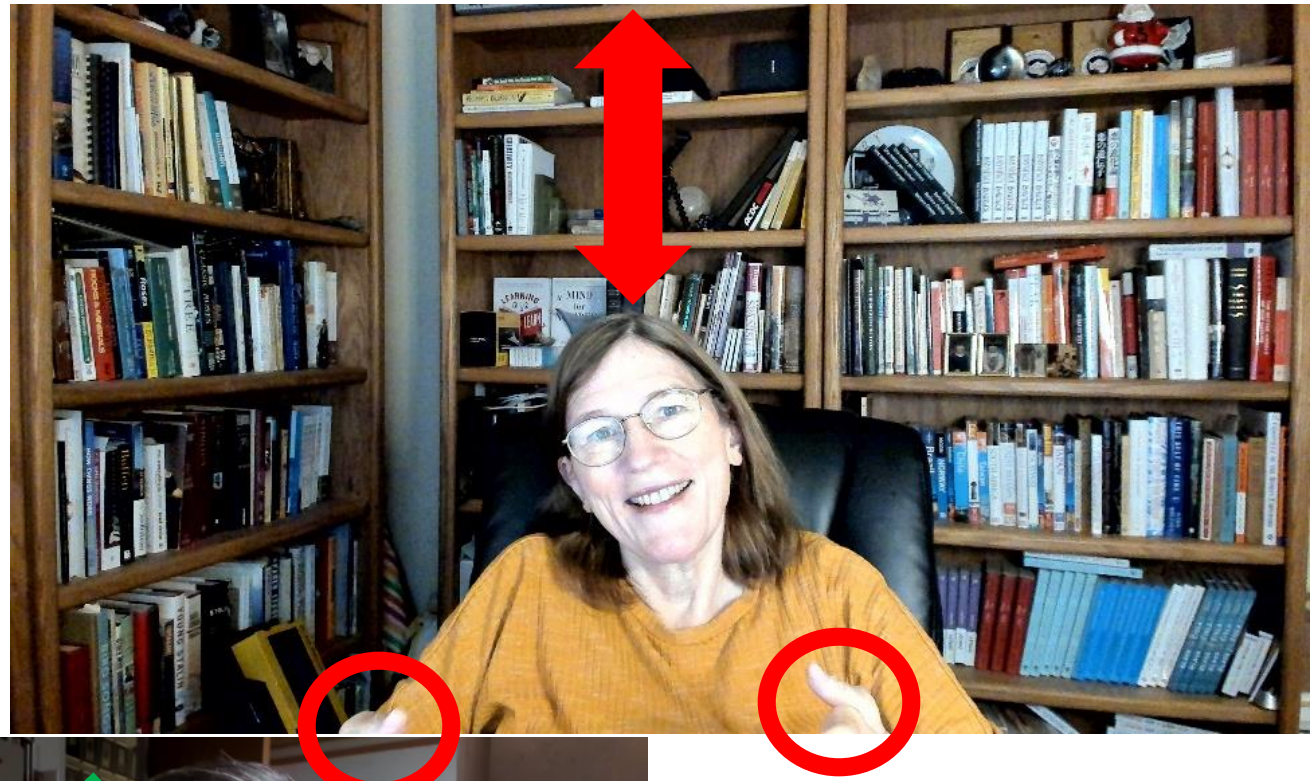
Teacher

Guy Fieri

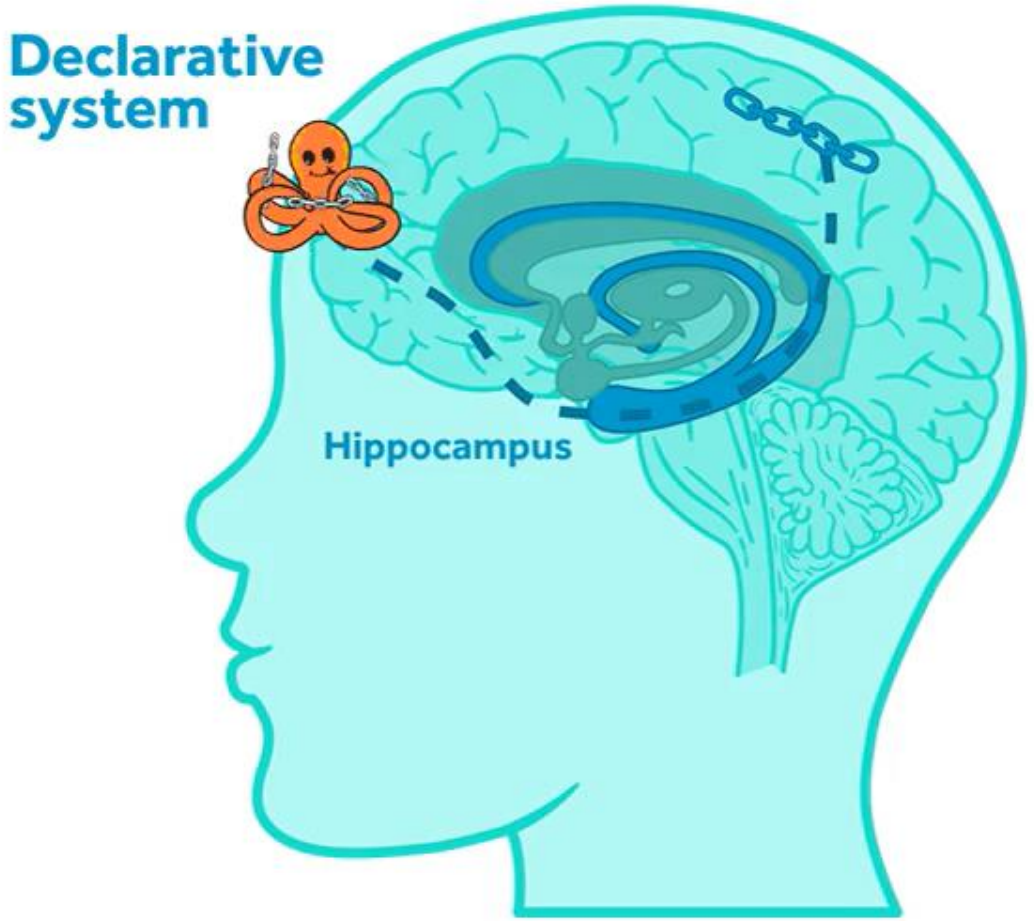
Camera subtracts 10 charisma points

Remember the "Familiarity Principle"


Beth Rogowsky
Mute
Stop Video
Security
Participants
Chat
Share Screen
Polling
Record
End



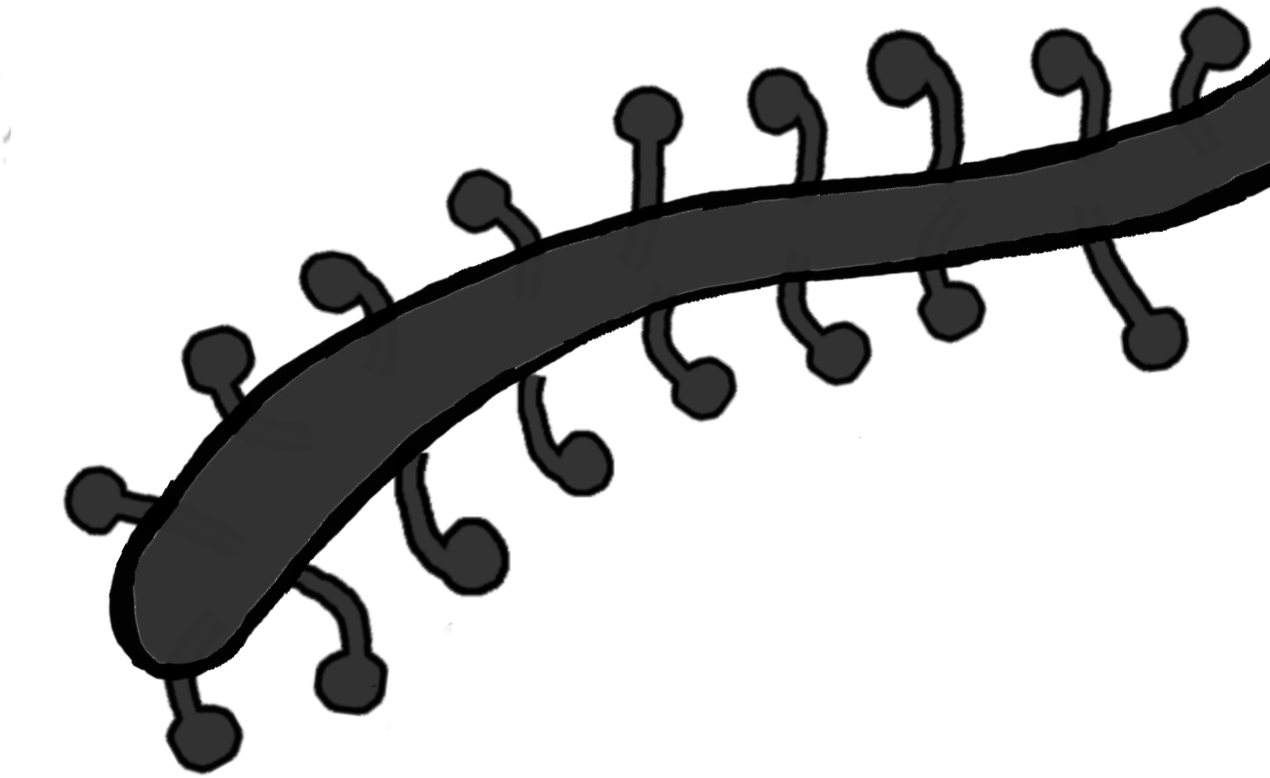
I can tell you this…but



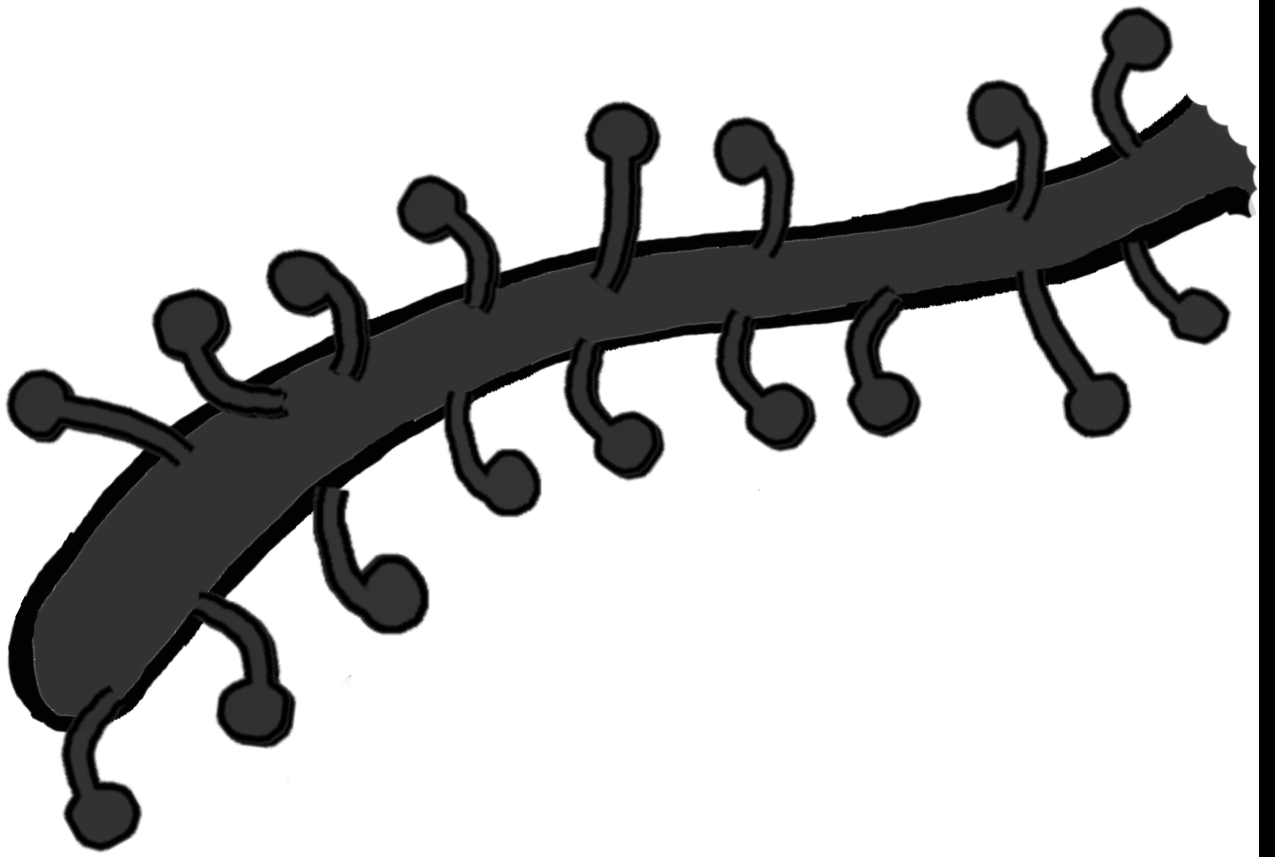
Differing bath of neurochemicals

Fast learner—doesn't forget

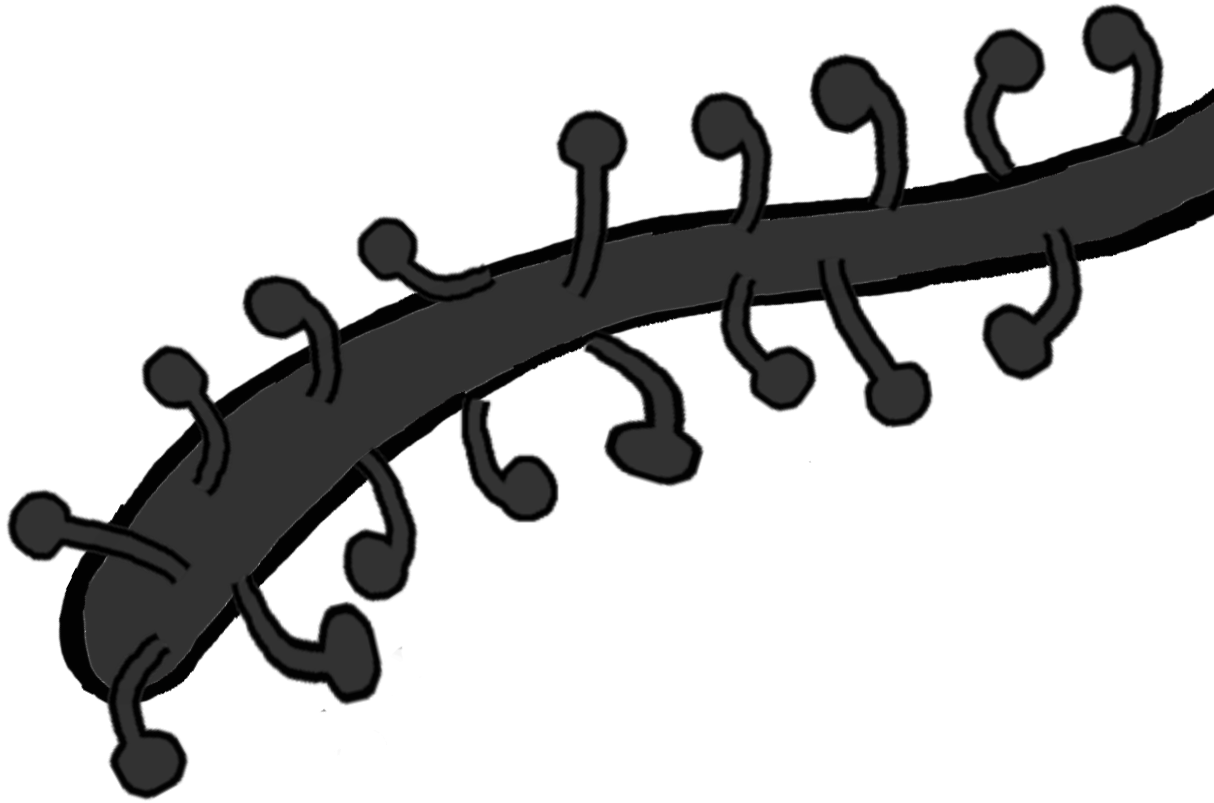
Slow Learner—forgets



Fast learner—doesn't forget



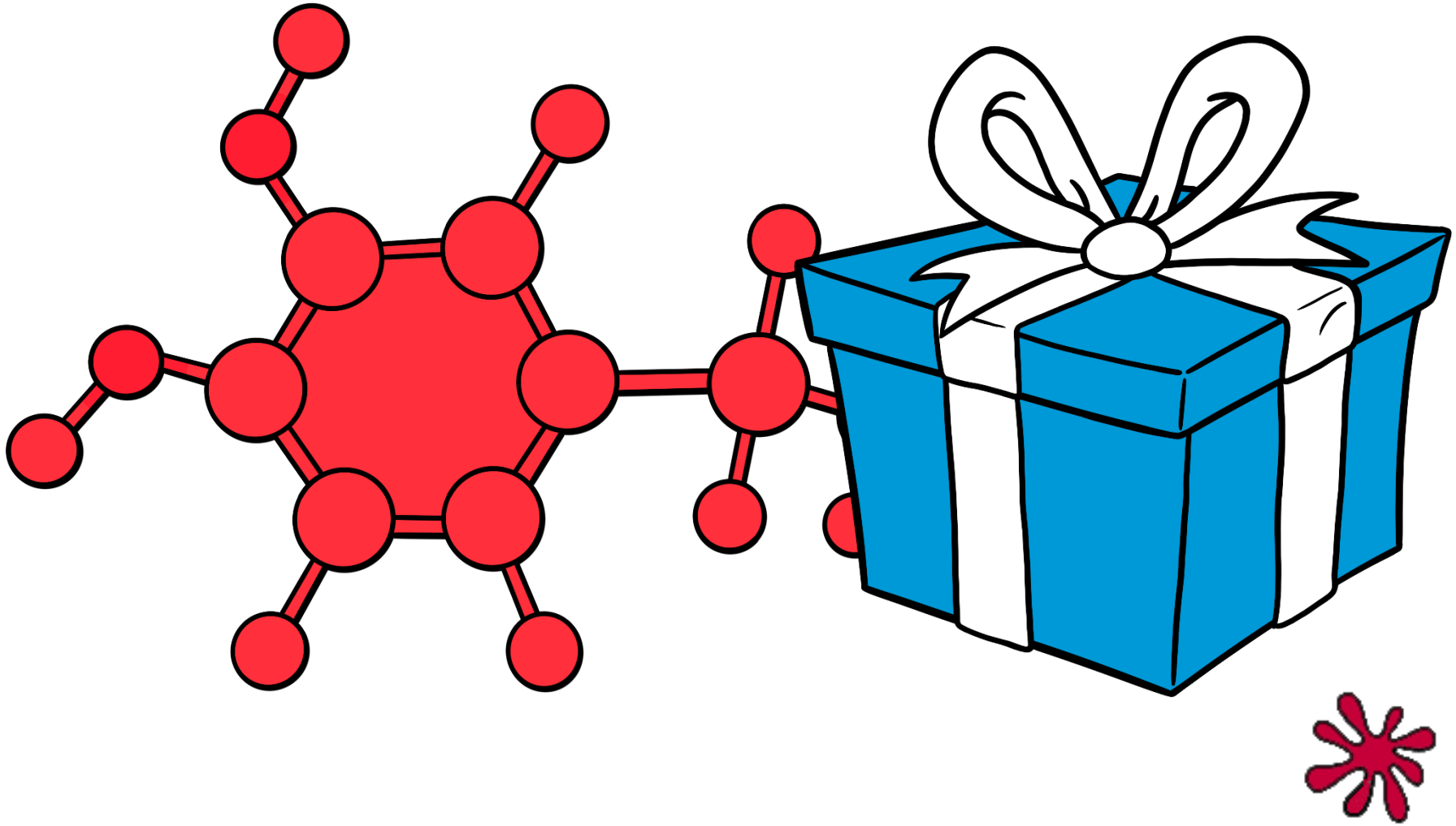
Slow Learner—forgets & relearns



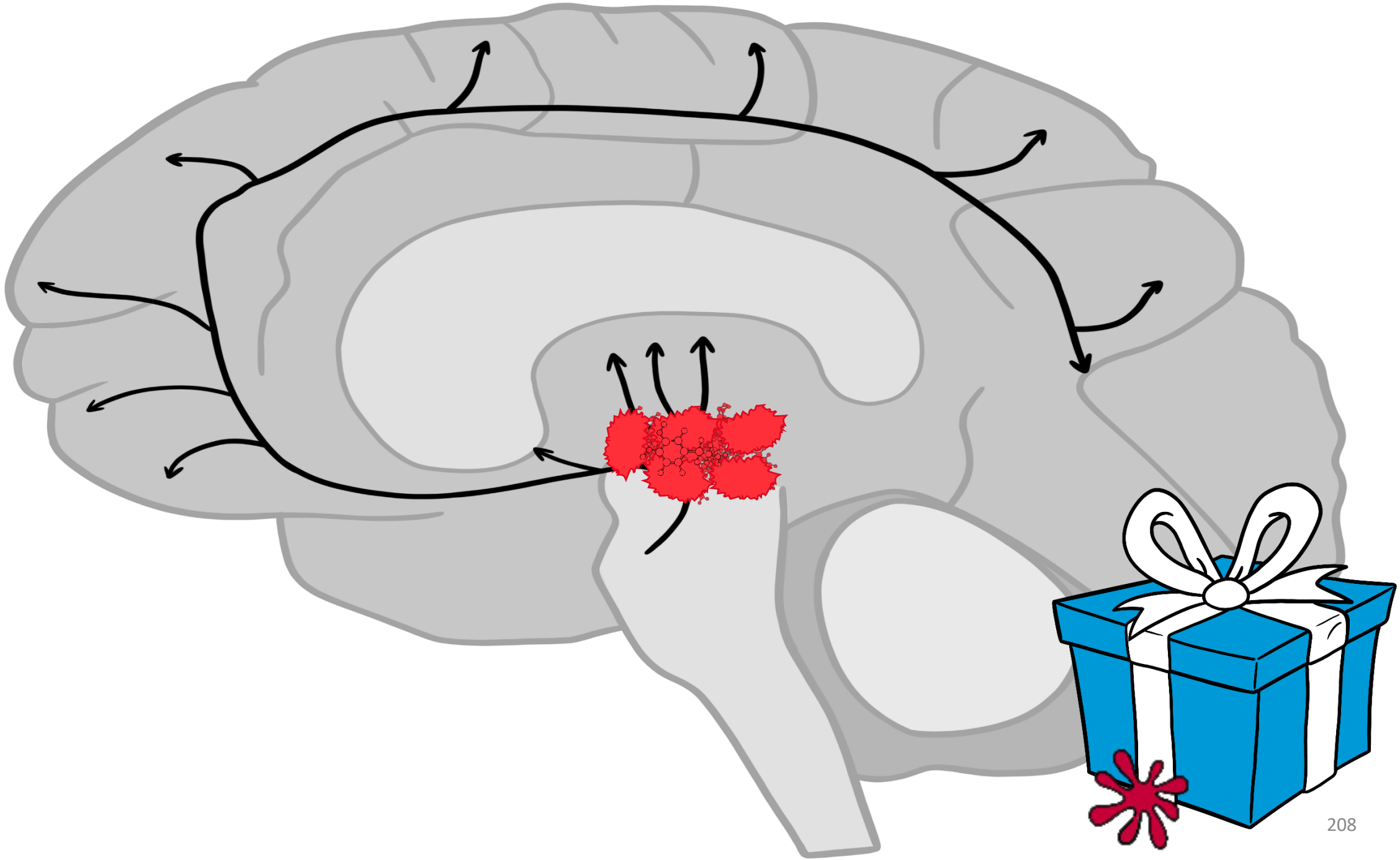
Race car learners

Hiker learners

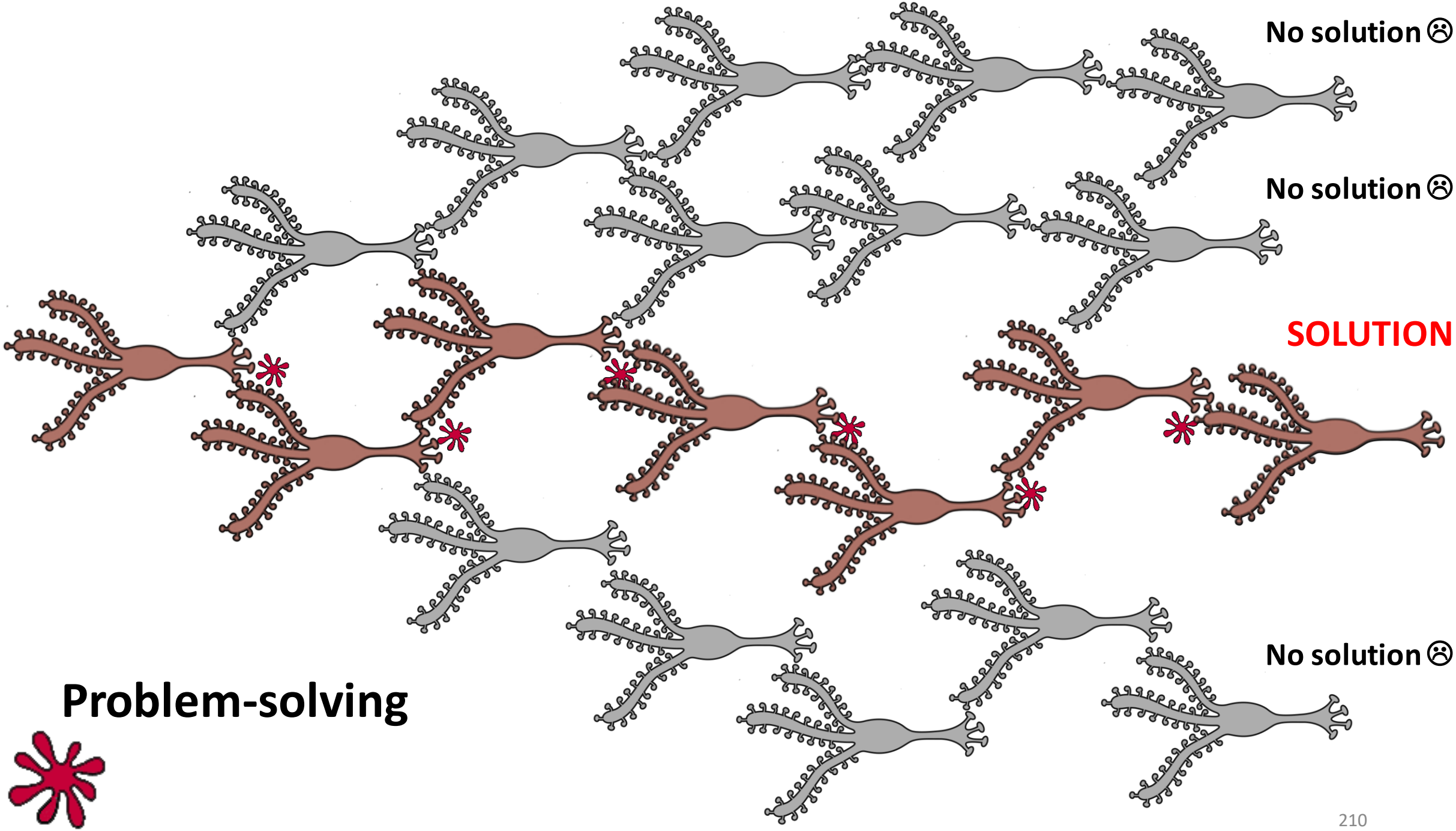
The value of good hooks



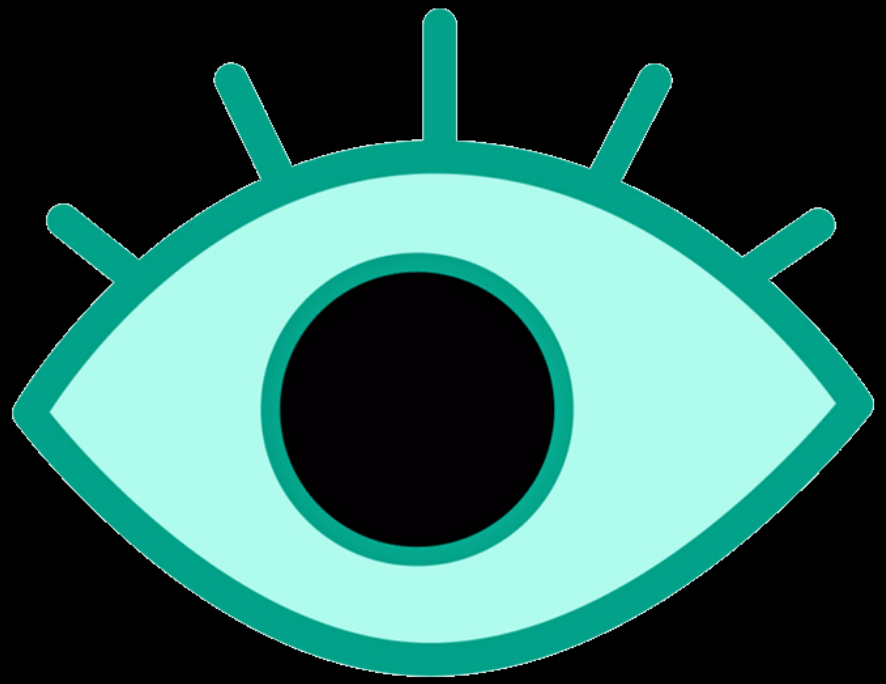
Dopamine—the “feel good molecule”

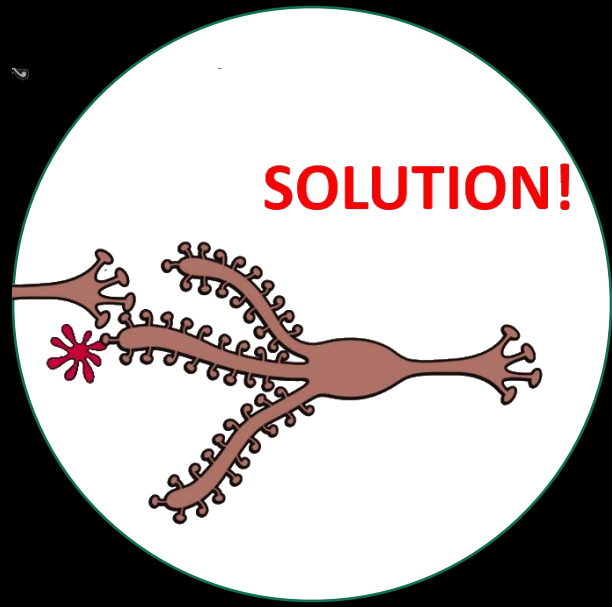


Mice with inactivated dopamine systems *can't learn anything new.*

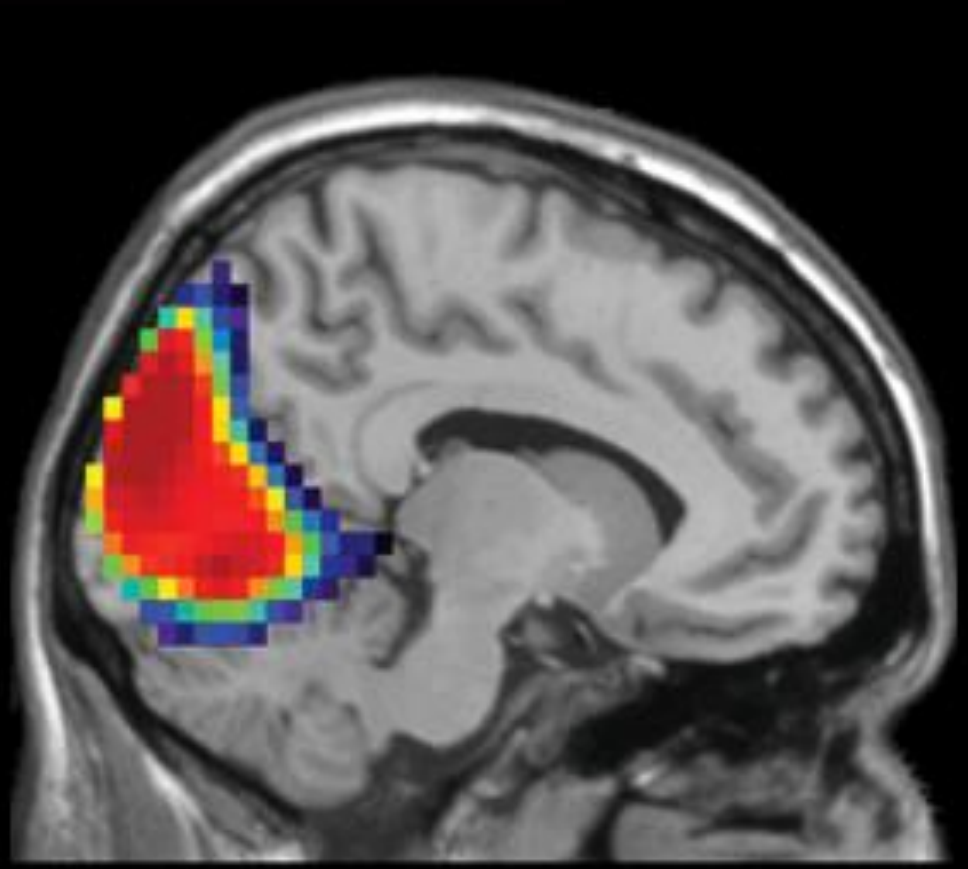

No solution ☹
No solution ☹
SOLUTION!
No solution ☹
Problem-solving

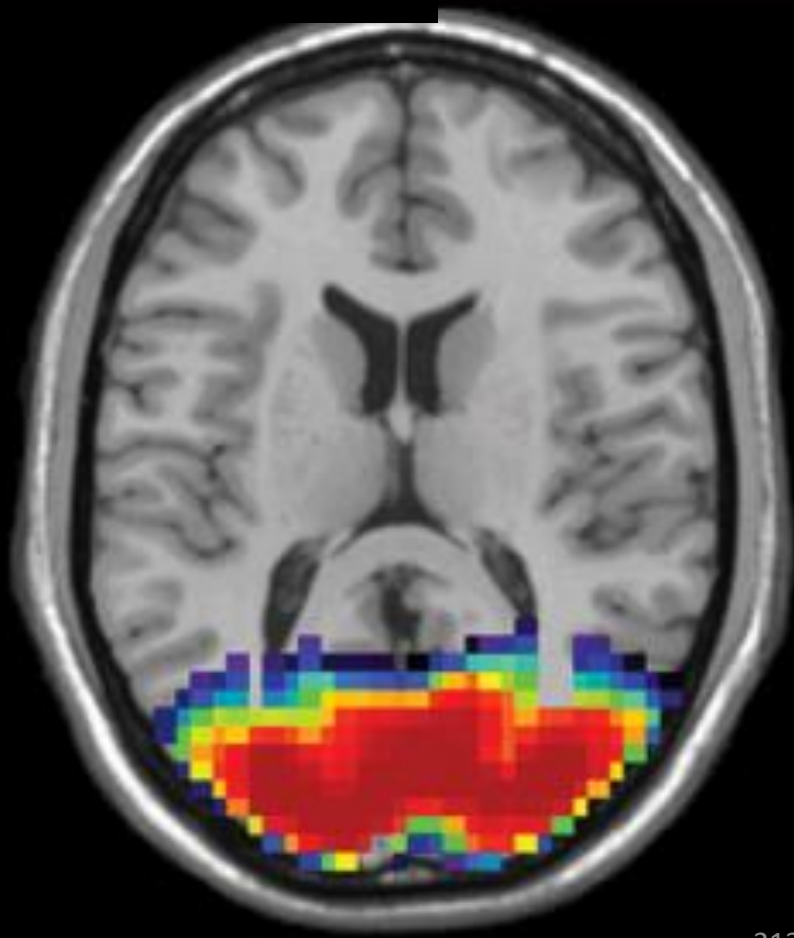
Hooks & curiosity suppress diffuse mode and enhance focus

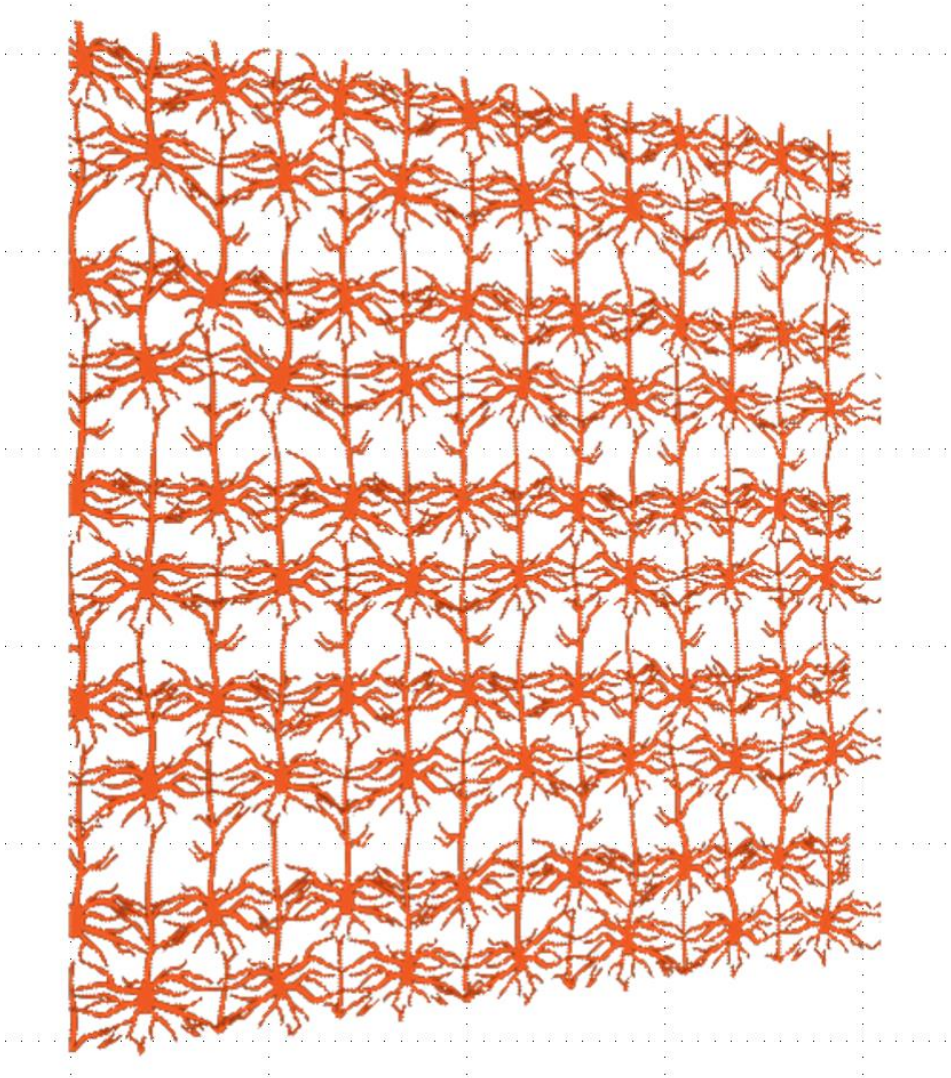


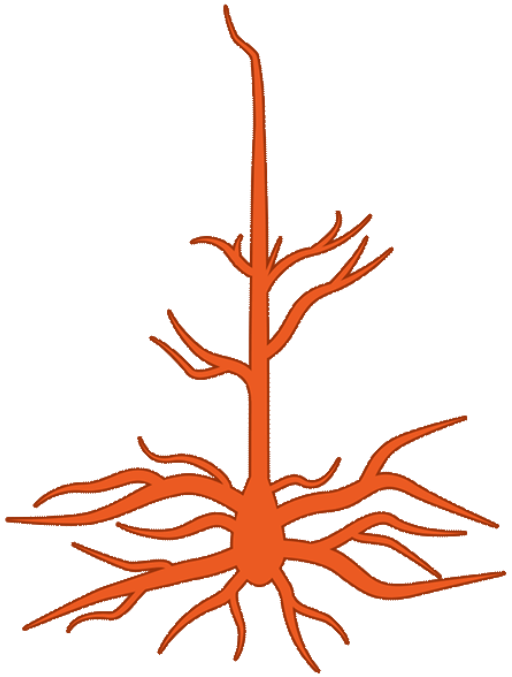


Good visuals are important!

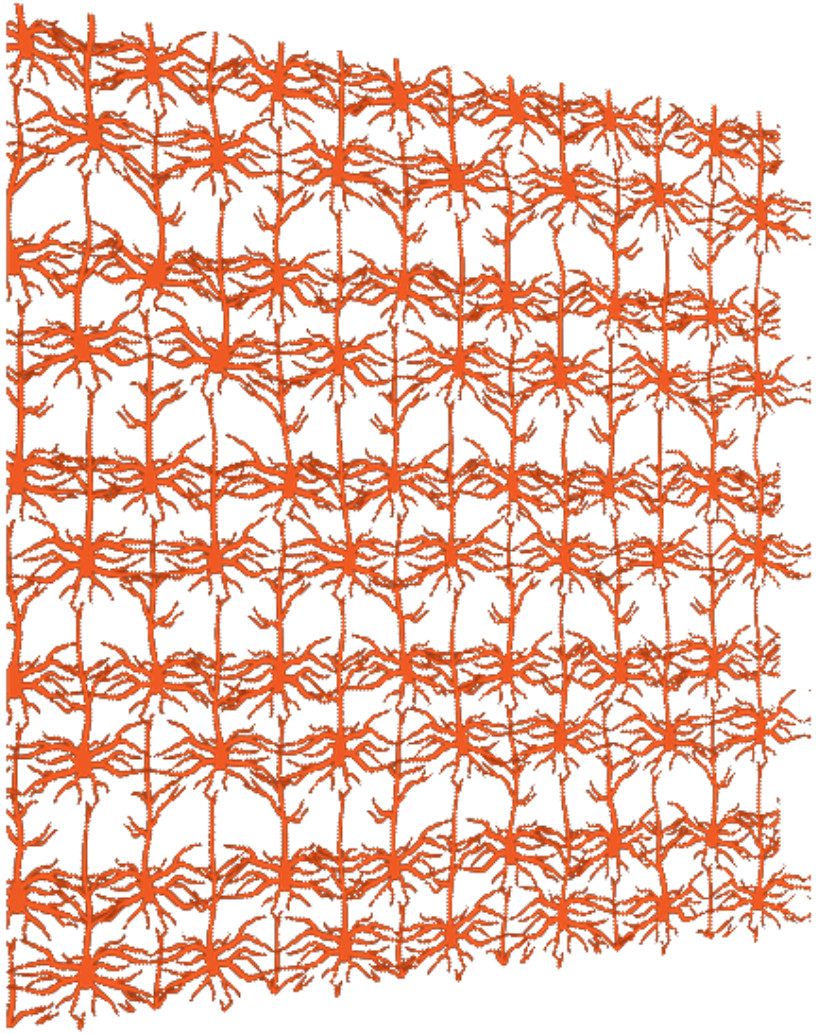




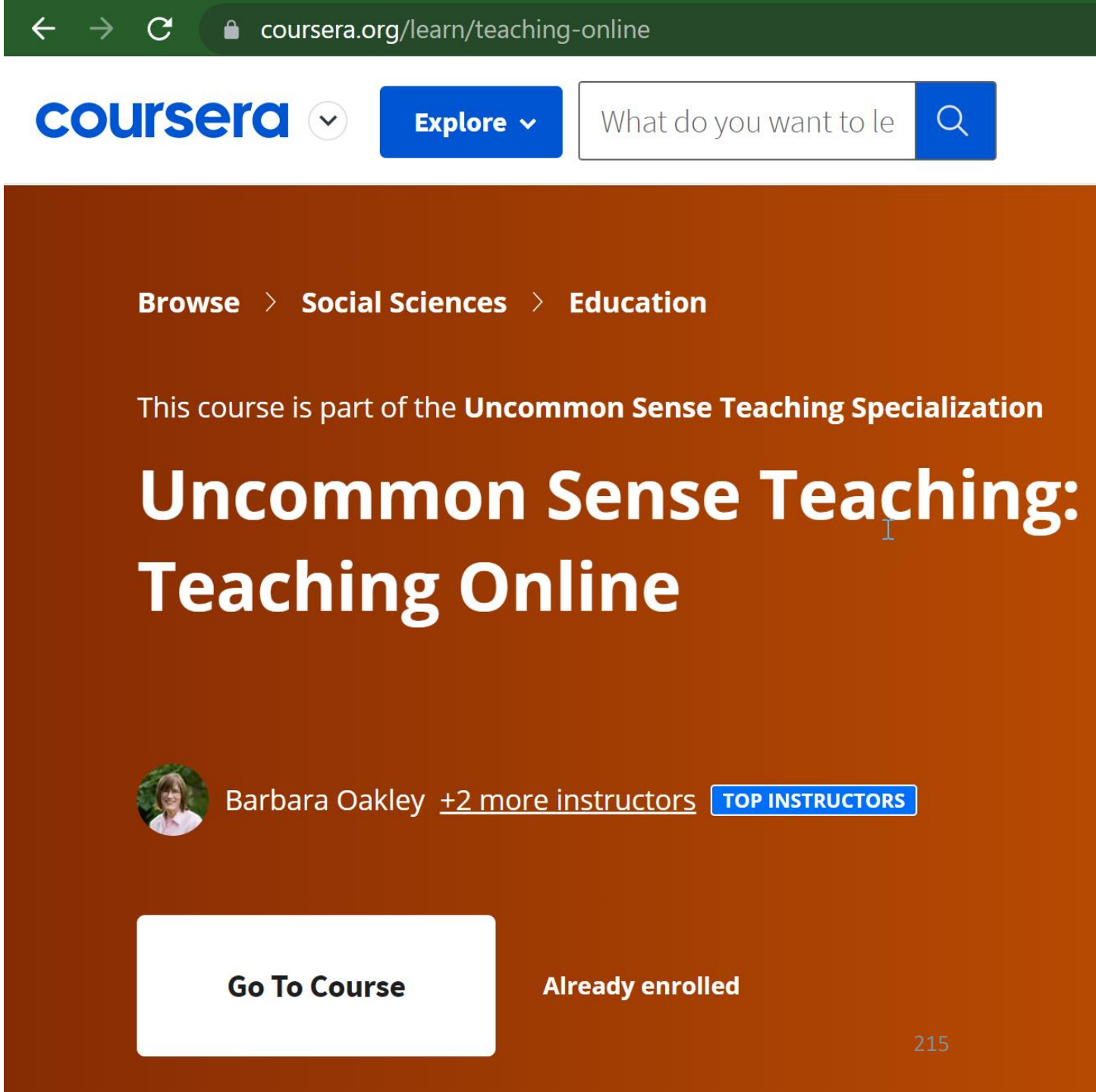




New learning boosts spirits



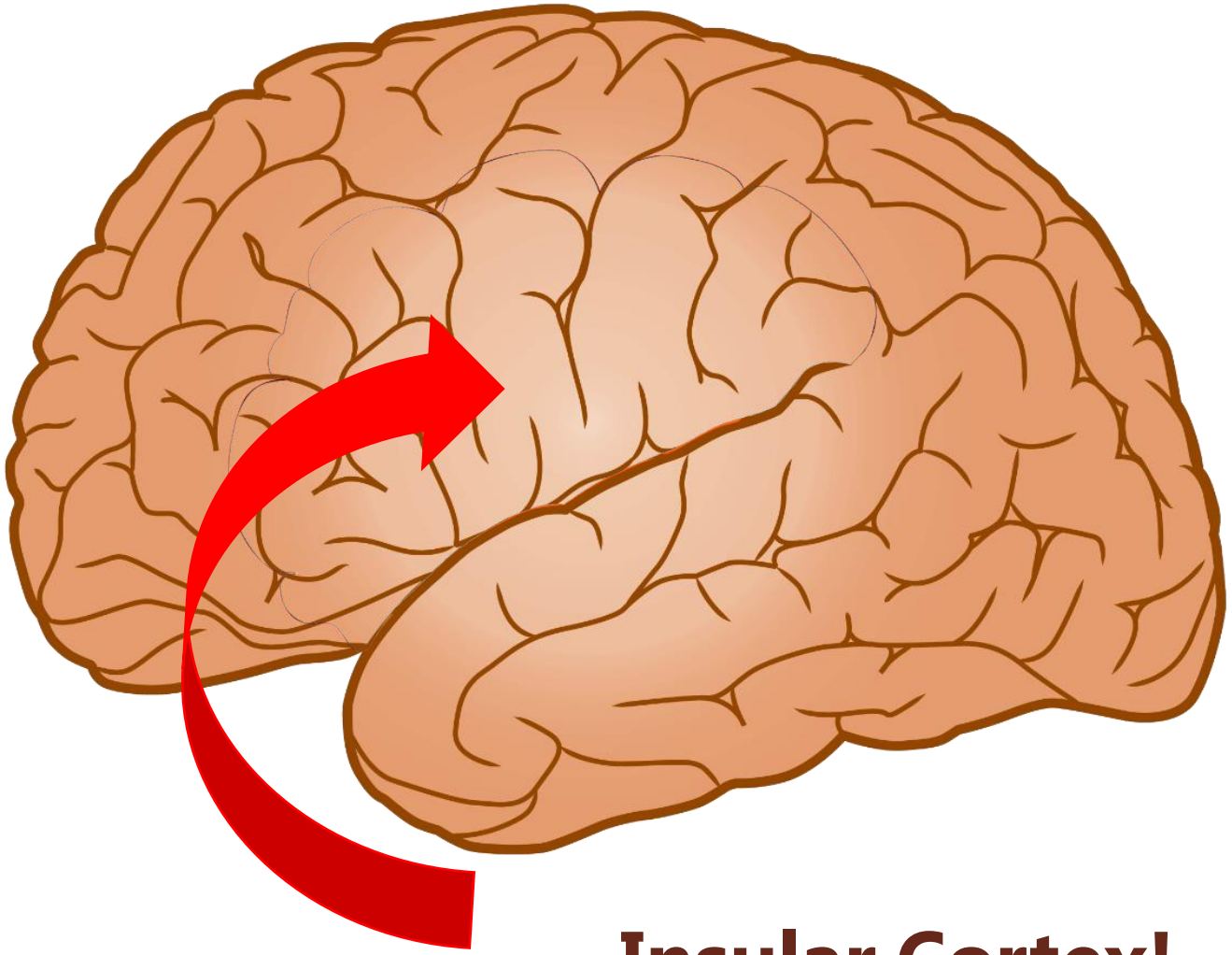
www.coursera.org/
learn/teaching-online



Santiago
Ramón y Cajal

Procrastination

Procrastination



Insular Cortex!

3

Feel happy (temporarily)

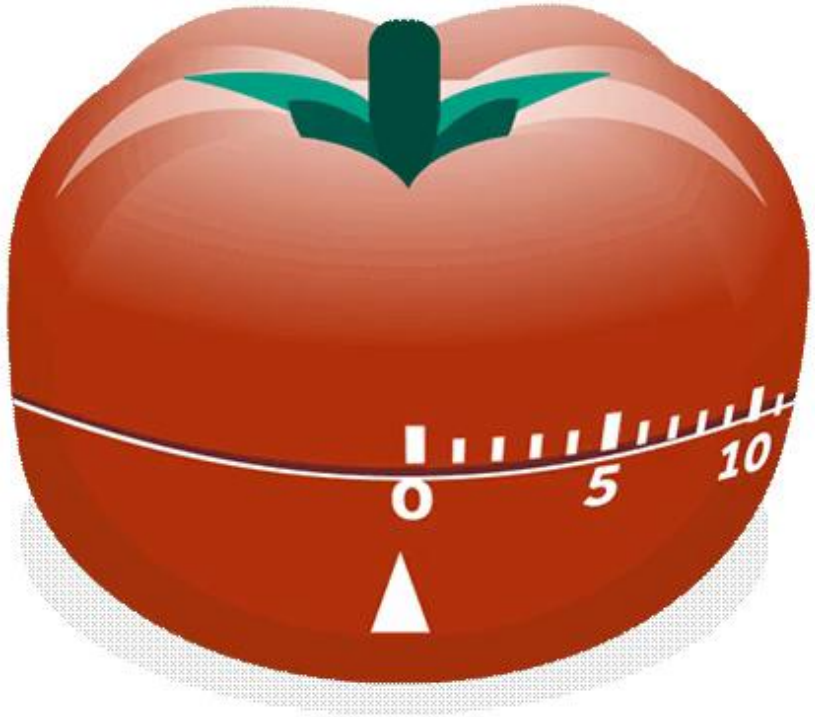
2

Turn your attention to something more pleasant

Zombie Tube

1

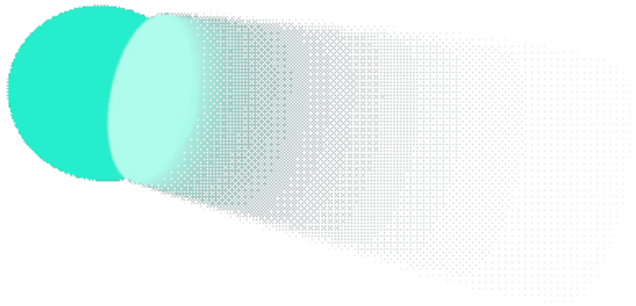
Unhappy feeling

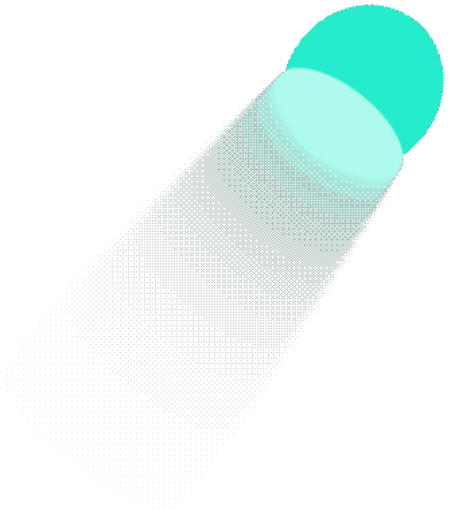


- **Turn off all distractions**
- **Set timer for 25 minutes**
- **Focus**
- ***Reward!***

Pomodoro Technique

Multi-tasking





Dual tasking

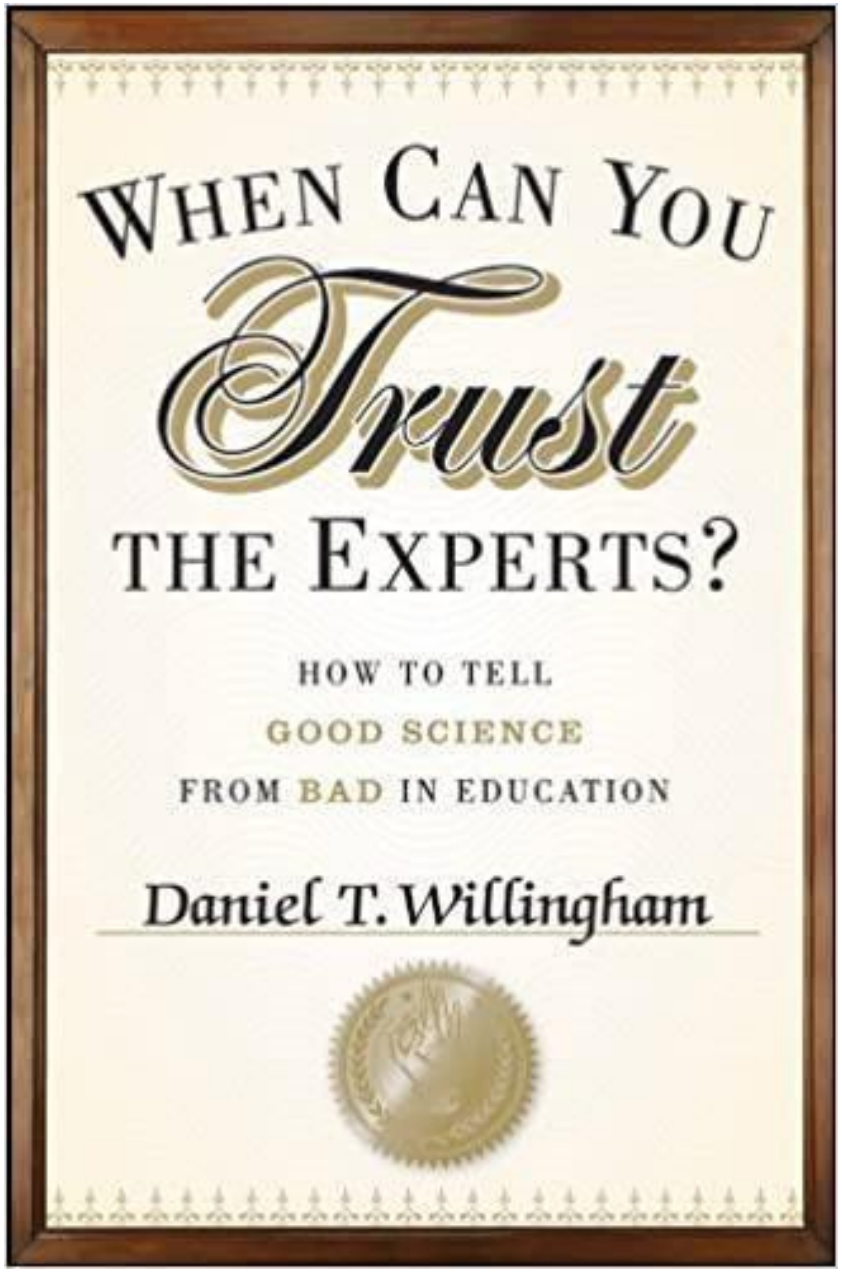
Task switching

Loss of efficiency

Never multi-task?

Creativity arises from multi-tasking

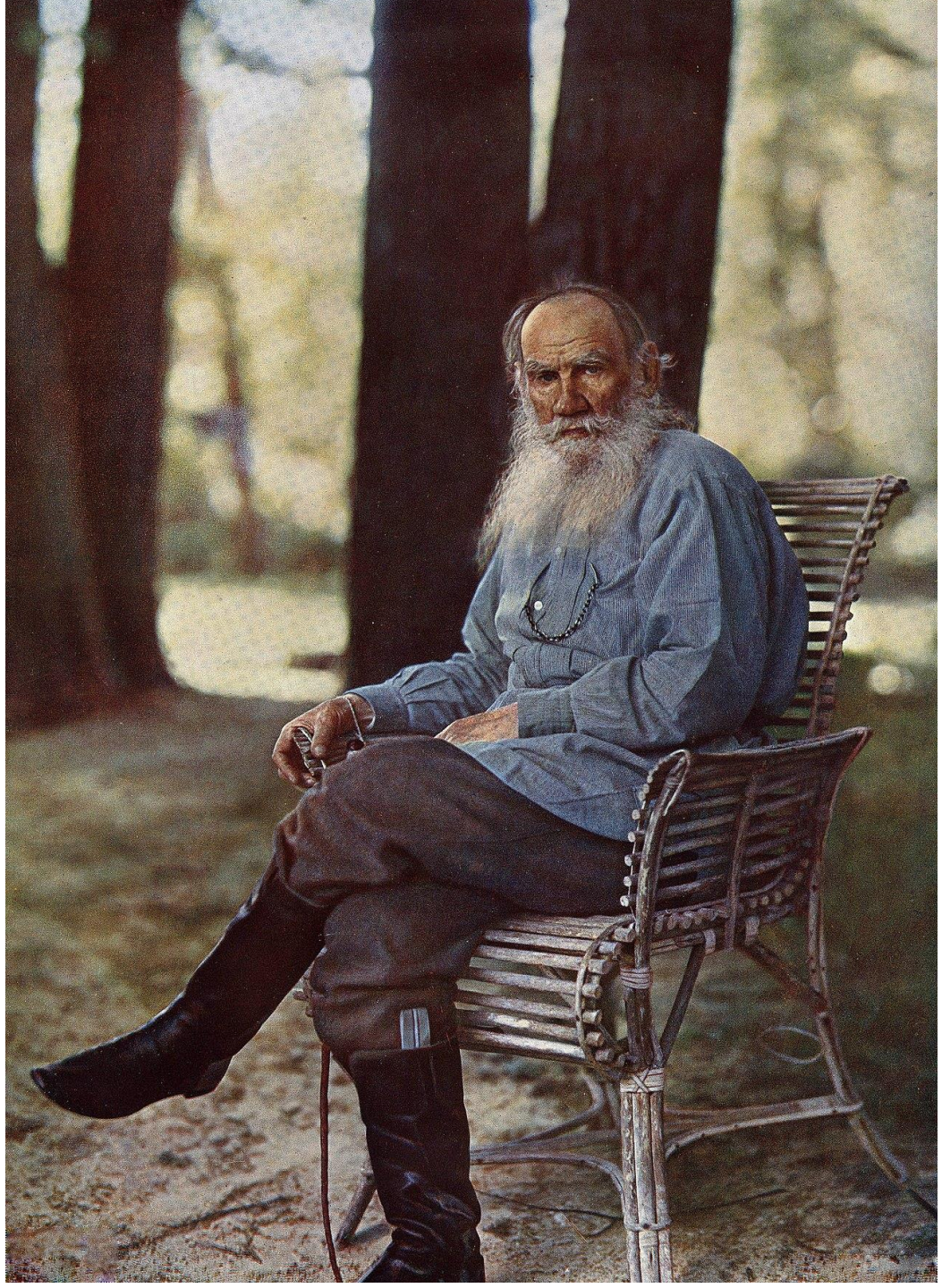
- **Kapadia, Chaitali and Shimul Melwani**. "More tasks, more ideas: The positive spillover effects of multitasking on subsequent creativity." *Journal of Applied Psychology*, (2020): Advance publication online.
- **Lu, Jackson G., et al.** ""Switching On" creativity: Task switching can increase creativity by reducing cognitive fixation." *Organizational Behavior and Human Decision Processes* 139, (2017): 63-75.



Educators fall into two groups:

Understand the world through:

- **Reason**
- **Experience**



Leo Tolstoy

"…the simplest thing cannot be made clear to the most intelligent man if he is firmly persuaded that he knows already, without a shadow of doubt, what is laid before him."

Biases

Confirmation bias:

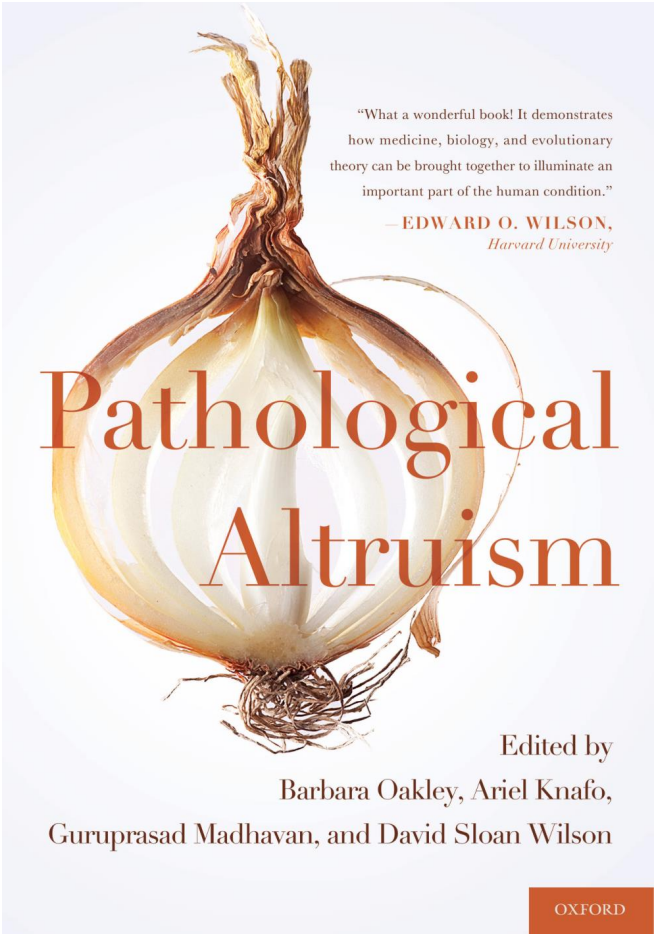
- Raymond S. Nickerson, "Confirmation bias: A uiquitous phenomenon in many guises," *Review of General Psychology* 2 (1998): 175–220.

Desirability bias:

- Ben M. Tappin, Leslie van der Leer, and Ryan T. McKay, "The heart trumps the head: Desirability bias in political belief revision," *Journal of Experimental Psychology: General* 146 (2017): 1143–49.
- Ziva Kunda, "The case for motivated reasoning," *Psychological Bulletin* 108 (1990): 480–98.

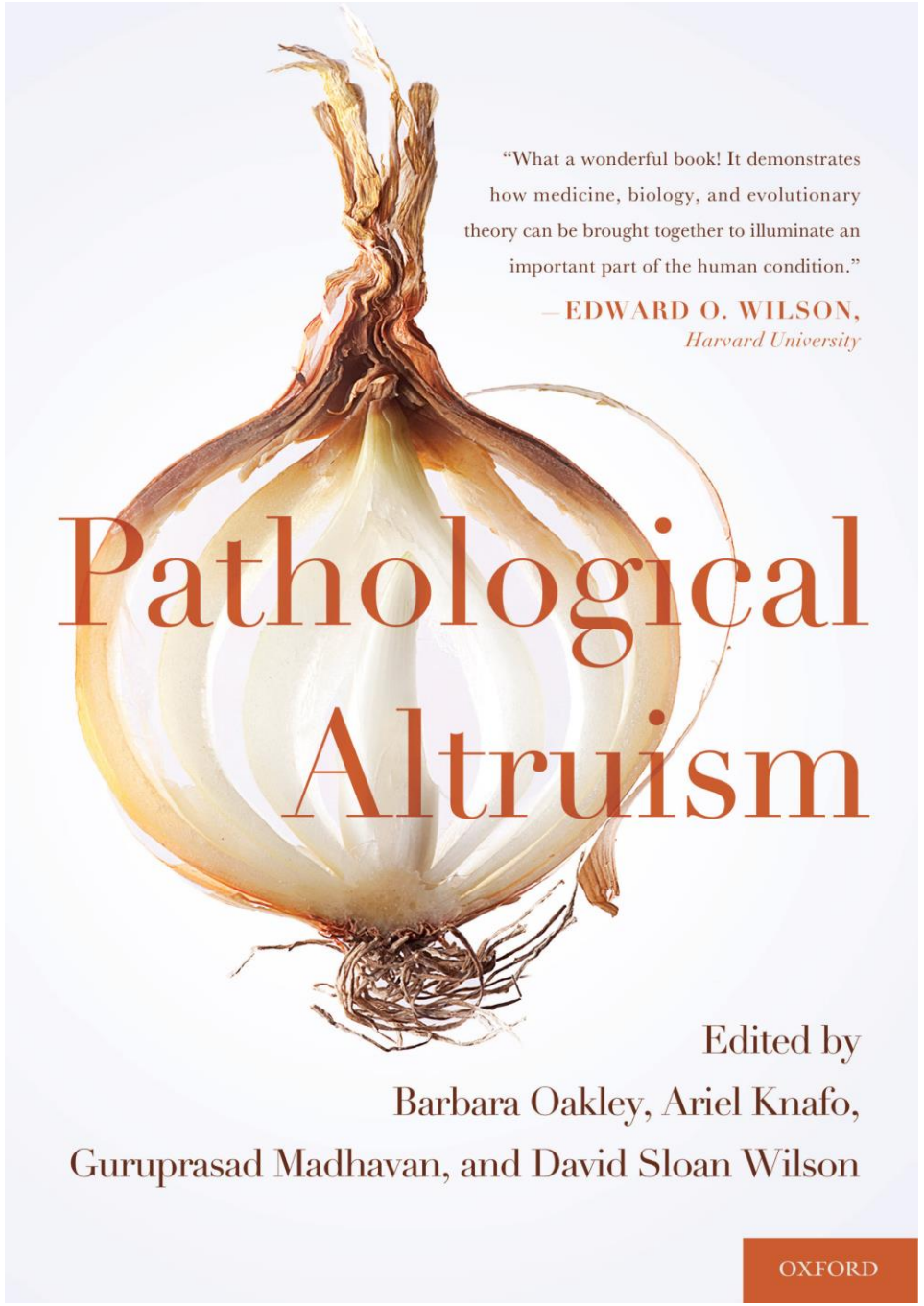
Altruism bias:

- Oakley, BA. "Concepts and implications of altruism bias and pathological altruism." *Proceedings of the National Academy of Sciences* 110, Supplement 2 (2013): 10408-10415.



"I'm not biased" bias:

- Emily Pronin, Daniel Y. Lin, and Lee Ross, "The bias blind spot: Perceptions of bias in self versus others," *Personality and Social Psychology Bulletin* 28 (2002): 369–81.
- West, RF, et al. "Cognitive Sophistication Does Not Attenuate the Bias Blind Spot," *Journal of Personality and Social Psychology* 103 (2012): 506–19.



Train people to target the easy and obvious "right" thing, and then it's hard for highly intelligent people to change, because of inflexibility.

Joan McCord

(1930 – 2004)

- American Professor of Criminology at Temple University
- First female president of the American Society of Criminology
- Longitudinal studies: Cambridge Somerville Youth Study

"A Thirty-Year Follow-up of Treatment Effects," Joan McCord, *American Psychologist*, 1978

- Counseling
- Tutoring
- Medical care
- Psychiatric care
- Summer programs

- More likely to commit a crime
- More alcoholism
- More serious mental illness
- More symptoms of stress
- More stress-related disease
- Died younger
- Occupations with lower prestige
- Less likely to find their work satisfying

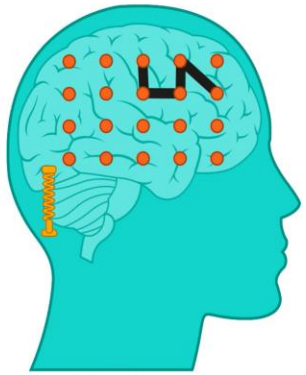
2/3^{rds} thought the program improved their lives

Agenda

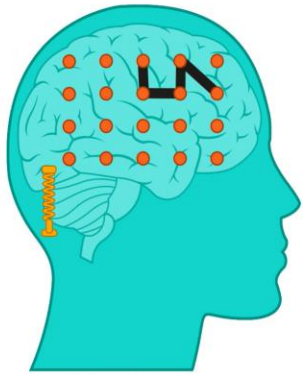
- Introduction
- Direct instruction
- Learning means linking neurons
- Metaphors in learning
- Retrieval practice and spaced repetition
- Focused and diffuse modes of thinking
- Working memory, long-term memory, and illusions of competence in learning
- Mental models and schemas (memory frameworks)
- Identity schemas and motivation
- Mental models contrasted with schemas and events
- Teaching & learning means getting in neural “synchrony”
- A deeper understanding of retrieval practice with regards learning math even at in-depth, post-doctoral levels, including the role of the hippocampus
- Consolidation
- Learning becomes easier as a schema expands
- Greater versus lesser capacity working memory in learning – scaffolding
- Declarative (hippocampal) versus procedural (basal ganglia) learning pathways and their relation to direct instruction
- Interleaving
- Neurodiversity
- Mirroring and motivation
- The value function
- Fast & slow learners
- Dopamine and the importance of "hooking" students
- The impact of teaching for society

There are differences between terms!

Focused mode



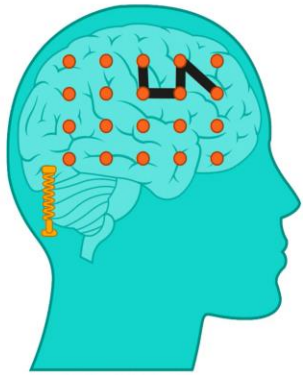
Focused mode



Diffuse mode

Hippocampal learning pathway (declarative)

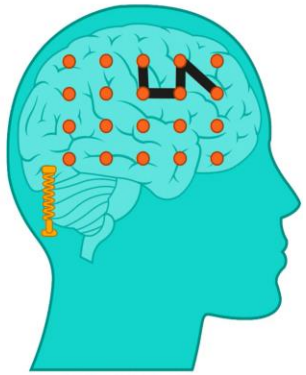
Focused mode



Diffuse mode

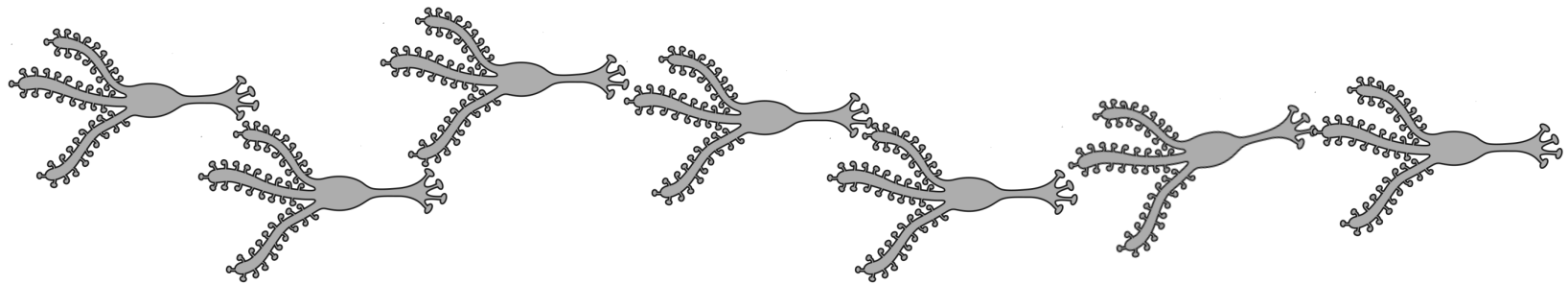
Hippocampal learning pathway (declarative)

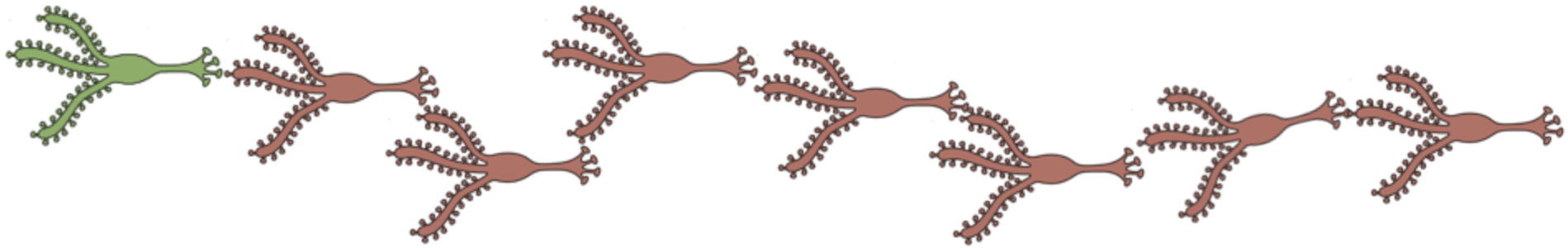
Focused mode

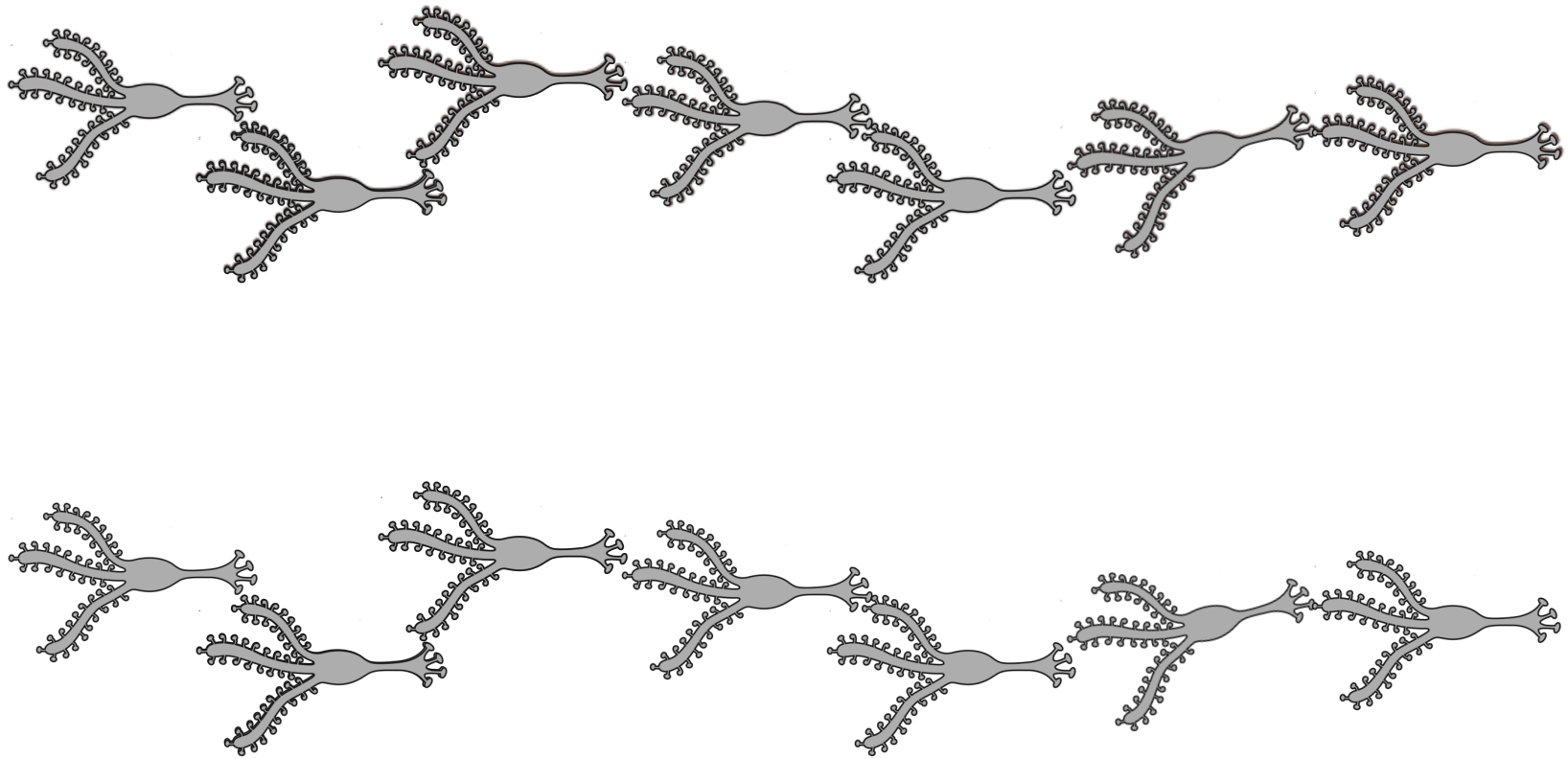


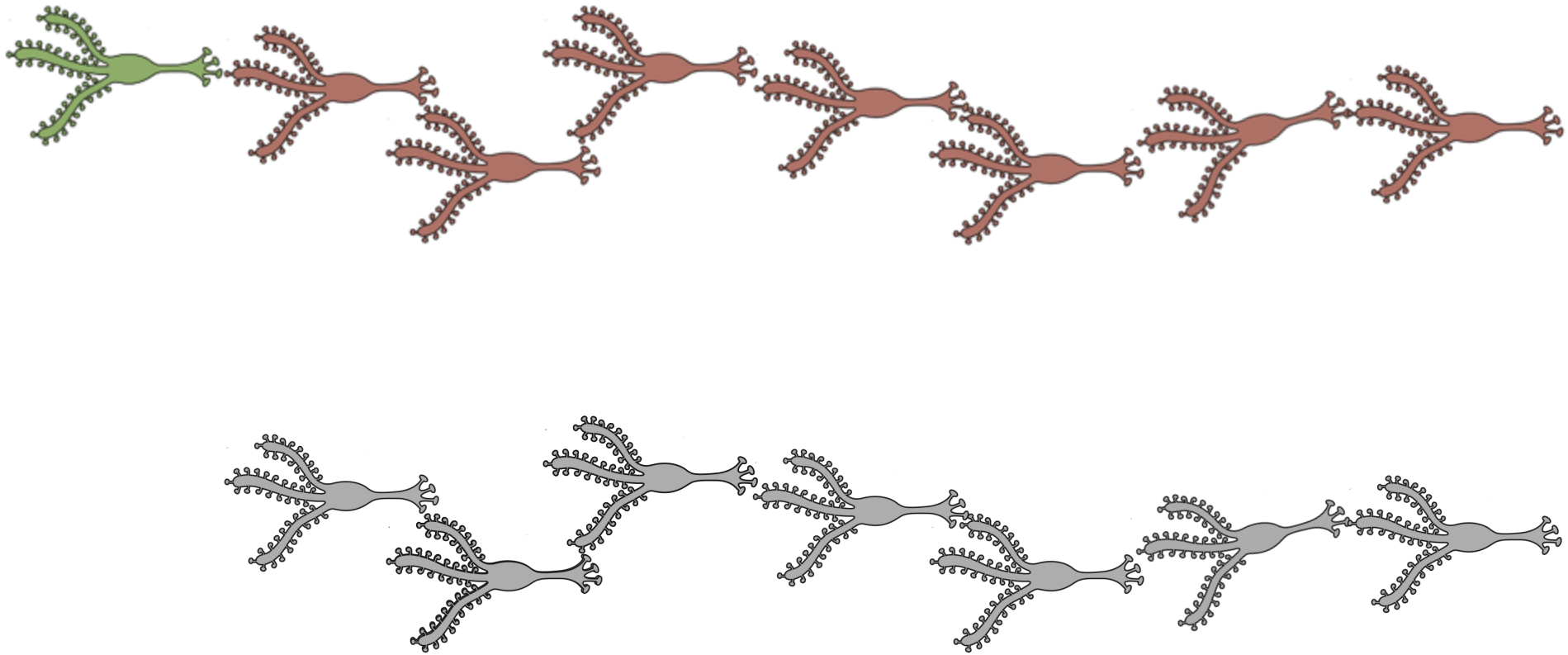
Diffuse mode

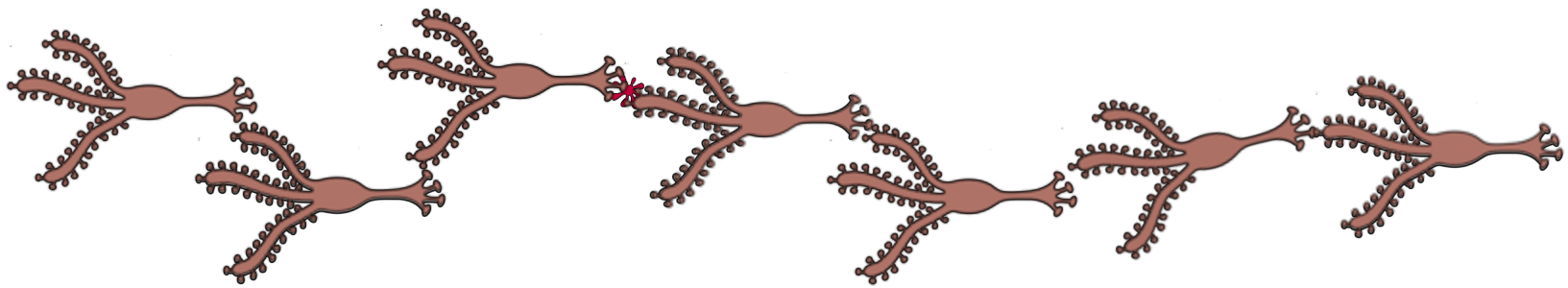
Basal ganglia learning pathway (procedural)

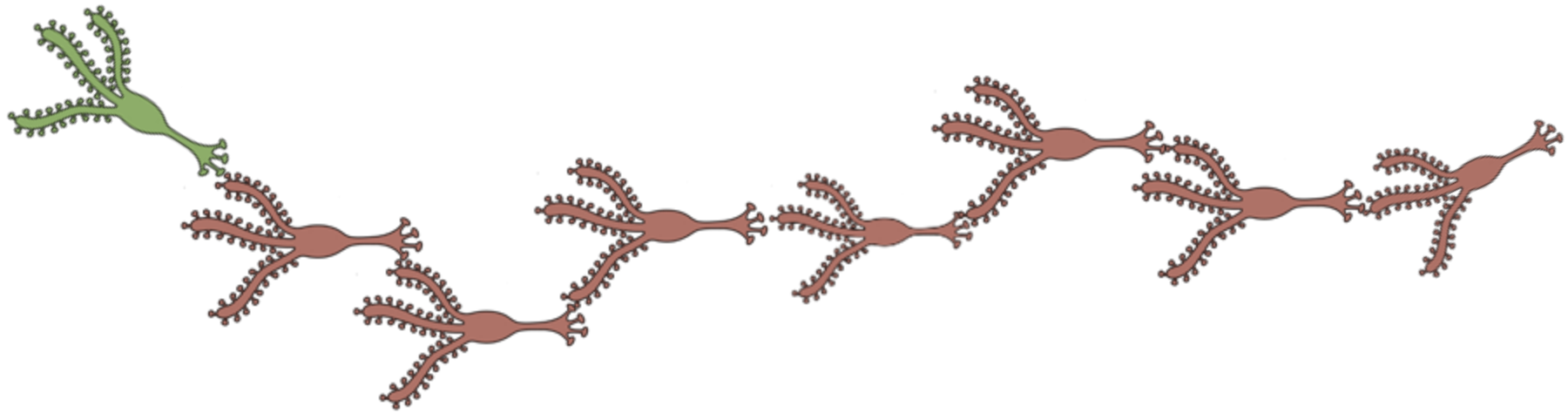




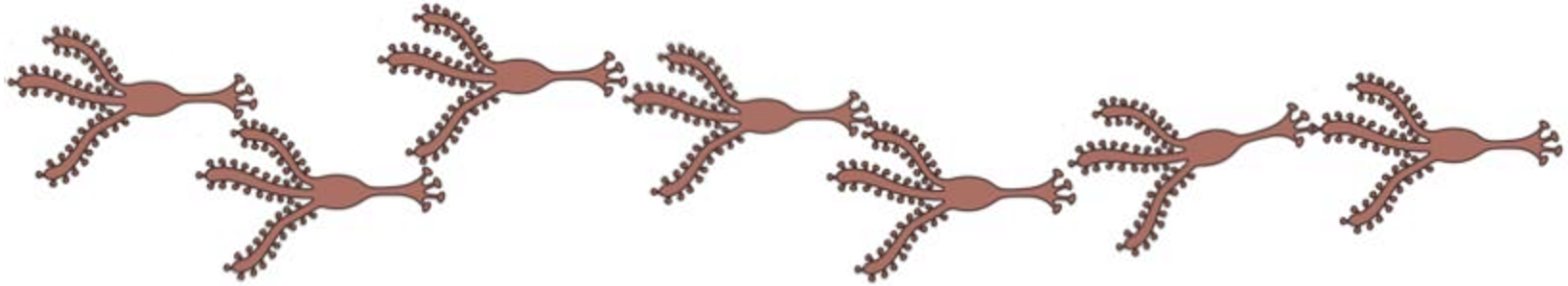








Why interleaving is important



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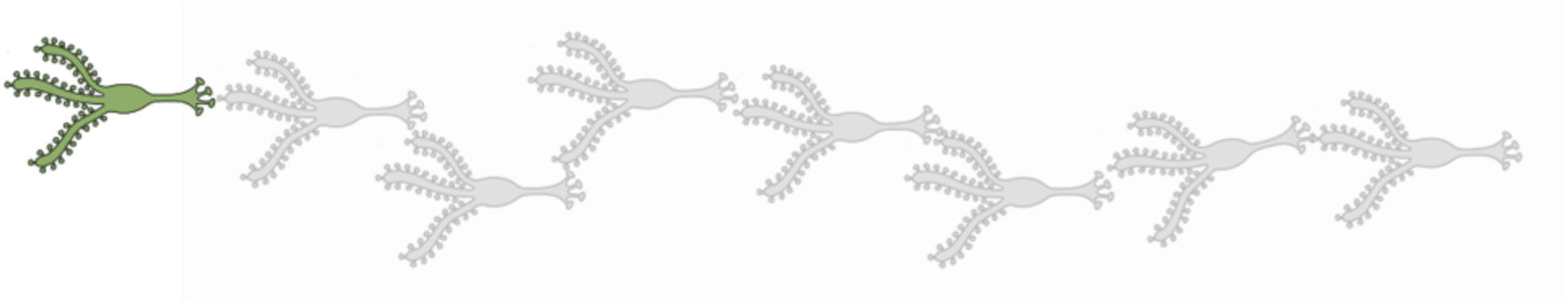
“hedgehog”

https://commons.wikimedia.org/wiki/File:Igel.JPG

“hedgehog”



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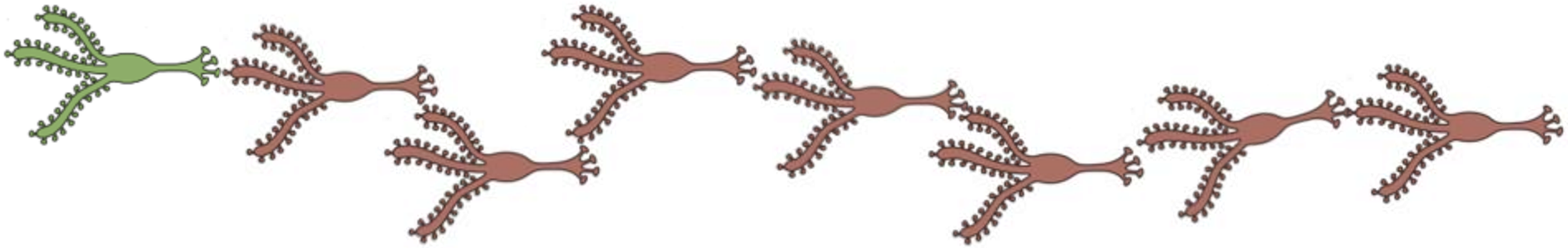

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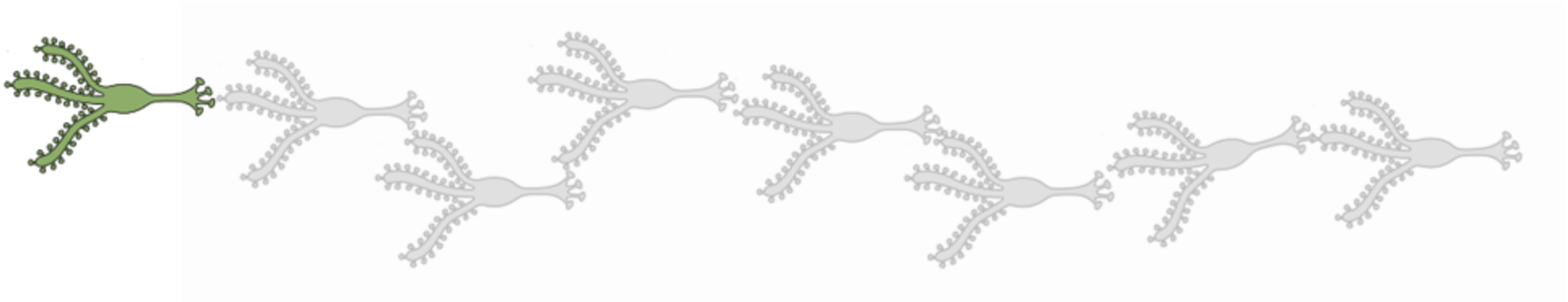

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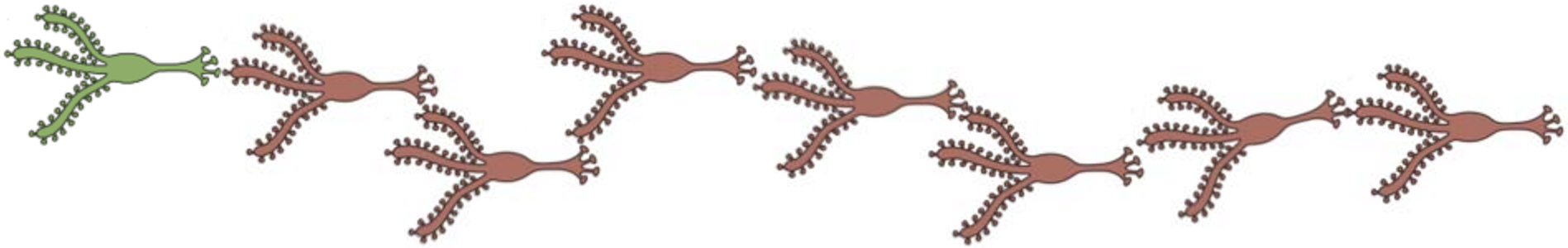

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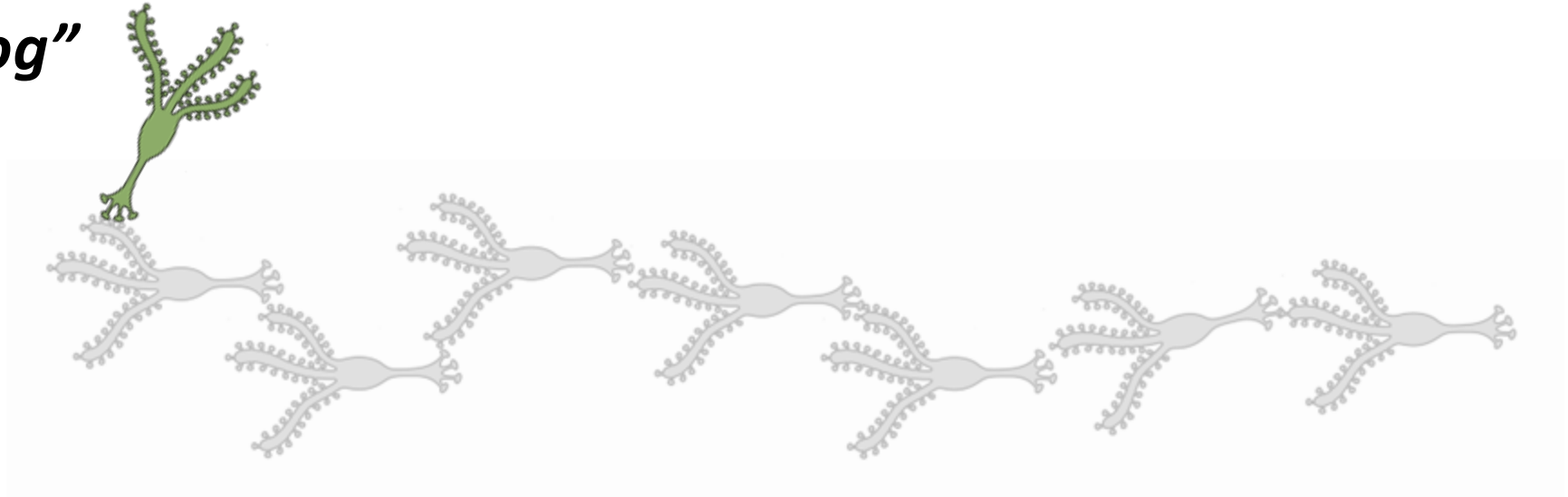

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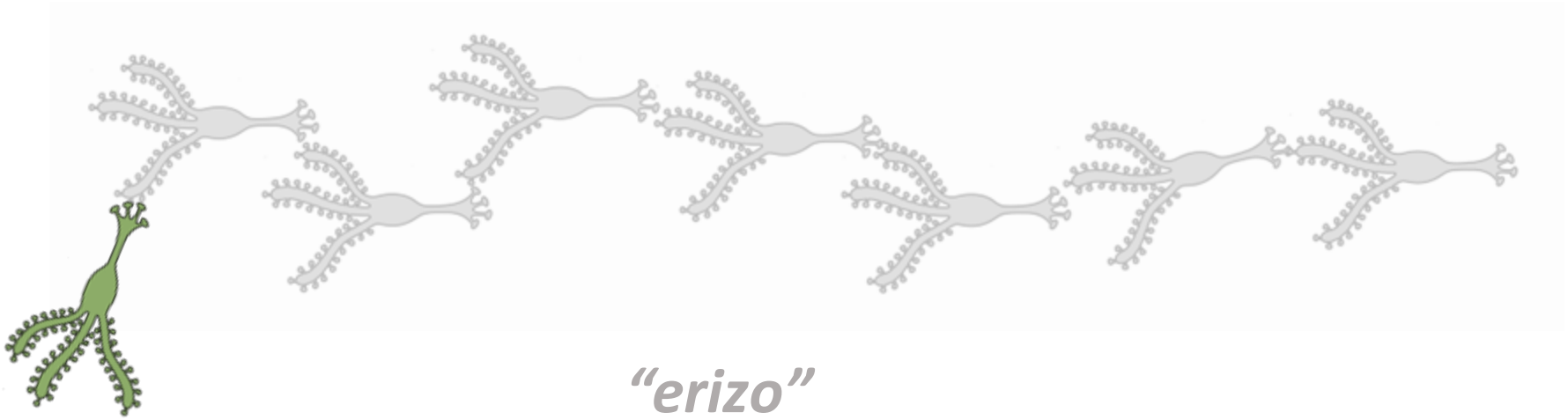

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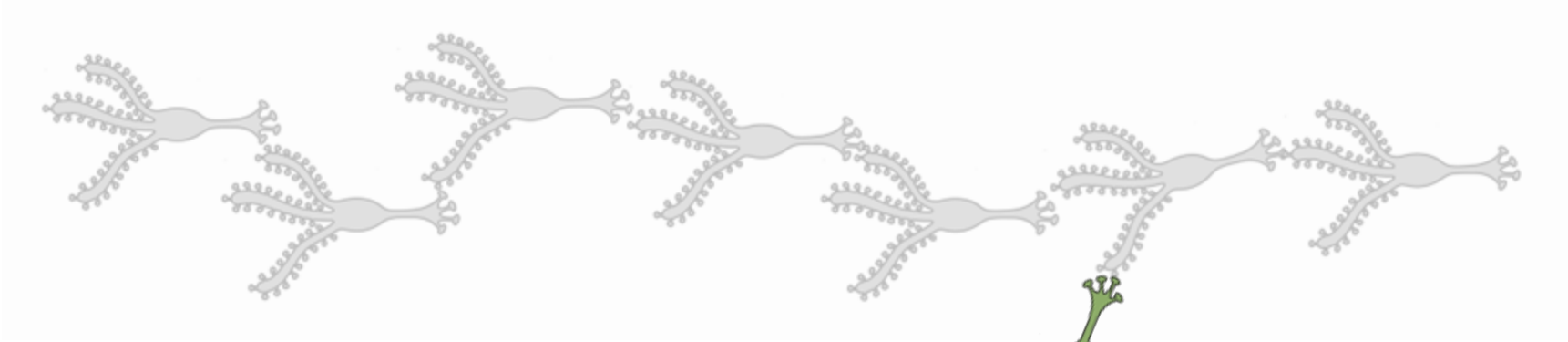

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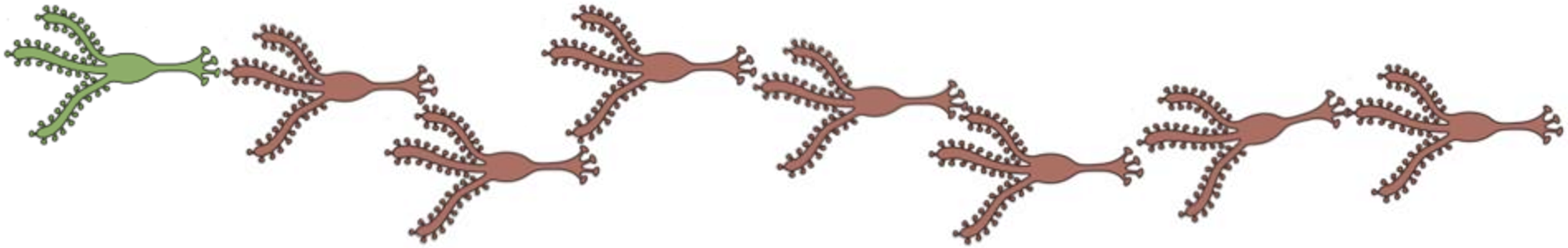

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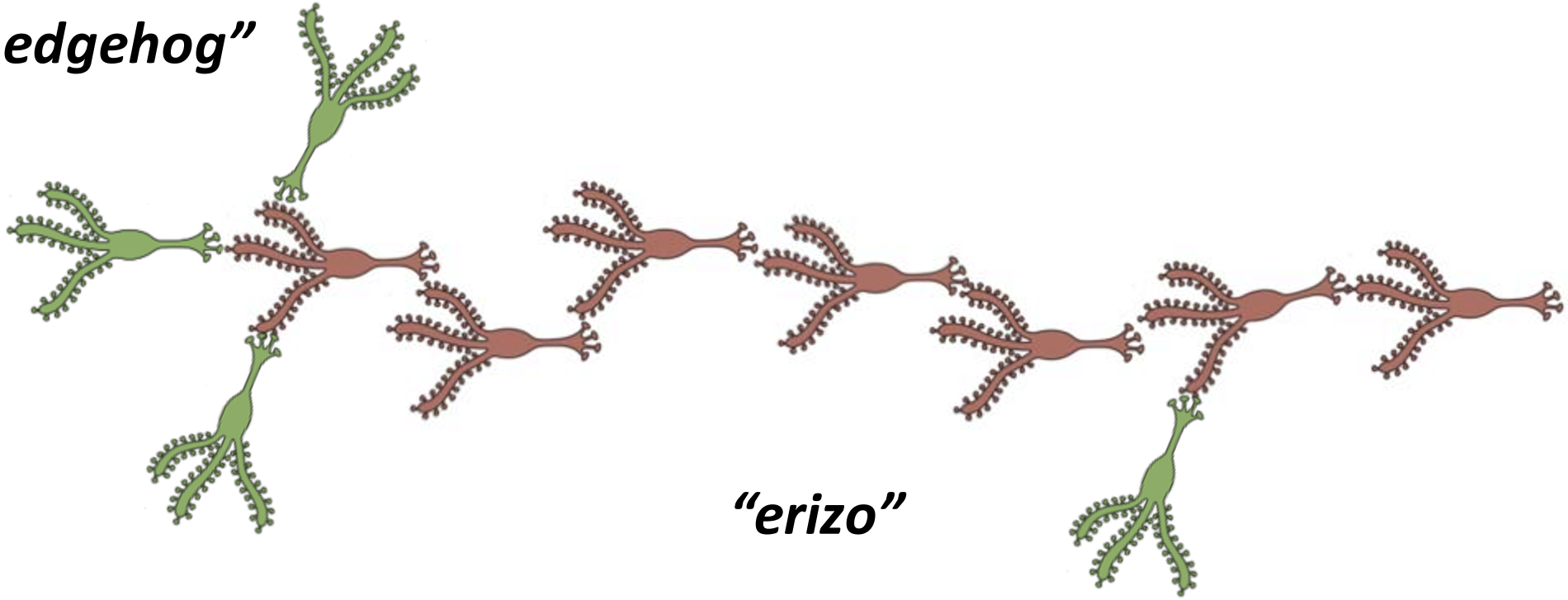

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Interleaving provides practice with different contexts and approaches!